

Name: _____ Date: _____ Group: _____

Newton's Laws and Roller Coasters

(Lexile 810L)

- 1 In 1687, Sir Isaac Newton published the *Principia*. This book contained his three laws of motion. They changed physics forever. These three laws are the basis of classical mechanics. Since then, Newton's three laws of motion have been proven over and over again. They are the basis of many of our modern inventions.
- 2 Roller coasters use the laws of motion to thrilling ends. They are the best use of Newton's laws of motion. Roller coasters are known for their twists, turns, and loops. They seem to defy everything we know about how people and objects move. Roller coaster designers, however, use Newton's laws to push people past their usual limits. Early roller coasters even caused whiplash and broken necks due to abrupt high g-forces.
- 3 Newton's first law is the law of inertia. This states that an object at rest stays at rest until unbalanced forces act upon it. Likewise, an object in motion stays in motion until unbalanced forces act upon it. Most roller coasters run by the law of inertia. Since an object at rest stays at rest, all roller coasters have to be pushed or pulled to get started. Most are pulled up a large hill called a lift hill. The first hill is usually the biggest hill. As the cars go up, they store potential energy. At the top, the cars have the most gravitational potential energy. They are about to be put into motion. Roller coaster cars will gain enough energy from the lift hill to zip through the rest of the ride. Once put into motion, they will stay in motion. The cars will not stop until the brakes are applied at the end of the ride.
- 4 Newton's second law is the law of force and acceleration. That law states the relationship between force and acceleration. The acceleration of an object depends on the object's mass and the magnitude of the force acting upon it ($F = ma$). You feel this second law when you start going down the hills. The coaster cars and your body have mass. The acceleration is from gravity. That causes force. The rider feels the force as it moves the cars along the coaster track. The track directs the force and the cars. The mass of your body and the coaster cars is constant. The amount of force changes due to changes in acceleration. The changes in acceleration are due mostly to friction. The thrill of acceleration on a roller coaster comes from Newton's second law.





Reading Science

- 5 Newton's third law is the law of action-reaction. This states that for every action there is an equal and opposite reaction. This means that as you push down on the seat, the seat pushes back at you. This law is really shown with newer roller coasters that expose riders to high g-forces. A "g-force" relates an acceleration on a body to the acceleration due to gravity. What happens in a two g-force turn? A body would experience an acceleration twice as strong as the pull of gravity. Older roller coasters did not expose riders to very many g-forces. Newer roller coasters, however, can expose rider to very high g-forces. At least one death has been caused by a rider's body reacting to the g-forces on a roller coaster.
- 6 G-forces are not just acting on the things we can see. They are also acting on our blood and our blood vessels. They push your body into the seat. But, they also push your blood away from your brain and toward your feet. G-forces can hurt your eyes, or even make you pass out. We will continue to use the laws of physics to create more exciting roller coasters. It will be important to keep in mind the limits of our human bodies.



- 1** What kind of statement is, "Roller coasters are the best use of Newton's laws of motion"?
- A** an opinion
 - B** a fact
 - C** the truth
 - D** without question
-
- 2** What conclusion can you make about g-forces based on the information in paragraph 6?
- A** G-forces help your heart to beat properly.
 - B** G-forces can be harmful to your health.
 - C** G-forces make the blood in your body rush to your head.
 - D** G-forces lift you out of the roller coaster seat.
-
- 3** What does Newton's first law explain?
- A** Why roller coasters start with a big hill.
 - B** Why roller coasters can cause damage to the human body.
 - C** Why roller coasters need constant pulling to stay moving.
 - D** Why roller coasters are fun.



- 4** What does Newton's second law explain?
- A** Why roller coasters start with a big hill
 - B** Why roller coasters have seat belts
 - C** Why roller coasters do not have brakes
 - D** Why the speed of the ride changes
-
- 5** Which of Newton's laws states that for every action, there is an equal and opposite reaction?
- A** Newton's first law
 - B** Newton's second law
 - C** Newton's third law
 - D** None of the above