

# CURIOSITY AT HOME

## ROLLER COASTER PHYSICS



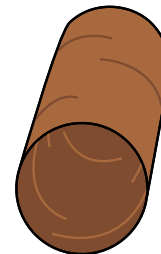
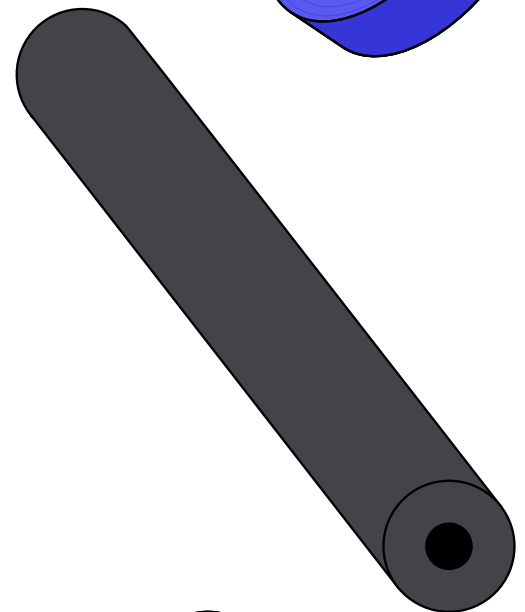
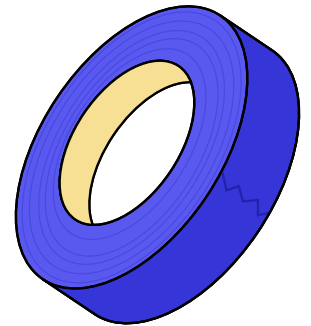
*Roller coaster engineers use a lot of physics to make sure their rides are both thrilling and safe. To build your own scale model of a roller coaster, you'll have to consider forces like gravity, movement energy, and friction. How exciting can you make your marble roller coaster?*

### MATERIALS

- Marble (substitute a small ball)
- Painter's tape (do not use tape that will leave residue on walls or furniture)
- Pipe insulation (substitute cardstock, toilet paper tubes, or various recycled materials)
- Scissors and an adult to use them
- A wall or piece of furniture to build on
- Science notebook or paper
- Something to write with

### PROCEDURE

- In your science notebook, brainstorm a design for your marble roller coaster. The highest point of your coaster will need to be at the very beginning, and the overall height of the coaster should decrease after that until you reach the floor. Make sure to include hills and turns for maximum fun.
- Next, create your track pieces.
  - If you're using pipe insulation or toilet paper rolls, have an adult cut it in half the long way, so that it makes a "u" shape.
  - If using cardstock, get help cutting it in half the long way. Fold the pieces of paper into a squared off "u" shape that looks like the bottom half of a rectangle.
- Tape a first piece of building material to the wall or a piece of furniture at the highest point of your coaster. Use as much tape as you need to secure it. Be sure to test how steep you can make your track to get your marble moving without getting stuck or falling off.



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- Follow your design plan to add more features to your roller coaster.
  - To build a hill, you'll need to make sure that the structure isn't too large for the marble to build up enough speed to get past it.
  - Any corners will need to be wide enough for the marble to easily fit through.
  - To make turns in paper or toilet paper rolls, cut small notches into the paper and tape it back together slightly overlapping, so the resulting track piece is at an angle. This can take some practice to get right.
- As you continue to add features, be sure to complete test runs to make sure the marble is able to follow the full track and make it to the bottom.
- If at any point the marble gets stuck, test out different solutions to free it. Change one thing at a time until your coaster works again. It's okay if you have to go back and change your original design to get the roller coaster working.
- Once the coaster is finished and works consistently, show it off to a friend or family member.

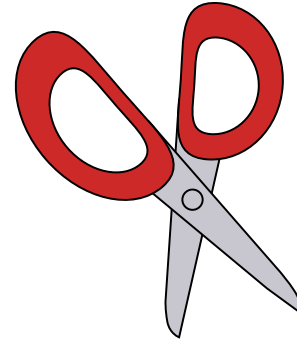
### EXPLORE MORE

- Can you include a loop in your coaster? To build a loop you'll need to build up enough speed that your marble has enough energy to momentarily overcome the force of gravity. Where would be a good place to add a loop to your design?
- Try making a horseshoe turn. Horseshoe turns are a roller coaster element where the track goes back in the same direction it came from, with the middle part of the turn raised higher than the rest of the turn.

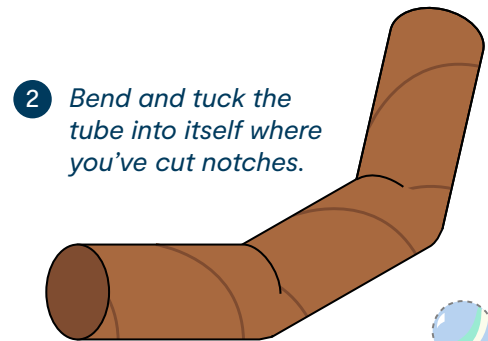
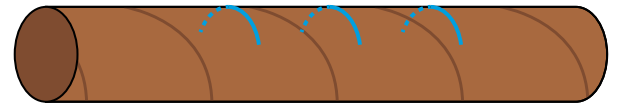
### WHAT'S HAPPENING?

When you held your marble at the top of the track, right before letting go, you had an example of **potential** energy. The force of gravity was pulling the marble towards the ground. When you released the marble, the potential energy was transferred into **kinetic** energy, or energy in motion, as gravity caused the marble to fall down the track. Eventually, the marble was going fast enough that it had enough momentum to perform gravity-defying stunts like loops and rolls.

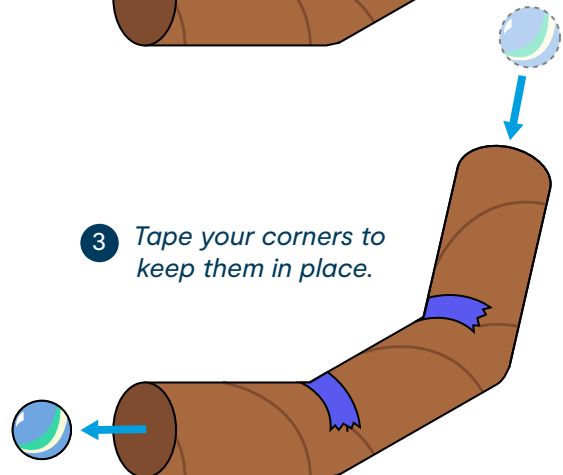
#### Making Turns with Paper Tubes



- 1 Cut small notches partway into the paper tube.



- 2 Bend and tuck the tube into itself where you've cut notches.



- 3 Tape your corners to keep them in place.



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### K-2 GRADE EXPLORATION

- When the marble collides with the roller coaster track, what happens to the marble's movement?
- When you were holding the marble, right before letting it go, what was pushing or pulling on it to keep it in place?
- In your science notebook, draw a diagram showing the pushing and pulling of different forces on your marble. Include gravity, friction, the marble, and the roller coaster.



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### 3–5 GRADE EXPLORATION

Explore the following questions and write your observations in your science notebook.

- In your science notebook, draw a diagram showing the pushing and pulling of different forces on your marble. Include gravity, friction, the marble, and the roller coaster. Draw arrows showing the direction of the forces. Draw larger arrows for stronger forces and smaller arrows for weaker forces.
- Which of the forces you labelled require objects to be in contact with each other? Which ones do not require objects to be in contact?
- When you were holding the marble, right before letting it go, what forces pushing or pulling on it kept it in place? How did those forces change when you let go?
- Imagine you took your marble roller coaster to the Moon. Would the marble roll faster, slower, or the same speed? Why is this?



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### 6–8 GRADE EXPLORATION

Explore the following questions and write your observations in your science notebook.

- In your science notebook, draw a diagram showing the pushing and pulling of different forces on your marble. Draw arrows showing the direction of the forces. Draw larger arrows for stronger forces and smaller arrows for weaker forces. Make sure to consider how forces act in opposition to each other.
- Which of the forces you labelled require objects to be in contact with each other? Which forces act at a distance?
- Imagine you took your marble roller coaster to the moon. Would the marble roll faster, slower, or the same speed? Why is this? What does that say about the effect of the mass of the Moon on its gravitational pull?



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