Western Engineering Outreach

Round and Round – Ferris Wheel Design

Grade 3-5

Meet Today's ENG HERO!

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Jeff is an associate professor in Mechanical & Materials Engineering. He is currently the Associate Dean, Undergraduate Studies for the Faculty of Engineering. He completed his Bachelor and Master's degrees at the University of Waterloo and his PhD at McMaster University. His research primarily focuses on lightweight structural materials.
To learn more about Dr. Wood visit:
https://www.eng.uwo.ca/mechanical/faculty/wood_j/index.html

Learning Goal:

- Students will explore mechanical engineering when they create their own Ferris wheel and chair
- Curriculum connections: Grade 3 - Strong and Stable Structures; Grade 4 - Pulleys and Gears; Gr. 5 - Forces Acting on Structures and Mechanisms

Materials Needed:

- Approx. 40 popsicle sticks
- 1 Skewer
- Hot glue, wood glue or tape
- String
- Scissors

Engineering and Science Connections:

Today, we will be mechanical engineers as we design our own Ferris wheel and chairs!

How does a Ferris wheel work?

You may have heard of Sir Isaac Newton and his Laws of Motion. The second Law of Motion has to do with the behaviour of objects when existing forces are not balanced. In a Ferris wheel, forces are not balanced. Objects that have circular motion have something called "centripetal force". Centripetal is a word meaning "centre seeking." The centripetal force always points to the centre of the circle. Ferris wheel physics is directly related to centripetal acceleration. Acceleration is a measure of how fast velocity (speed and direction) changes over a certain amount of time. This acceleration results in riders feeling "heavier" or "lighter" depending on their position on the Ferris wheel.

The centripetal acceleration is given by this equation:

$$a_P = w^2 R$$

w is the angular speed of the Ferris wheel, and R is the radius of the wheel.

The centripetal acceleration always points towards the center of the circle. So at the bottom of the circle, the centripetal acceleration is pointing up, so riders feel heavier than their true weight. At the top of the circle, it is pointing down, so riders feel lighter than their true weight. The motion of a Ferris wheel affects your body's weight, which varies depending on where you are on the ride. The riders only feel their "true weight", when the centripetal acceleration is pointing horizontally and has no vector component parallel with gravity. This results when the riders are exactly halfway between the top and the bottom (they are the same height as the centre of the Ferris wheel).

What is the force of friction?

Friction is the resistance of motion when one object rubs against another. Anytime two objects rub against each other, they cause friction. The force of friction works against the motion and acts in the opposite direction. Relating the force of friction to the Ferris wheel, friction occurs when the axial of the Ferris wheel rubs on the base that holds the Ferris wheel up from the ground. This results in the Ferris wheel to go slower.

Video Recommendation: ***Centripetal Force***

https://www.youtube.com/watch?v=KvCezk9DJfk

Activity:

Before beginning, think about the following questions:

- What are the different parts of a Ferris wheel?
- How many sides does a hexagon have?
- What is the strongest shape?

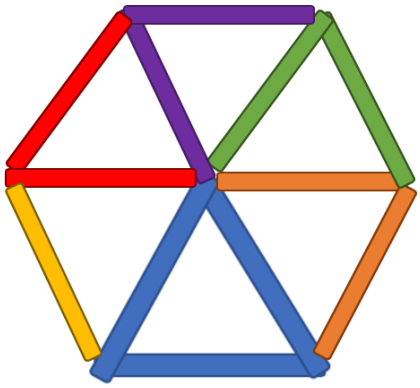
Choose a Theme!

Your engineering team has been hired by planners of the 2025 World Expo taking place in Osaka, Japan! Your job is to design a fantastic Ferris wheel for all the world to enjoy, as the Expo estimates 28 million visitors. Choose a theme and decorate your materials to match! The theme of the expo is "Designing Future Society for Our Lives" but you can be as creative as you want!

Part 1: Building the Ferris Wheel

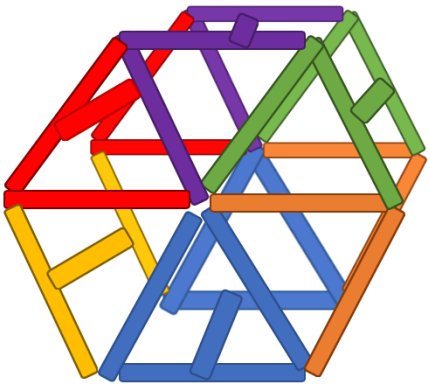
1. Begin by making a triangle out of three popsicle sticks on a flat surface. Glue them together.

2. Lay out popsicle sticks to complete the 6-sided hexagon. After arranged properly, glue together. It might take some rearrange to get a good hexagon. Try to leave a little bit of space right in the centre for the skewer to go through later.

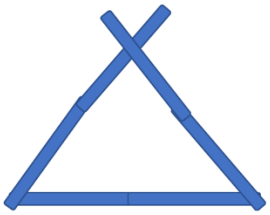


3. Make a second hexagon. These will be the two sides of the Ferris wheel. Allow the hexagons to fully dry.

4. Next we will attach the hexagons together. Cut three popsicle sticks in half. Glue the halves onto the midpoint of each triangle on one hexagon, so that they stick up. Glue the other hexagon onto the popsicles sticking up. Try to line up the centres as much as possible It will look something like this:



5. Create the base of the Ferris wheel by making a big triangle using two popsicle sticks attached for each side. Make sure to overlap at the top so that it creates a spot for the axel to sit (skewer). It should look like this:



Then make a second triangle for the other side of the base.

6. Attach the two triangles together by gluing three full length triangle to the bottom of one half then glue the full length popsicles to the bottom of the other triangle. Let the base dry fully.

7. To create the axel, use a wooden skewer. It should go through the centre of each hexagon then sit in the crosses of both base triangles. Turn the skewer to turn your Ferris wheel! If the skewer seems too long, trim it to your preferred length.

Part 2: Chair Design Challenge

Get creative! Design chairs that will be attached to your Ferris wheel. Create six chairs and use string to tie the chair to the Ferris wheel. You can use any material for your chair.

What Did You Learn?

- There is another force that is always working on a Ferris wheel (and everything else!). Do you know what it is? (It's gravity!)
- Who developed the Laws of Motion?
- What is the force called when you have circular motion?
- Why did we use triangles to make our Ferris wheel? Triangles are a very strong shape, so they give our structure stability!

Future Learning

- If you are interested in the physics behind the Ferris wheel and would like to learn more about the equations of force watch this video: https://www.youtube.com/watch?v=x49ANkGRvPY
- Create another machine that moves that you have seen in your day-to-day life! Maybe it will be a car or another ride you've seen at the fair.

Share your creations!

We would love to see what you made. Email as at discover@uwo.ca or tag us on social media.

Instagram: @westernueng
Twitter: @westernueng
Facebook: @westernueng

Thanks for discovering with us!