Everyday Mysteries: Why don’t I fall out of an upside-down roller coaster?
Library of Congress, adapted by Newsela staff

Question: Why don’t I fall out when a roller coaster turns upside down?

Answer: As your roller coaster speeds along, the force of gravity, which pulls you down to the earth, is overcome by another force: acceleration. This is the force that pushes you forward.

Have you ever wondered how roller coasters stay on their tracks and why people can hang upside down in them? It is all a matter of different forces and different kinds of energy acting together.

No Engine, No Problem
A roller coaster does not have an engine. A lift or cable pulls it up the first hill. This builds up a supply of stored, or potential, energy that will be used to go down the hill as the train is pulled by gravity. Then, all of that stored energy is released as kinetic energy, which is what will get the train to go up the next hill. So, as the train travels up and down the hills, its motion is constantly shifting between potential and kinetic energy.

The higher the hill the coaster is coming down, the more kinetic energy is available to push the cars up the next hill, and the faster the train will go. Plus, according to Newton’s First Law of Motion, “an object in motion tends to stay in motion, unless another force acts against it.” Wind resistance and the wheels along the track are forces that work to slow down the train over time. So, toward the end of the ride, the coaster has less energy. For that reason, the coaster's final hills tend to be made lower than the first hills.

Centripetal Force
There are two major types of roller coasters: wooden and steel. Wooden tracks are not as bendable as steel tracks, so usually they do not have complicated shapes, such as loops that flip passengers upside down. After tubular steel tracks were introduced in the 1950s, more complicated and adventurous coasters became possible. On this type of track, the wheels run along the top, bottom and side of the tube. They secure the train to the track as it travels through loops and twists.

When you go around a sharp turn on a roller coaster, you feel pushed against the outside of the car. This force is known as centripetal force, and it helps keep you in your seat.

Inertia Keeps You In Your Seat
In the loop-the-loop, upside-down design, however, inertia is what keeps you in your seat. Inertia is a force that presses your body to the outside of the loop as the coaster spins around. In this way, inertia is a resistance against change in direction.

Although gravity is pulling you toward the earth, at the very top of the loop, the acceleration force is stronger than gravity. It pulls you upward and thus cancels out the effect of gravity. For this to work, the loop must be an elongated loop, or ellipse, rather than a perfect circle. Otherwise, the centripetal force would be too strong for safety and comfort.

How do we know whether a roller coaster is safe? Engineers and designers follow industry standards and guidelines. The first “riders” are sandbags or dummies, after which engineers and park workers get to try it out. Would you want to be one of the first passengers on a new ride?
Russian Ancestor

The ancestor of the roller coaster is a 15th-century Russian sled ride called Russian Mountains.

One of the first roller coasters was built in France in 1817. It was known as Les Montagnes Russes à Belleville, or the Russian Mountains of Belleville.

In 1827, the Mauch Chunk Switchback Railroad of Summit Hill, Pennsylvania, built a track 18 miles down a mountain to transport coal. In 1873, it became a scenic, yet bumpy, pleasure ride. It remained in operation until 1938.

In 1884, La Marcus Thompson built the first American roller coaster, the Switchback Railway at Coney Island in Brooklyn, New York.

One of the first high-speed coasters was the Drop-The-Dip, which debuted at Coney Island in 1907. It was at this time that seat belts first started to be used in roller coaster cars.

Kingda Ka Is World's Tallest, Fastest

The first tubular steel coaster was the Matterhorn Bobsleds at Disneyland in Anaheim, California. It was introduced in 1959.

In 1975, Knott's Berry Farm in Buena Park, California, introduced the Corkscrew, the first coaster to turn passengers completely upside down.

The King Cobra at Kings Island in Cincinnati, Ohio, was the first roller coaster that allowed people to stand up. It was introduced in 1984.

The longest roller coaster built so far is the 8,133-foot Steel Dragon 2000, located in Japan's Nagashima Spa Land.

The tallest steel roller coaster in the world is the 456-foot-tall Kingda Ka at Six Flags Great Adventure in Jackson Township, New Jersey. Kingda Ka is also the world's fastest coaster. It travels at a speed of 128 miles per hour, with rides lasting only 50.6 seconds.

Instructions:

• Answer the following questions on your own sheet of paper.
• Answer in complete sentences.
• Use evidence from the text to prove your answers.

1. Define the term acceleration.

2. Explain the difference between wood and steel tracks when making roller coasters.

3. What words does the author use to paint picture in your mind of how a roller coaster works?

4. How do gravity and inertia work together to make sure you don’t fall out of a roller coaster when it goes upside down?