



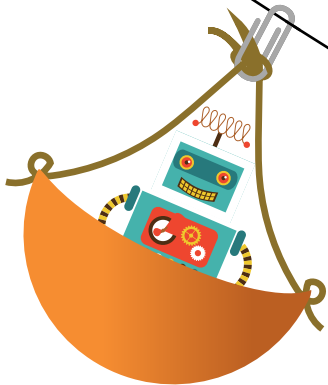
Who says all the fun has to happen at The Tech Interactive? This DIY engineering activity can be done with inexpensive store-bought supplies and things you find around the house!

Introduction

Ziplines are a method of transportation consisting of a sturdy cable set between two points on a downward slope. You may have heard of ziplines as a thrilling ride, but they are also used to transport precious cargo from the top of high slopes to the ground using only the force of gravity. This engineering activity explores how factors such as weight distribution, balance and friction affect a zipline vehicle's performance.

Design Challenge

Create a vehicle that can transport a load, such as a passenger or cargo, from the top of a zipline to the bottom using only gravity.



Subject:

Engineering design
challenge

Ages:

6+

Time:

30+ minutes

Key Concepts:

Gravity, Balance, Weight
Distribution, Friction

Materials

Check out the suggested materials to get started but don't limit yourself to what is here. Look around your home and think about what items could fit in the categories below. Keep in mind that vehicles may fall from up high during testing, so make sure to use things that are durable or disposable.

Things you can use

Structural pieces for your vehicle		Items to hold the passenger or cargo	
<ul style="list-style-type: none"> • Straws • Ribbon spools • Chopsticks • Silverware • Bottle caps • Hangers • Cardboard tubes 		<ul style="list-style-type: none"> • Plastic cups and bowls • Empty food containers • Cardboard • Fabric • Coffee filters 	
Fasteners		Zipline supplies	
<ul style="list-style-type: none"> • Pipe cleaners (chenille stems) • Rubber bands • Clothespins • Plastic clips • Twist ties • Hair clips and accessories • Plastic laundry hooks • Paper clips • Binder clips 		<p>Use a smooth, sturdy material for your zipline.</p> <ul style="list-style-type: none"> • String (ex: clothesline, fishing line, kitchen twine) • Stick or rigid item (ex: broom handle, curtain rod, dowel rod) • Your passenger/cargo (small toy or other item)  	
Tools (Optional)			
<ul style="list-style-type: none"> • Scissors • Hole puncher • Masking tape 			



Tips for Zipline Materials

It's important to choose the right kind of material for your zipline. It should be:

- **As smooth as possible:** Materials like bumpy wood, yarn or braided rope will increase the friction between your vehicle and the line, making it difficult to test.
- **Non-elastic:** If your material is too elastic, it may stretch or bow under the weight of your vehicle.
- **Easy to knot (if string):** When using string, you don't want your line to be too bulky or slippery. Try one of these useful knots: Bowline Knot or the Tautline Hitch.

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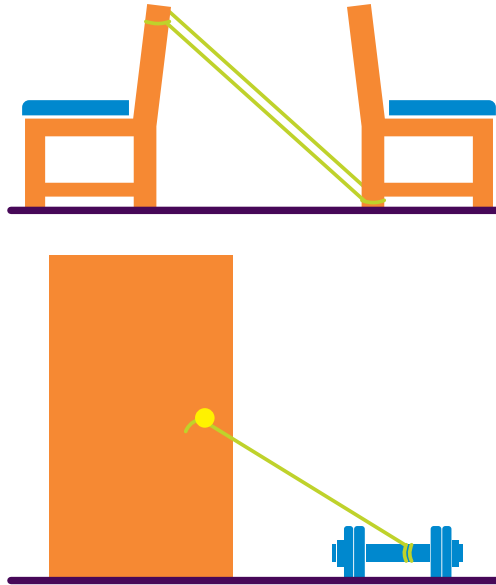


Instructions

Set up the zipline

To set up your zipline, all you need is a sturdy string or nylon cord and something to tie it to. If you don't have a string or cord, you can even try using something long and rigid like a curtain rod or broom handle. Check out our tips on what materials work best for creating your zipline on the previous page.

Consider setting up two parallel lines for even more design possibilities. Create the setup that works best for you!



Check to make sure that your line is safe and stable for you and your furniture. It's important for your testing zone to be large and open, and for lines to be marked clearly to ensure there is no risk of anyone tripping or running into the zipline. Zipline vehicles can travel fast, so be sure to protect your landing zone with something soft like a pillow or blanket to prevent your vehicle from breaking.



Define the Problem

As you look at your building materials, consider your load. Thinking about the characteristics of what you are transporting will help guide you in creating your design.

- Are you transporting a passenger or cargo? What are the different needs of passengers vs. cargo and how can you address that in your vehicle?
- What will you use to represent your load? Perhaps a light plastic figure, heavy toy or some other object? Is it tiny or large?
- Both passengers and cargo need to be protected as they travel down the zipline. What kinds of safety features might you need to include in your vehicle?

Story or scenario: Adding an interesting narrative twist, like imagining you are developing an amusement park ride or trying to deliver a piano to an upper floor apartment, can also help you focus your goal and think about who you are designing for. Addressing a more specific scenario will add fun while also building empathy.

- **The tortoise and the hare challenge:** See if you can design vehicles that travel down the zipline at different speeds. Try challenging yourself to create both the slowest vehicle and the fastest vehicle possible, but make sure the passenger or cargo stays safe!
- **Engineer an amusement park ride:** Design a thrilling (or relaxing) amusement park ride prototype with your zipline. Create a vehicle that can safely hold 4+ passengers. Observe the ride during testing and consider whether the passengers would have enjoyed it.

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Create

When you are ready, start assembling your zipline vehicle. Think about different ways you can attach the vehicle to the zipline, and consider ways it could move smoothly.

- Will your vehicle be attached at one point or multiple points on the zipline?
- Is your vehicle balanced on top of the line or hanging underneath?

Balance, weight and friction can affect your vehicle differently depending upon how the testing area was set up, so don't be afraid to try out lots of different designs.

Using easily removable fasteners like the ones listed in the Materials section, rather than tape or glue, will help you make quick adjustments.



Test & Reflect

Once you have engineered your vehicle, it is time to test it out. Place the load inside the vehicle, place it on or attach it to the zipline, and observe what happens.

- Was the ride bumpy or smooth? Did your vehicle lean or tilt to the side?
- Did the vehicle reach its destination, or did it get stuck or fall off the line?
- How does the weight distribution affect the ride?

Use what you observed to make changes to your design, then keep testing, observing and reiterating.

Explore More

- **Add a drop-off system:** For an extra challenge, design a way to release the load, like a trap door. Add a landing zone area at the end of the zipline and see if you can drop the item into it. Don't forget to provide a soft surface in the landing zone.
- **Wind-powered zipline challenge:** Try setting up a horizontal zipline with a standing fan next to the line at the startpoint. Try different fan speeds and see if the wind can move your vehicle to end.
- **Data tracking challenge:** Use the [Google Science Journal app](#) to track the acceleration of your vehicle. The Science Journal app lets you use your phone's sensors to create experiments and record data on the world around you. Mount your phone safely on your vehicle and see how fast it goes!



Top Tips

- If your vehicle is having trouble moving or gets stuck, there may be too much friction between the attachment piece and the zipline. Test different attachment methods on the zipline to see which ones move smoothly.
- Weight can both help and hinder the vehicle during testing. Think about how you distribute the weight on the vehicle. Where might extra weight help your vehicle move forward, or slow it down?
- Consider adjustments to your zipline during testing, such as making it tighter. Attaching one end of the zipline to something moveable, like a door or a weight, can allow you to make changes to the line's tension.

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