GOALS
In this activity you will:
• Measure and recognize that the product of force and distance is identical for lifting the object to the same height irrespective of the angle of the ramp.
• Define work where $F$ is the force and $d$ is the displacement and where the dot signifies a special kind of multiplication.
• Explain the relationship between work and gravitational potential energy and spring potential energy.
• Define power as the rate of doing work and the units of power as watts.

What Do You Think?
The greatest drop for a roller coaster is 125 m (400 ft.). The roller coaster must be pulled up to that height to get the ride started.

• Does it take more energy to slide the roller coaster up a steep incline than a gentle incline?
• Why is it more difficult to walk up a steep incline than a gentle incline?

Record your ideas about these questions in your Active Physics log. Be prepared to discuss your response with your small group and the class.
For You To Do

1. From the starting hill, the roller coaster is able to complete its entire trip without any motors, pushes, tires, or chains. The roller coaster car heads down a hill and has enough speed at the bottom to make it up to the next hill.

   a) Why do you think that the roller coaster cannot scale a higher hill than the one from which it began?

2. The roller coaster at the top of the hill is ready to go. It goes up and down the hills and around the curves without any energy input. The roller coaster is a closed system. No energy is added to the system and no energy leaves the system. Nobody adds energy to the roller coaster with motors. No energy is assumed lost by the system to friction or air resistance. The roller coaster as a closed system (an idealized, conceptual roller coaster) will keep on going back and forth forever. The cart will go from point A to B to C to D to E to F to G. It will then reverse and go from G to F to E to D to C to B to A. It will then begin the trip again.

3. You will now investigate the force required to lift a roller coaster car to a certain height. You will use a cart and a track in your classroom. You can pull the cart to the top of the track with the use of a spring scale. The spring scale will indicate the force required to pull the cart. A meter stick can be used to record the distance that the cart moved along the track. You can then vary the length and angle of the track while keeping the height of the track constant.
\( a \) Create a data table in which you can record the force required to pull the cart up four different tracks. (Reminder: You must always pull the cart to the same height and parallel to the track.)

4. Complete your investigation.
\( a \) What conclusion can you reach about the distance along the track to attain a specific height and the force required to move the cart?

5. When one quantity increases and a second quantity decreases, this is referred to as an inverse relation. If \( x \) is one quantity and \( y \) is the other quantity, one inverse relation can be described mathematically by the equation \( xy = k \) where \( k \) is a constant. At left are some \( x \) and \( y \) values forming an inverse relation where \( xy = 12 \).

\( a \) Make a graph to show the relationship for the inverse relation \( xy = 12 \).

6. Create a graph for the data from your experiment.
\( a \) In the equation \( xy = 12 \), the product of the \( x \) and \( y \) values always equals 12. Does the product of the force and distance in your experiment always equal a certain value? Make the calculations and record the results on the side of your chart.