

section 1 Newton's First Law

● Before You Read

What do you have to do to move an object like a shopping cart? What causes motion?

What You'll Learn

- the difference between balanced and net forces
- Newton's first law of motion
- how friction affects motion

● Read to Learn

Force

To make a soccer ball move, you kick it. You can pick up a book from your desk. If you hold the book in the air and then let it go, gravity pulls it to the floor. The motion of the soccer ball and the book was changed by something pushing or pulling on each of them.

A **force** is a push or a pull. When you throw a ball, your hand exerts, or puts, a force on the ball. Then, gravity puts another force on the ball. Gravity pulls it to the ground. When the ball hits the ground, the ground exerts a force on the ball to stop it from moving.

Forces can act on objects in different ways. For example, you can pick up a paper clip with a magnet. The magnet puts a force on the paper clip. Or, you can put a force on the paper clip with your hand to pick it up. If you let go of the paper clip, Earth's gravity exerts a force on the paper clip and it falls to the ground.

How can forces be combined?

More than one force can act on an object at the same time. Imagine holding a paper clip near a magnet. You, the magnet, and Earth's gravity are all putting forces on the paper clip. The **net force** is the combination of all forces acting on an object.

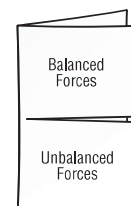
Study Coach

Make Flash Cards As you read, write main ideas and vocabulary terms on note cards. When you finish reading, use your flash cards to make sure you understand the main ideas and terms.

FOLDABLES™

A Compare and Contrast

Make the following two-tab Foldable to organize important information about balanced and unbalanced forces.



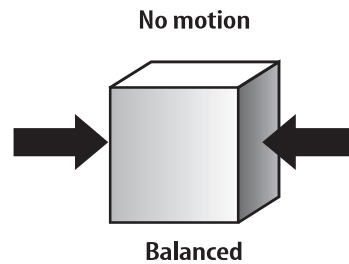
How does net force determine motion?

When more than one force is acting on an object, the net force determines the motion of the object. If a paper clip near a magnet is not moving, then the net force on the paper clip is zero.

How do forces combine to form the net force? If the forces are in the same direction, they add together. If two forces are in opposite directions, the net force is the difference between the two forces. If one of the forces is greater than the other, the motion of the object is in the direction of the greater force.

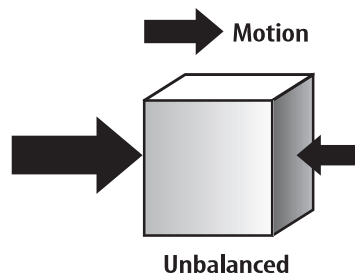
What are balanced forces?

Suppose you and a friend push on opposite ends of a wagon. You both push with the same force, and the wagon does not move. Your forces cancel each other because they are equal and in opposite directions. **Balanced forces** are two or more forces acting on an object that cancel each other and do not change the object's motion. The net force is zero if the forces acting on an object are balanced. The figure below shows balanced forces.



What are unbalanced forces?

Unbalanced forces are forces that don't cancel each other. When unbalanced forces act on an object, the net force is not zero. The net force causes the motion of the object to change. The figure below shows how unbalanced forces change the motion of an object.



Think it Over

- Infer** Imagine two people pushing on a door. One person pushes the door to close it. The other person pushes on the other side of the door to open it. If both people are pushing with the same force, what will happen to the door?

Picture This

- Identify** Look at the box with unbalanced forces. In which direction is the strongest force—to the right or to the left? In which direction is the box moving?

Newton's First Law of Motion

When you stand on a skateboard, you don't move. If someone gives you a push, you and the skateboard move. You and the skateboard were objects at rest until someone pushed you. An object at rest stays at rest unless an unbalanced force acts on it and causes it to move.

If someone pushes you on a skateboard, do you keep going? You probably would roll for a while, even after the person stops pushing you. An object can be moving without a net force acting on it.

One of the first to understand that objects could be moving without a force acting on them was Galileo Galilei. He was an Italian scientist who lived from 1564 to 1642. Galileo's ideas helped Isaac Newton understand motion better. Newton was able to explain the motion of objects in three rules. These rules are called Newton's laws of motion.

Newton's first law of motion describes how an object moves when the net force acting on it is zero. **Newton's first law of motion** states that if the net force acting on an object is zero, the object stays at rest or, if the object is already moving, it continues to move in a straight line with the same, or constant, speed.

Friction

Galileo knew that the motion of an object doesn't change unless an unbalanced force acts on it. So, why does a book stop sliding across a desktop just after you push it? There is a force acting on the sliding book. **Friction** is the force that resists sliding motion between two touching surfaces.

Friction also acts on objects moving through air or water. If two objects are touching each other, friction always will try to keep them from sliding past each other. Friction always will slow an object down.

What is static friction?

Have you ever tried to push something heavy, like a refrigerator or a sofa? At first heavy objects don't move. As you push harder and harder, the object will start to move. When you first push, the friction between the object and the floor is opposite to the force you are putting on it. So, the net force is zero. The object does not move. Static friction is the type of friction that prevents an object from moving when a force is applied.

FOLDABLES™

B Classify Make the following table Foldable to help you organize Newton's laws of motion with examples from your own life. Write about Newton's first law as you read this section. You can complete your Foldable as you read Sections 2 and 3.

| Force | Example in Your Life |
|-----------|----------------------|
| First Law | |
| | |
| | |



Think it Over

- 3. Infer** Think about Newton's first law. What would happen to a moving object if there were no friction?

What causes static friction?

Static friction is caused by the attraction between the atoms of two surfaces that are touching each other. This makes the two surfaces stick together. The force of static friction is greater when the object is heavy or if the surfaces are rough.

What is sliding friction?

Static friction keeps an object at rest. Sliding friction slows down an object that slides. If you push a box across a floor, you have to keep pushing to overcome the force of sliding friction. Sliding friction is caused by the roughness of the surfaces that are sliding. A force must be applied to move the rough areas of one surface past the rough areas of the other. Sliding friction slows down the sliding baseball player in the figure.

Picture This

4. **Identify** Draw an arrow below the sliding baseball player to show the direction of the force due to friction.



What is rolling friction?

Rolling friction is what makes a wheel turn. There is rolling friction between the ground and the part of the wheel touching the ground. Rolling friction keeps the wheel from slipping on the ground. If a wheel is rolling forward, rolling friction exerts a force on the wheel that pushes the wheel forward.

It is usually easier to pull a load on a wagon that has wheels than it is to drag the load along the ground. This is because the rolling friction between the wheels and the ground is less than the sliding friction between the load and the ground.

Reading Check

5. **Explain** If a wheel is rolling forward, what type of friction pushes the wheel forward?
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● After You Read

Mini Glossary

balanced forces: two or more forces acting on an object that cancel each other and do not change the motion of the object

force: a push or a pull

friction: the force that resists sliding motion between two touching surfaces

net force: the combination of all forces acting on an object

Newton's first law of motion: if the net force acting on an object is zero, the object stays at rest; or, if the object is already moving, it continues to move in a straight line with constant speed

unbalanced forces: forces that don't cancel each other

1. Review the terms and their definitions in the Mini Glossary. When you push a skateboard on a flat surface, why does it stop after a while? Use at least one term in your answer.

2. Complete the table below to show how Newton's first law of motion affects objects at rest and objects that are moving. Name the types of friction that could affect objects at rest and moving objects.

| | How is the object affected by Newton's first law? | Which type or types of friction affect it? |
|------------------|---|--|
| Object at rest | | |
| Object in motion | | |

3. At the beginning of the section, you were asked to make flash cards. Did your flash cards help you learn about Newton's first law? Why or why not?
