

Newton's First Law

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CHAPTER 1

Newton's First Law

Lesson Objectives

- State Newton's first law of motion.
- Define inertia, and explain its relationship to mass.

Lesson Vocabulary

- inertia
- Newton's first law of motion

Introduction

The amusement park ride pictured in **Figure 1.1** keeps changing direction as it zooms back and forth. Each time it abruptly switches direction, the riders are forced to the opposite side of the car. What force causes this to happen? In this lesson, you'll find out.



FIGURE 1.1

Amusement park rides like this one are exciting because of the strong forces the riders feel.

Force and Motion

Newton's first law of motion states that an object's motion will not change unless an unbalanced force acts on the object. If the object is at rest, it will stay at rest. If the object is in motion, it will stay in motion and its velocity will

remain the same. In other words, neither the direction nor the speed of the object will change as long as the net force acting on it is zero. You can watch a video about Newton's first law at this URL: <http://videos.howstuffworks.com/discovery/29382-assignment-discovery-newtons-first-law-video.htm> .

Look at the pool balls in **Figure 1.2**. When a pool player pushes the pool stick against the white ball, the white ball is set into motion. Once the white ball is rolling, it rolls all the way across the table and stops moving only after it crashes into the cluster of colored balls. Then, the force of the collision starts the colored balls moving. Some may roll until they bounce off the raised sides of the table. Some may fall down into the holes at the edges of the table. None of these motions will occur, however, unless that initial push of the pool stick is applied. As long as the net force on the balls is zero, they will remain at rest.



Force from the moving pool stick starts the white ball rolling. Force from the moving white ball sets the other balls into motion.



FIGURE 1.2

Pool balls remain at rest until an unbalanced force is applied to them. After they are in motion, they stay in motion until another force opposes their motion.

Inertia

Newton's first law of motion is also called the law of inertia. **Inertia** is the tendency of an object to resist a change in its motion. If an object is already at rest, inertia will keep it at rest. If the object is already moving, inertia will keep it moving.

Think about what happens when you are riding in a car that stops suddenly. Your body moves forward on the seat. Why? The brakes stop the car but not your body, so your body keeps moving forward because of inertia. That's why it's important to always wear a seat belt. Inertia also explains the amusement park ride in **Figure 1.1**. The car keeps changing direction, but the riders keep moving in the same direction as before. They slide to the opposite side of the car as a result. You can see an animation of inertia at this URL: <http://www.physicsclassroom.com/mmedia/newtlaws/cci.cfm> .

Inertia and Mass

The inertia of an object depends on its mass. Objects with greater mass also have greater inertia. Think how hard it would be to push a big box full of books, like the one in **Figure 1.3**. Then think how easy it would be to push the box if it was empty. The full box is harder to move because it has greater mass and therefore greater inertia.



FIGURE 1.3

The tendency of an object to resist a change in its motion depends on its mass. Which box has greater inertia?

Overcoming Inertia

To change the motion of an object, inertia must be overcome by an unbalanced force acting on the object. Until the soccer player kicks the ball in **Figure 1.4**, the ball remains motionless on the ground. However, when the ball is kicked, the force on it is suddenly unbalanced. The ball starts moving across the field because its inertia has been overcome.



FIGURE 1.4

Force must be applied to overcome the inertia of a soccer ball at rest.

Once objects start moving, inertia keeps them moving without any additional force being applied. In fact, they won't stop moving unless another unbalanced force opposes their motion. What if the rolling soccer ball is not kicked by another player or stopped by a fence or other object? Will it just keep rolling forever? It would if another unbalanced force did not oppose its motion. Friction—in this case rolling friction with the ground—will oppose the motion of the rolling soccer ball. As a result, the ball will eventually come to rest. Friction opposes the motion of all moving

objects, so, like the soccer ball, all moving objects eventually come to a stop even if no other forces oppose their motion.

Lesson Summary

- Newton's first law of motion states that an object's motion will not change unless an unbalanced force acts on the object. If the object is at rest, it will stay at rest. If the object is in motion, it will stay in motion.
- Inertia is the tendency of an object to resist a change in its motion. The inertia of an object depends on its mass. Objects with greater mass have greater inertia. To overcome inertia, an unbalanced force must be applied to an object.

Lesson Review Questions

Recall

1. State Newton's first law of motion.
2. Define inertia.
3. How does an object's mass affect its inertia?

Apply Concepts

4. Assume you are riding a skateboard and you run into a curb. Your skateboard suddenly stops its forward motion. Apply the concept of inertia to this scenario, and explain what happens next.

Think Critically

5. Why is Newton's first law of motion also called the law of inertia?

Points to Consider

In this lesson, you read that the mass of an object determines its inertia. You also learned that an unbalanced force must be applied to an object to overcome its inertia, whether it is moving or at rest. An unbalanced force causes an object to accelerate.

- Predict how the mass of an object affects its acceleration when an unbalanced force is applied to it.
- How do you think the acceleration of an object is related to the strength of the unbalanced force acting on it?

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