SIEMENS STEM DAY | Science Technology Engineering Math

SIEMENS STEM DAY ACTIVITY

GRAND PRIX

REAL-WORLD SCIENCE TOPICS

- An exploration of projectile motion
- An exploration of forces and motion

ADDRESSES NGSS

LEVEL OF DIFFICULTY

2

GRADE RANGE

K–2

OVERVIEW

In this activity, students will use a ramp to launch a car and reach a finish line.

TOPIC

Projectile motion

OBJECTIVE

Students will gain an understanding of how the force on an object affects the distance it travels.

MATERIALS NEEDED

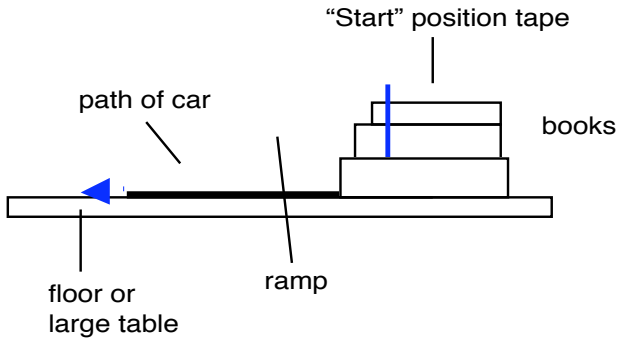
- large, heavy object, such as a desk or box of books
- wooden board or kinetics track (2–3 feet long)
- Hall's carriage or toy car
- several books or other adjustable-height objects (to support the ramp)
- stopwatch
- masking tape or duct tape
- large open area, such as a large table or tile floor

TEACHER NOTES

Use your discretion on the best way to conduct this activity based on the individual level of your class. For some of the younger K–1 classes, you may wish to perform some or all of the steps of the activity, encouraging children to make predictions and observations. If the group is older or more advanced in their abilities, students can take a more hands-on role in performing the related tasks. Leveled methodologies for K–1 and 2–3 grade levels are provided, where appropriate, throughout the activity. Use your knowledge of each class to determine what the best option for your particular group is.

TEACHER PREPARATION

You may wish to construct the ramp ahead of time. It is important that the carriage or car roll down the ramp in a straight line. If you are using a board for a ramp, you may wish to attach strips of cardboard to the board to form a chute for the car to roll in. This will ensure the car rolls straight down the board.



Place a piece of tape at the top of the ramp to mark the "Start" position.

You should caution students to be very careful and alert during the experiment. Students should not launch the car unless all members of the class are paying attention. Remind students to pick up the car immediately to avoid a tripping hazard.

NGSS THREE-DIMENSIONS

Science and Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts
Cause and Effect Simple tests can be designed to gather evidence to support or refute student ideas about causes.	**PS2.A: Forces and Motion** Pushes and pulls can have different strengths and directions. Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it.	**Planning and Carryout Out Investigations** With guidance, plan and conduct an investigation in collaboration with peers.

1. **Warm-up activity:** Introduce the concept of the relationship between the amount of force applied to an object and the object's final speed. Point out a large, heavy object in the classroom and ask one student to try to move the object by pushing or pulling on it. (Ideally, the object should be heavy enough that one student cannot move it.) Ask students for ideas of ways to move the object. Students should suggest having additional people help the student. Have more students push or pull on the object until it begins to move. Ask students to explain why having more people push on the object made it move.

2. Set up the board or kinetics track as a ramp on the floor as detailed under Teacher Preparation. Place the Hall's carriage or car so that its nose is parallel with the "Start" line taped on the board. Then release it. mark the place on the floor where the carriage stops with tape.

   Ask students what makes the car roll down the ramp. Have them write their answers under question 1 on the *Grand Prix!* Student Handout. Ask volunteers to share their ideas.

3. Have the students jump once. Ask them what pulled them back to the ground. Explain to the students that gravity pulls their bodies down to the ground so they do not float away. Point out that gravity also makes the car roll down the ramp. Explain that the carriage began rolling on the ramp because gravity was pulling it down the ramp. gravity pulls the car straight down, but the car cannot go straight down because the ramp is in the way.

4. Invite a volunteer to roll the car down the ramp. Be sure the student volunteer places the nose of the car parallel with the "Start" line so that each release originates at approximately the same place. mark the place on the floor where the carriage stops with tape. It should stop near the first mark. Ask students what they could do to change where the car stops. Students should suggest raising or lowering the ramp and possibly using a larger or smaller car.

5. Suggest that you try changing the height of the ramp to see what happens. Invite a volunteer to lower the ramp by removing one or two of the books.

   Ask students to predict what will happen when the car is released now that the ramp is lower. Ask them whether the change in height will make the car travel farther or not as far. Have them write their answers under question 2 on the Student Handout. Ask volunteers to share their ideas.

6. Invite a volunteer to roll the car down the ramp. Be sure the volunteer places the nose of the car parallel with the "Start" line on the board so that each release originates at approximately the same place. mark the place on the floor where the carriage stops with tape. It should stop closer to the ramp than the first two marks.

   Ask students to describe what happened. Ask students if the car traveled farther or not as far as it did when the ramp was higher. Ask them if their prediction was correct. Have them write their answers under question 3 on the Student Handout. Invite volunteers to share their answers.

7. Suggest that you try to make the ramp higher than it was when you started to see what happens. First, explain that you need to return the ramp to its original height by putting back the books that were taken out when the ramp was lowered (in Step 5). Add back the books that had been removed. Invite a volunteer to make the ramp higher by adding one or two additional books.

   Ask students to predict what will happen when the car is released now that the ramp is higher. Ask them whether the change in height will make the car travel farther or not as far. Have them write their answers under question 4 on the Student Handout. Ask volunteers to share their ideas.

8. Invite a volunteer to roll the car down the ramp. Be sure the volunteer places the nose of the car parallel with the "Start" line on the board so that each release originates at approximately the same place. mark the place on the floor where the carriage stops with tape. The car should roll more quickly down the ramp and travel farther away from the ramp than all of the prior launches.

   Ask students to describe what happened. Ask them if the car traveled farther or not as far when the ramp was lower. Ask them if the car appeared to move slower or faster. Ask students if their prediction was correct. Have them write their answers under question 5 on the Student Handout. Invite volunteers to share their answers.

9. Have students think about why the car traveled farther when the ramp was higher than it did when the ramp was lower. Explain to students that as the ramp gets higher the more the gravity on the car pulls it along the ramp. The more gravity pulls on the car, the faster it moves. The faster it moves, the farther it travels. The closer the ramp gets to being straight up and down (vertical), the faster and farther the car moves.
10. Once students understand the relationship between the height of the ramp, the speed of the car, and the distance the car travels, remove the prior pieces of tape from the floor. Place a new piece of tape on the floor and tell students that this is the "finish line" the car must reach. Dismantle the ramp and have two or three volunteers build what they think is a ramp of the proper height so that the car will come as close to the tape as possible. Have another volunteer mark where the car stops. If it did not cross the "finish line," ask students what changes they think should be made. Invite the volunteers to make the suggested adjustment and try again. Continue until the group gets the car across the "finish line."
11. **Wrap-up activity:** Ask children to recall what force is pulling the car down the ramp. As time allows, have other volunteers demonstrate and explain what happens to the car when the ramp is lowered. Have students discuss what other types of changes they could make to get the car to the "finish line" (such as, use a longer ramp or a heavier car).

    Have students think of examples of real-world activities that use ramps such as skate boarding and ski jumping.

GRAND PRIX! EXTENSION ACTIVITIES

1. Have students use a smaller or larger car and use the same ramp. Will the car cross the "finish line"?Have students manipulate the ramp to get the car across the line.
2. Have students experiment with releasing the car from different "Start" points on the ramp (keeping the ramp height constant). Ask them to determine how the distance along the ramp that the car travels is related to the travel distance of the car on the ground.

What makes objects move?

An object's motion can change only if a force acts on it. This is also known as Newton's first law of motion. Any time an object's motion is changing (that is, if it is speeding up, slowing down, or changing direction), a force must be acting on the object.

Newton's second law of motion states that larger forces produce larger changes in motion if an object's mass does not change. In other words, to get an object to move more quickly, you should apply more force to it.

Why does the car roll down the ramp?

A car resting on a perfectly flat surface will not move (assuming no other unbalanced forces are acting on it). Gravity pulls the car down toward Earth, but it cannot move downward because the surface it is sitting on keeps it from moving.

If you rest the car on a ramp, however, it begins to roll. This happens because now, as gravity pulls down on the car, the car can move downward. It cannot move straight down, because the ramp is in the way. Instead, it rolls down the ramp.

Why does the height of the ramp affect the final position of the car

If the ramp is steeper, then the force of gravity acting of the car is greater, and this causes the car to achieve a higher speed. The greater the horizontal speed, the farther the car will roll.

KEY VOCABULARY

force: A push or pull
gravity: A force between two objects that pulls them toward one another

Answer the following questions:

1. What makes the car roll down the ramp?
   [gravity]

2. What do you predict will happen when the car is released when the ramp is lower?
   [The car will not roll as far.]

3. What happened when the ramp was lowered? Was your prediction correct?
   [The car did not roll as far. I was right.]

4. What do you predict will happen when the car is released on the higher ramp?
   [The car will roll farther.]

5. What happened when the ramp was made higher? Was your prediction correct?
   [The car rolled farther. I was right.]

GRAND PRIX

Answer the following questions:

1. What makes the car roll down the ramp?

2. What do you predict will happen when the car is released when the ramp is lower?

3. What happened when the ramp was lowered? Was your prediction correct?

4. What do you predict will happen when the car is released on the higher ramp?

5. What happened when the ramp was made higher? Was your prediction correct?