Fab Lab Fort Smith
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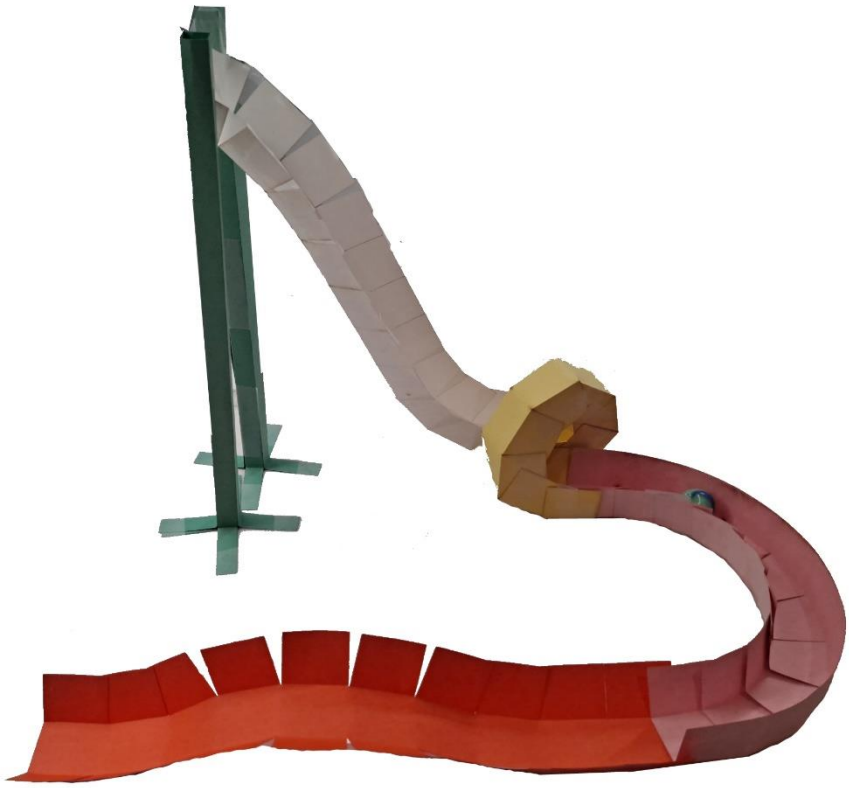
Fort Smith, Arkansas 72916

Marble Roller Coaster

Introduction

Have you ever ridden a roller coaster and when you got off wanted to design your own? In this project you will construct a roller coaster using paper, some tape, and a marble. By the end of it you will have learned some of the basic physics about how they work. This project was originally from https://www.sciencebuddies.org/stem-activities/paper-roller-coaster#instructions

A Brief Overview



Roller coasters are all about physics and energy.

They rely on gravitational potential energy which is gained by initially going up a large hill.

- **Potential energy** is "stored energy" and the higher the object's initial elevation the more it will have.
- **Kinetic energy** (energy of the motion) is converted from the potential energy when the roller coaster goes down the initial hill.
- During the roller coaster, some of the energy is lost; some is converted into heat due to friction between the wheels and the track, air resistance and movements in the track. These loses add up and will quickly cause your coaster to slow down and to eventually stop.
- The total amount of energy in the system must be stay the same from the start of the ride to when it stops; this is known as the Law of **conservation of energy**.
    - The initial amount of potential energy = kinetic energy + energy losses

Roller coaster designers have to make sure the coaster has enough initial potential energy to make it through the rest of the track. Because of these limitations, the coaster cannot go through a loop or over other hills that are taller than the starting hill. Having enough initial potential energy at the start of your roller coaster is the key for your marble to make it through your entire track.

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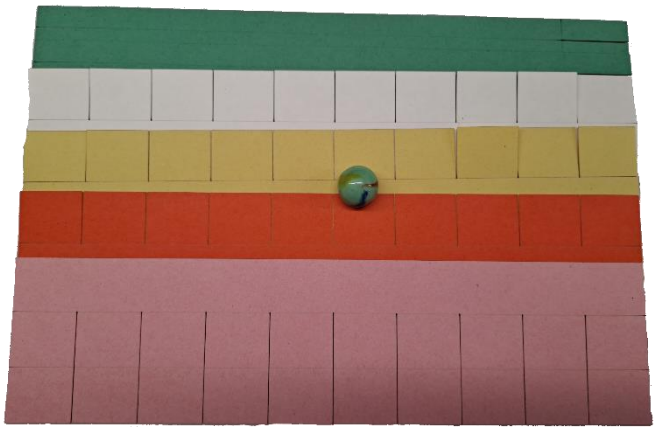
Materials

- A Roller Coaster kit contains the following:
  - 2 Support Stands - Green
  - 1 Main Hill - White
  - 1 Loop (optional) - Yellow
  - 1 Curve - Pink
  - 1 Small Hill - Red
  - 1 Marble
- You will need some tape



Roller Coaster Pieces

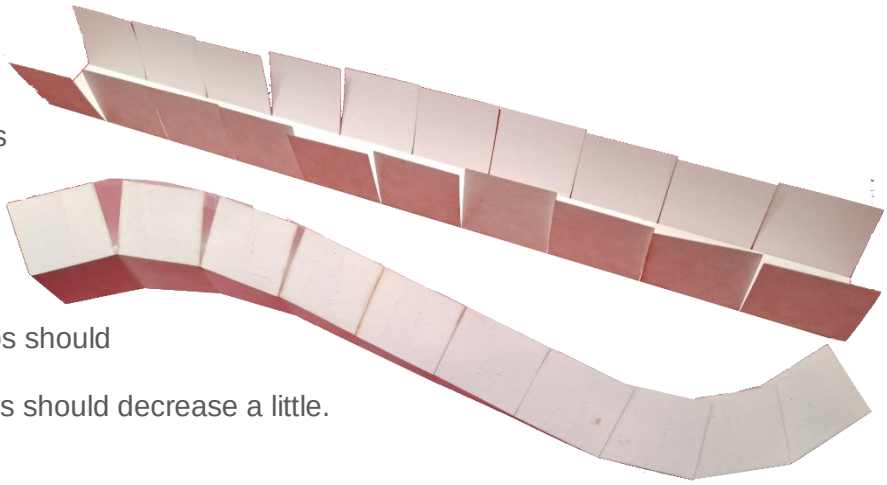
Before you try building an entire roller coaster, tape the individual track segments. All of the pieces have been cut so the only thing you need to do is:

- Design each individual roller coaster section
- Assembly the sections together
- Experiment
- Have fun!

Support Stands

- Fold the green piece along the four lines until it is a square.
- Tape the sides and bend the four legs outward.
- Do this for both green pieces.

Main Hill



- Using the white piece, fold the ten tabs on one side upward along the long line.
- Do this again for the other side.
- Use small pieces of tape to bend this piece into an elongated S shape.
- The spaces between the first three tabs should increase a little.
- The spaces between the last three tabs should decrease a little.
- The middle tabs should be straight.

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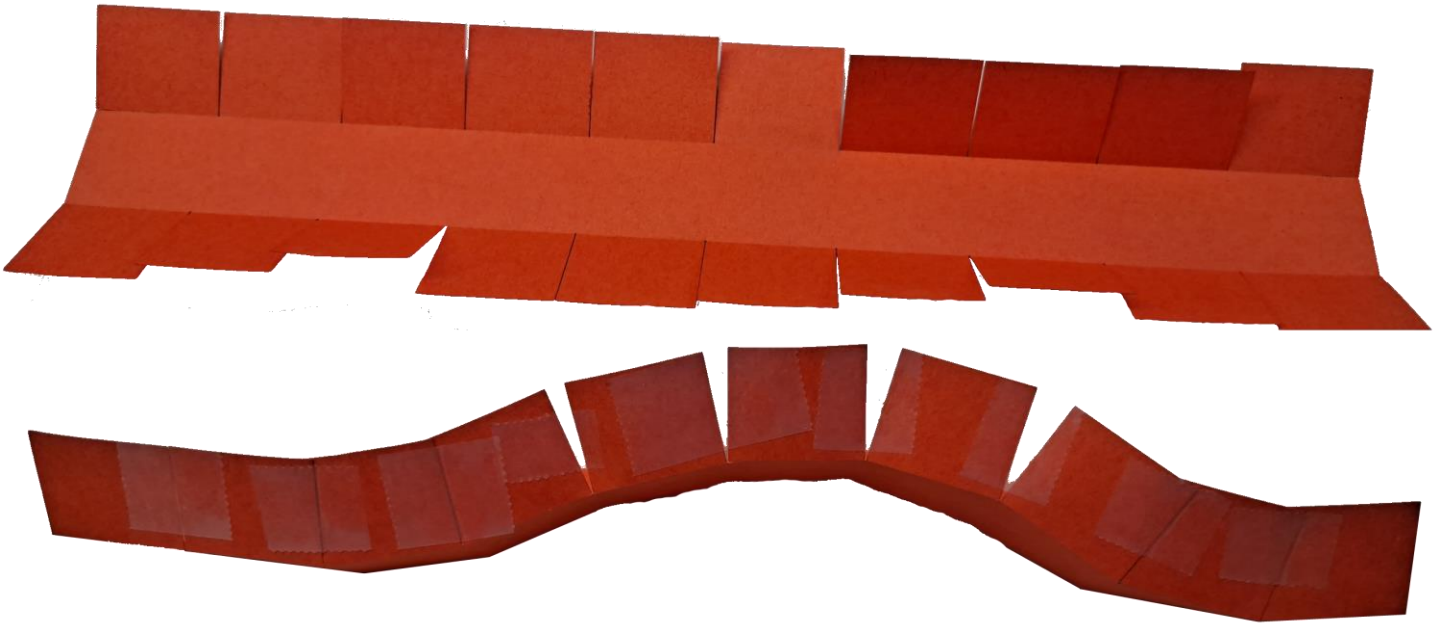
Curve

- Fold the tabs on the pink piece to form the curve.
- Overlap each piece by about ¼". Tape the tabs together to hold the curve in place.
- It should be a half circle when complete.

Small Hill

- Fold the two sides up 90 degrees along those lines to form walls.
- Starting at the middle, make a small hill in the center.
- Make the hill small enough so the ends of the track will be parallel to the table.



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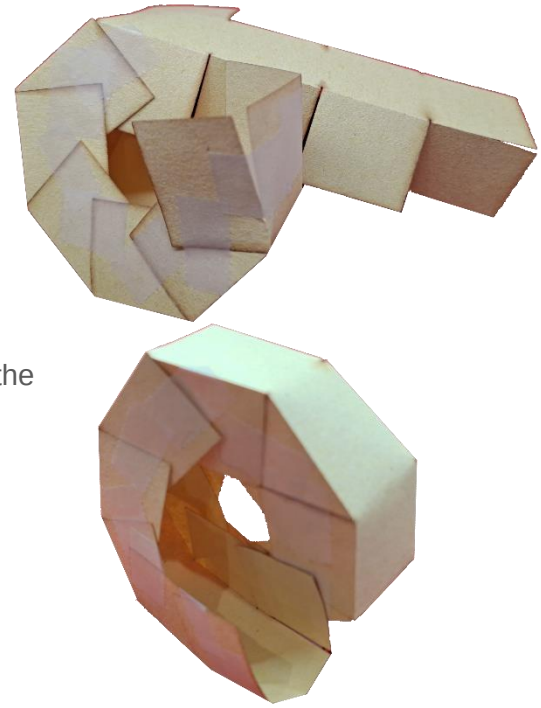
Loop (Optional)



This part is the hardest piece. If you get frustrated, of if you have younger children you can skip this piece.

Tips

- Make the loop as small as possible.
- Fold the pieces so they lap over the next.
- Use small pieces of tape so adjustment are easier to make.
- It is easier to tape and fold one side and then tape the other side afterwards.
- Using the yellow piece, fold the ten tabs on one side upward along the long line.
- Do this again for the other side.
- Start at the middle.

Assembling your Roller Coaster

- Tape the Support Stands the table or to a piece of cardboard.
- Connect the Main Hill to the Support Stands
- Tape the remaining track segments together.

Experimenting with your Roller Coaster

- Place the marble at the top of your track and let it go.
- Most likely the first couple of times your marble will not make it to the end.
    - Is there a spot in your track where the marble got stuck? Was the marble going too slow to make it through a loop?
    - If necessary, make changes to your design, like making the curves more gradual or the starting hill taller, and try again.
    - If you made your starting hill tall enough, and all the curves and loops of your roller coaster were gradual, your marble should have been able to get all the way to the end. However, if your coaster had any sharp turns or corners, your marble might have gotten stuck.
- Try to figure out why and make a single change and try it again.
- If the marble made it the whole way to the end, try making your track longer by adding more pieces.
- How long can you make your track before the marble comes to a stop?

Fab Lab Fort Smith is a 501(C)(3) community center, but instead of having sports teams and athletic equipment, we have power tools and technology stations. Our goal is to teach people (kids, retirees, designers, inventors, tinkerers, and other creative people) how to use new technologies that they normally would not have access to in a fun, exciting, and supportive environment. We offer a wide variety of digital rapid prototyping fabrication machines and manufacturing equipment allowing members to create their designs and projects with cutting-edge technologies that are not normally available to them.