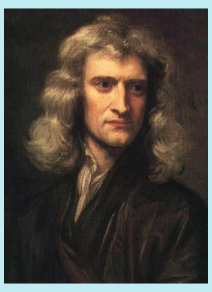
Newspapers In Education and the Puyallup Fair Presents

PHYSICS AND THE PUYALLUP FAIR

Chapter 1: Moving and Shaking at the Fair

Sir Isaac Newton and the Three Laws of Motion



Sir Isaac Newton is one of history's most influential physicists. He was born on December 25, 1642, and grew up in Lincolnshire, England. Isaac's father died before his birth, and young Isaac was raised by his mother and grandmother. He left home at age 19 to study at Trinity College in Cambridge. He eventually went on to be a professor there, and wrote several publications on mathematics, physics and optics, including Principia (its full name is Philosophiae Naturalis Principia Mathematica, which is Latin for Mathematical Principles of Natural Philosophy). In his later years, Queen Anne gave Newton a knighthood for his many accomplishments. After his death in 1727, he was buried in Westminster Abbey.

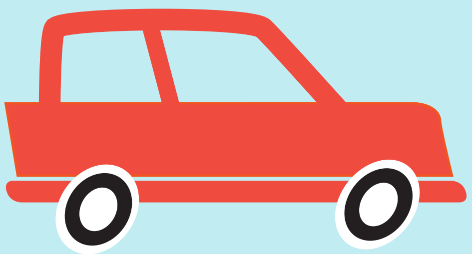
In Principia, Newton introduced new ways of thinking about the natural world, including what we now know as matter, mass, momentum and force. Also in this publication, Newton defined three laws of motion:

LAW #1 An object in motion will stay in motion unless acted upon by an outside force. An object at rest stays at rest unless acted upon by an outside force.

LAW #2 The rate at which the momentum of an object changes is proportional to the force acting on it.

LAW #3 For every action, there is an equal and opposite reaction.

You can see these laws and physics concepts in action at the Puyallup Fair, especially at rides like the Extreme Scream, The Coaster, Giant Slide and the Bumper Cars.



Driving to the Fair

You have probably experienced Newton's First Law of Motion while riding in a car or bus. As your family or class drives to the Puyallup Fair, pay attention to how you feel when you speed up, slow down or take turns.

When you first get into the car and sit down, your body is at rest and you are relaxed. When the driver presses on the gas pedal, the car will start to accelerate (including the seat you are in). Once this happens, all of the bodies in the car, including yours, will want to stay at rest. This is why you might feel the sensation of being pushed backwards in your seat as the car begins to move.

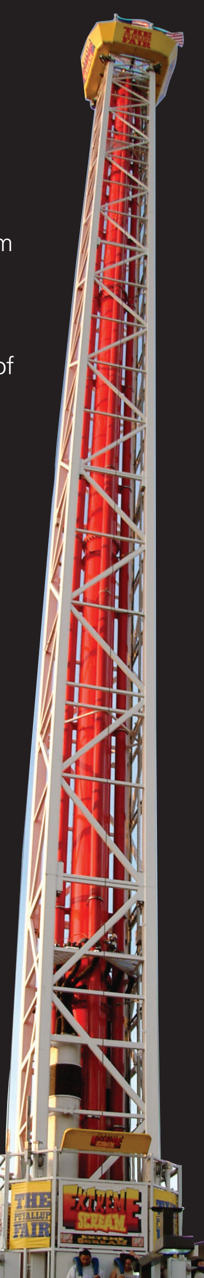
The same thing happens when your car brakes. When the driver first pushes the brake pedal, the car and its passengers are in motion. As you know from Newton's First Law, objects in motion will stay in motion unless acted upon by an outside force. Once the driver hits the brake, the car will start to slow down, but your body will stay in motion until the outside force (your seatbelt) slows you down. This is why you feel the sensation of falling forward as the car slows down.

Arguably the three most famous and influential physicists: **Albert Einstein** for explaining the photoelectric effect and why the sky is blue; contributing to theories of atomic motion; formulating theories of special and general relativity. **Isaac Newton** (see article to the left). **Galileo Galilei** for supporting a heliocentric view of the solar system; improving the telescope and the microscope; demonstrating the principles of gravity in formulating the basic law of falling bodies.

Bumper Cars

Why do you feel a jolt when your bumper car hits your friend's bumper car? Check Newton's Third Law of Motion: For every action there is an equal and opposite reaction. When your car hits another car, the second car exerts a force on your car, equal in magnitude and opposite in direction. That's why you feel a jolt – the other car pushes back!

Extreme Scream



The main driving force of the Extreme Scream is gravity. Once the riders are locked in, an air compression pump propels them up 185 feet, suspends them in the air for nearly 10 seconds, then drops them, letting the force of gravity send them plummeting back down. As you are going up, and when you stop at the top, the seat you are in is applying an external force upon your body. Once you drop, the seat falls out from under you and you no longer feel its force. For a brief period of time, you feel a sensation of weightlessness.

The Extreme Scream demonstrates another physics concept first introduced by Galileo Galilei: free fall. Under only the influence of gravity, an object in free fall accelerates toward the center of the Earth. All objects in free fall accelerate at the same rate. In the case of the Extreme Scream, all the passengers, regardless of their masses, will fall at the exact same rate. You can test this concept in your classroom or home by dropping objects of different masses from the same height and observing when they hit the ground in relation to one another. If this experiment were done in a vacuum, all of your objects would hit the ground at the exact same time. Since you are not in a vacuum, what might prevent a feather from hitting the ground as quickly as a tennis ball?

The Coaster

Potential energy is the energy an object has due to its position relative to other objects. A roller coaster car sitting at the top of a very tall hill has a LOT of potential energy.

Kinetic energy is the energy an object possesses due to its motion. A roller coaster car zooming down a very tall hill has a LOT of kinetic energy!

To understand what potential and kinetic energy are and how they differ from one another, consider The Coaster at the Puyallup Fair.

The Coaster does not have an engine in it to push it through the entire ride. Instead, it relies on the potential energy at the top of the first hill to propel the ride all the way through to the end (a total of 2,650 feet and 1:45 minutes). Once The Coaster's cars have been pulled up to the top of the first hill, the ride has its maximum gravitational potential energy.

Calculate the potential energy of one car sitting at the top of The Coaster's first hill:

$PE_{gravitational} = m*g*h$

m (mass of one car) = 397 kilograms (That's 875 pounds!)

g (gravitational acceleration) = 9.8 meters/second^2

h (height of the first hill) = 16 meters

Once the car has crested the hill, its potential energy is converted to kinetic energy. Calculate the kinetic energy for the car as it zooms down the hill:

$KE = ½ mv^2$

m (mass of one car) = 397 kilograms

v (velocity of one car) = 22 meters/second

Time to Think!

What information do you need in order to calculate the kinetic energy of a roller coaster car as it races down a steep hill?

How can you find this information?

If an object in motion stays in motion unless acted upon by an outside force, what stops The Coaster at the end of the ride?

photo credit: Patrick Hagerty

Giant Slide

photo credit: Patrick Hagerty

Kids who ride the Giant Slide have to sit on burlap sacks on their way down. Can you guess why?

Pretend you work at the Puyallup Fair and your job is to make people go down the Giant Slide at a slower rate. What modifications would you make to the slide or the sacks to slow people down?

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