



## WOW! on Wheels – STEM Labs

### Rolling Things

### Teaching Topics

The Rolling Things activity was originally purchased from and created by SAE International.  
<https://www.sae.org/learn/education/curriculum/rolling-things>

#### WHAT DO STUDENTS EXPLORE IN THIS CHALLENGE?

When students launch the cars from ramps, they will investigate the effects that different ramp heights and car weights have on distance traveled, measuring and recording data gathered through variable testing.

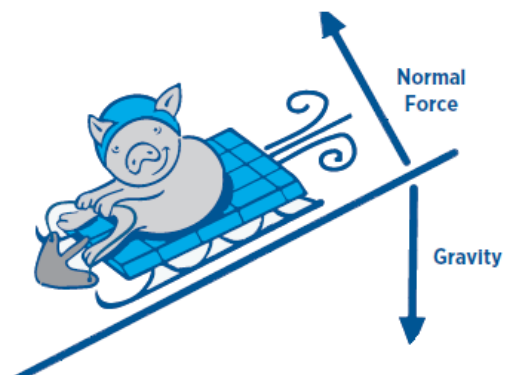
In this challenge, students are also experimenting with how ramp height and car weight affect momentum. Ramp height affects the velocity of the car when it strikes the crash box—the greater the height of the ramp, the greater the velocity of the car when it reaches the bottom of the ramp. Because momentum is the product of velocity and mass, it is greater when velocity is greater. The same holds true for mass—the greater the mass, the greater the velocity.

*The following topics can be addressed in this activity to the extent you wish:*

#### Why Do Things Roll (or Slide) Down Inclines?

##### Gravity

Sitting atop of a huge sledding hill, most people are getting ready for the thrill of the ride, not considering physics. But why do you careen down a hill on wheels or runners? The simple answer is gravity. Gravity and normal forces are the two basic forces acting upon you. Gravity pulls down on you toward the hill, while the normal force acts perpendicular to the hill. While these two forces cancel each other out



on a horizontal surface (gravity pulls down, while the normal force pushes up), on a hill the force of gravity pulls a sled or vehicle down.

### Potential and Kinetic Energy

In science, energy is the ability to do work. You use energy every time you do work. Energy has many forms and can change from one form to another. Potential energy is energy that an object has because of its position. A sled at the top of a hill has potential energy (stored energy) because it is not moving. Kinetic energy is the energy of motion. Anything in motion has a form of energy called kinetic energy. A sled moving down the hill has kinetic energy because it is in motion.

### Friction

Why doesn't something traveling down a hill just keep going faster and faster? One of the reasons is friction. Friction is a force between all moving objects that tends to resist motion and dissipate energy. Friction exists between moving parts, such as the pegs and the wheels, and the wheels and the chassis' of the cars. Friction also exists between the runners of a sled and the snow.

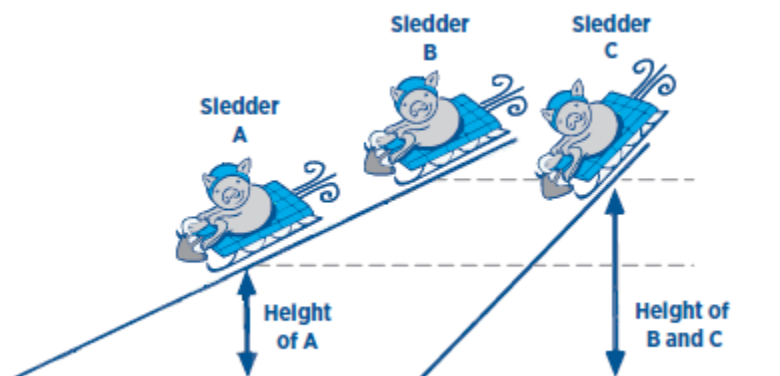
Friction acts in opposition to the direction you are traveling. This opposing force doesn't necessarily stop your vehicle (but it might if you sled onto a big patch of dirt), but it does slowly decrease your rate of acceleration.

### What Variables Affect Momentum?

#### Height of Object

The higher an object is, the more potential energy it has. As an object travels down a hill, its potential energy is converted to kinetic energy.

Therefore, an object that begins from a higher position on the hill will have more velocity (speed) when it reaches the bottom of a hill and therefore more





momentum. For example, in the following figure, Sledder A will be going slower than Sledder C when he reaches the bottom of the hill because he is sliding from a lower height. Because he is going slower, he will not have as much momentum.

It is important to note that when you slide down a frictionless surface, your speed doesn't depend on the path you take—it just depends on the slope of the hill. For example, it might be surprising to note that Sledders B and C in the figure will have the same momentum at the bottom of the hill because they are starting from the same height. However, despite the fact that the Sledder C gets to his final speed in a shorter time, their speeds will be the same when they reach the bottom of the hill.

### Mass of Object

Another factor that affects potential energy is mass. While mass does not exactly describe weight, the two terms are often used interchangeably. The scientific definition of mass is the amount of matter in an object, whereas the weight changes depending on gravitational pull (which is why something on Earth weighs more than something on the moon). The more massive an object, the more potential energy it has. Therefore, an object that has more mass will have greater velocity and momentum when it reaches the bottom of a hill.