2021

Go ENG Girl

University of Guelph

Paper Rollercoaster Activity

Have you ever been on a roller coaster? Have you ever wanted to design your own? In this project you'll make one out of paper and tape and learn about roller coaster physics along the way!

Here are the materials you will need:
* = To be supplied by the participant

- 3 x track segment template sheets
  - Hill/loop track segments
  - Curve track segments
  - Supports
- 1 x blank cardstock (roller coaster base)
- Marbles of various sizes
- Scissors*
- Tape*

If you have not received your supplies in the mail, you can still participate! You can print the template on the thickest paper you can (cardstock, construction paper) OR you can get thick paper and a ruler and use the "non-printer template" to guide the creation of the track pieces.

Participants are encouraged to decorate their track segments and roller coaster base prior to the event if they wish! If the envelope was not received in time or the participant wishes to leave the pieces blank, this is a great choice too as decoration is completely optional.

Steps:

1. **To build a support strut (with template):**
   a. Cut along the solid lines of the piece of paper labelled "support".
   b. Fold along the dashed lines to form a square shape (so two of the segments overlap) and use the tape to hold in place.
   c. Fold the tabs you cut at the end outward. This will allow you to tape the tabs flat to a piece of cardstock, so your strut can stand upright.

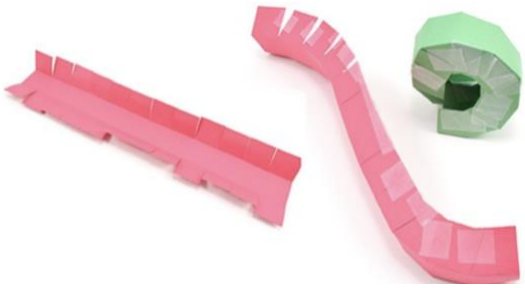
OR

If you do not have the printed template you can use tape to fix the end of your rollercoaster to a wall. You can then use books underneath for support. You can also use this option to save time even if you have the printed templates!

2. **To build a hill or loop:**
    a. Cut along the solid lines of the piece of paper labelled “hill/loop”.
    b. Fold along the dashed lines.
    c. Tape the tabs together to hold the hill/loop in place.

OR

If you do not have the printed template, measure a 7.5 cm x 27.5 cm rectangle. Divide the 7.5 cm length into three equal sections and cut 2.5 cm x 2.5 cm square tabs from the outer segments according to the “Non-printed template” section labeled “loop/hill”. Then fold the tabs upward as shown below.

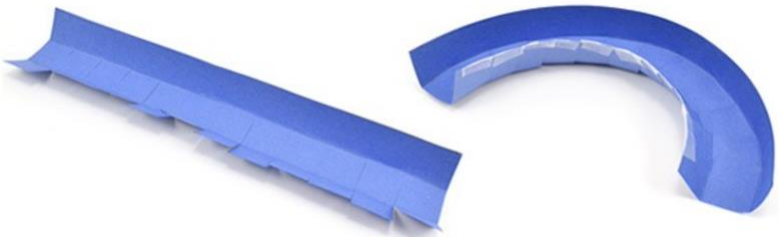


Notice that the loop ends are side-by-side. You may need to curve the loop to make it work. The loop will be the biggest challenge.

3. **To build a curve:**
    a. Cut along the solid lines of the piece of paper labelled “curve”.
    b. Fold up the uncut side of the paper 90 degrees to form a wall.
    c. Fold up the tabs along the other side to form the other wall.
    d. Tape the tabs together to hold the curve in place.

OR

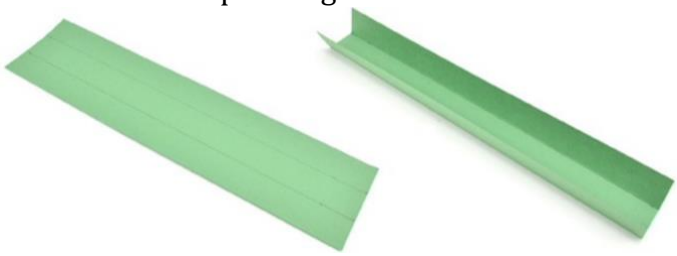
If you do not have the printed template, measure a 7.5 cm x 27.5 cm rectangle. Divide the 7.5 cm length into three equal sections and cut 5 cm x 2.5 cm rectangular tabs from 2 outer segments according to the “Non-printed template” section labeled “curve”. Then fold the tabs in half and upward as shown below. The inner half of the tab will act as the marble track, and the outer half of the tab will act as a wall along with the third section of the segment. Overlapping and taping the outer half of the tab will create a curved wall.



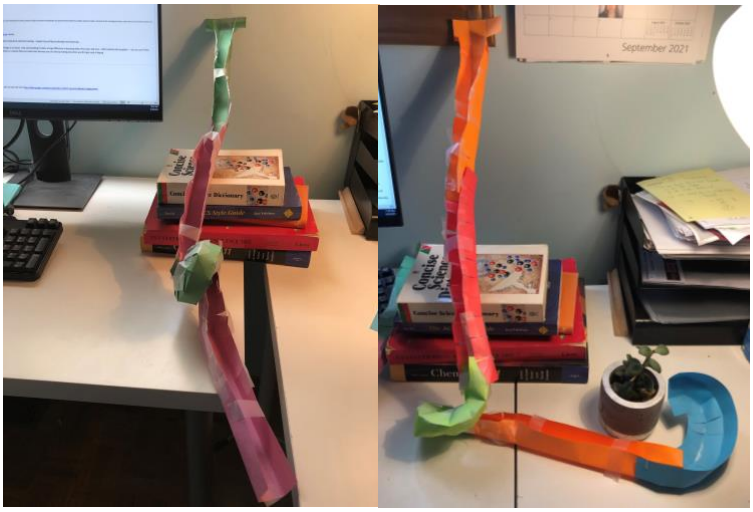
4. **To build a straight segment (this will require extra cardstock):**
    a. Cut a 7.5 cm (3 inch) wide strip of paper.
    b. Draw two parallel lines that divide it into three 2.5 cm-wide strips.
    c. Fold the two sides up 90 degrees along those lines to form walls.

    OR

    a. Cut along the solid **outer** lines of the piece of paper labelled "hill/loop" (do not cut along the inner solid lines which form the tabs).
    b. Fold the dashed lines up 90 degrees on both sides.



5. Assemble track pieces as desired by bending them into the desired shape then taping the walls to maintain the shape. Tape a support piece to the top of the first hill track segment and to the base, or tape the first hill track to a wall. Additional support pieces can be shortened with scissors and used to create stability in the rest of the coaster. It is recommended that you make one track segment at a time and add to test if it fits your track. Do not make multiple ramps and then try to fit together at the end.

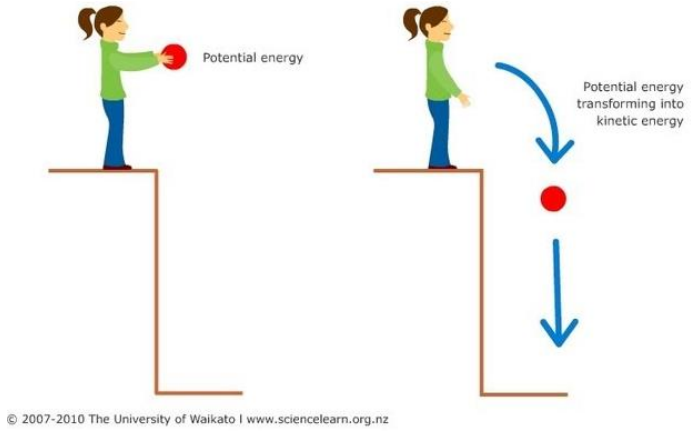


Sample of actual rollercoasters made by our team

While building your rollercoaster you may have noticed a couple of things:

What propels the marbles forward in this rollercoaster?
The paper rollercoaster relies on gravitational potential energy, which is gained when you placed the marble at the top of the hill. Energy is "stored" because of an object's elevation, or height off the ground. When the marble starts going down the hill, the potential energy is converted to kinetic energy, or the energy of motion. When the marble goes back up another hill, it will lose kinetic energy (it will slow down) and gain some potential energy again.

This is like when you hold a ball a distance above the ground, the ball has gravitational potential energy. Once the ball is dropped, that energy transforms to kinetic energy.



What causes the marble to slow down?
Some of the energy is also converted to heat due to air resistance and friction with the track, gradually causing the coaster to slow down. As a result, there is less gravitational potential energy and kinetic energy. This process continues as the coaster goes through loops, hills, and turns.

What is gravitational potential energy?
Gravitational energy is the potential energy held by an object because of its high position compared to a lower position. In other words, it is energy associated with gravity or gravitational force. For example, a pen being held above a table has a higher gravitational potential than a pen sitting on the table.

Gravity is the force of attraction that pulls objects together and causes things to fall to Earth. Even though most things fall to Earth at the same speed, it takes more energy to lift a bigger mass, so a

larger object actually has more energy. That means even though a train and a motorcycle were the same distance up, the train has a lot more gravitational potential energy. What goes up must come down!

What is kinetic energy?

While gravitational potential energy is due to an object's position or state, kinetic energy is due to an object's motion, like a car in motion or a football when kicked. Unlike when calculating an object's gravitational potential energy, when calculating object's kinetic energy, its velocity is an important factor. Can you think of other examples of kinetic energy?

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WiSE Word Search

A	C	C	E	L	E	R	A	T	I	O	N	O	K
E	N	G	I	N	E	E	R	I	N	G	T	G	N
S	E	C	R	A	C	Y	C	I	S	H	E	Y	A
T	G	A	G	E	C	L	L	N	A	U	E	L	A
E	R	B	O	U	G	E	B	Y	E	M	T	L	E
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M	O	N	E	E	T	R	A	C	K	C	L	G	C
O	L	C	E	N	M	E	I	M	A	R	B	L	E

SCIENCE
HILL
GUELPH
TRACK
ACCELERATION
MARBLE
LOOP
ROLLERCOASTER
ENGINEERING
GRAVITY
ENERGY
STEM

References

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https://www.sciencebuddies.org/stem-activities/paper-roller-coaster#exploremore