chapter 2

Forces

lesson 1 Combining Forces

Grade Eight Science Content Standard. 2.b. Students know when an object is subject to two or more forces at once, the result is the cumulative effect of all the forces. **Also covers:** 2.a, 2.c, 9.g.

Before You Read

On the lines below, describe what you would do to move a shopping cart around a grocery store. Read the lesson to learn about the forces that cause motion.

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MAIN Idea

When more than one force acts on an object, the combined effect is caused by the sum of all applied forces.

What You'll Learn

- what a force is
- how balanced and unbalanced forces affect motion

Read to Learn

What is a force?

A push or a pull is called a **force**. When you throw a ball, your hand exerts, or puts, a force on the ball. Forces are exerted by one object on another object.

What are contact forces?

A force that is exerted only when two objects are touching is a **contact force**. Some contact forces are small, such as the force you use to push a pencil across a sheet of paper. Some contact forces are large, such as the force exerted by a tow truck as it pulls a car behind it.

What are noncontact forces?

When you jump up in the air, you are pulled back to the ground, even though nothing seems to be touching you. A **noncontact force** is a force that one object exerts on another when they are not touching. Gravity, the force that pulls you back to Earth, is a noncontact force. Two objects do not have to touch to exert a gravitational pull on one another. Other noncontact forces include magnetic force and electric force. ☑

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.

Reading Check

1. **Identify** Which list of forces are noncontact forces? (Circle your answer.)
   a. gravity, magnetism, and electricity
   b. throwing a ball and pushing a pencil

How is force measured?

Recall that a vector, such as velocity, has a size and a direction. A velocity vector is often represented by an arrow. The arrow points in the direction of motion. The length of the arrow represents the object's speed.

Forces are also vectors that can be represented by an arrow. The direction of the arrow shows the direction of the push or pull. The length of the arrow represents the size, or strength, of the force.

Force is measured in newtons (N). The force needed to lift a hamburger is about 1 N. The force needed to lift a 2-L bottle of water is about 20 N.

Combining Forces

Academic Vocabulary
task (TAHSK) (noun) an assigned job or thing to do

You would need to use a lot of force to push a heavy dresser. But if someone helped you push, the task would be much easier. More than one force would be acting on the dresser. When this happens, the forces combine. The combination of all the forces acting on an object is called the **net force**. Forces combine differently, depending on the direction of the forces exerted on an object.

How do forces in the same direction combine?

Imagine that you and a friend push on the same side of the dresser. You are both exerting force in the same direction. When forces push in the same direction, they add together to form the net force. In the case of the dresser, the net force is in the direction that you both push. ☑

You should always give a reference direction when discussing forces. For example, you could choose "to the right" as the positive reference direction for the dresser. Then, both forces would be positive.

Reading Check

2. Explain What happens when forces push in the same direction?

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What happens when forces are in opposite directions?

Imagine the dresser again. This time, you are pushing on one side of the dresser and a friend is pushing on the other side. The two forces are in opposite directions.

If "to the right" is the positive reference direction, then one force is positive and the other is negative. The net force is in the direction of the stronger force. If you push on the dresser harder than your friend does, the net force is in the direction of your push.

What are unbalanced and balanced forces?

When you pushed on the dresser with your friend, the net force on the dresser was not zero. Even when you pushed in opposite directions, one of you was pushing harder than the other. So, the net force was still not zero. When the net force on an object is not zero, the forces are called **unbalanced forces**. However, if you and your friend pushed on the dresser with equal forces, but in opposite directions, the net force would be zero. When you add the forces together, they cancel each other out. When the net force on an object is zero, the forces are called **balanced forces**.

How do forces affect motion?

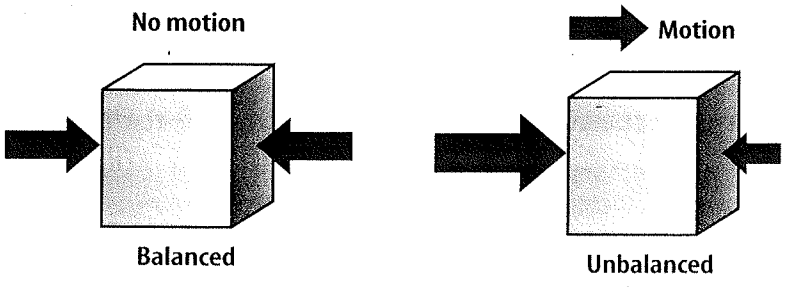
Changes in motion occur when an object changes speed or changes direction. Whether the motion of an object changes depends on whether the forces acting on an object are balanced or unbalanced.

What happens to the motion of an object when the forces are unbalanced?

If you pushed on the dresser with more force than your friend, it would move in the direction of your push. The net force on the dresser is not zero. This means that the forces acting on the dresser are unbalanced. Only unbalanced forces cause a change in an object's motion; shown in the figure on the right, below.

What happens to the motion of an object when the forces are balanced?

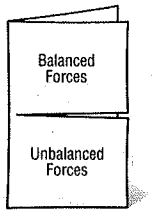
Imagine that you and a friend push on opposite sides of a dresser. If you both push with equal force, the dresser will not move. The forces acting on it are equal, but in opposite directions. The net force on the dresser is zero. This means that the forces acting on the dresser are balanced. Balanced forces do not change the motion of an object, as shown in the figure on the left, below.



FOLDABLES™

A Sketch and Describe

Make a two-tab Foldable. Label the tabs as illustrated. Describe and sketch examples of balanced forces and unbalanced forces on the front tabs and describe the importance of each under the tabs.



Picture This

3. Determine What do the different sized arrows suggest about the amount of force being exerted on the box in the figure on the right?

Newton's First Law of Motion

Isaac Newton was a scientist who lived from 1642 to 1727. He explained how forces cause objects to move. He developed three laws of motion. Newton's first law of motion describes how an object moves when the forces acting on it are balanced. According to **Newton's first law of motion**, if the net force on an object is zero, an object at rest remains at rest, or, if the object is moving, it continues to move in a straight line with constant speed. Simply put, if the net force on an object is zero, the motion of the object will not change. ☑

What is inertia?

According to Newton's first law of motion, objects resist changing motion. Objects only change motion when unbalanced forces act on them. The tendency of an object to resist a change in its motion is called inertia. A book sitting on a table is not moving. The book doesn't move unless an unbalanced force acts on it. A book sliding on a table is moving. The book will keep sliding with constant speed unless an unbalanced force acts on it.

What is the relationship between change in motion and mass?

It is harder to change the motion of an object that has more mass. Imagine trying to stop a basketball or a bowling ball moving at the same speed. The bowling ball can have 12 times more mass than the basketball. You have to exert more force to stop the bowling ball than to stop the basketball.

What have you learned?

In this lesson you read that forces acting on an object can be added together to determine the net force acting on the object. Forces are vectors, so the size and direction of the force must be considered when calculating the net force. If the forces add to a zero net force, the forces are balanced and motion of the object does not change. Newton's first law of motion states that the motion of an object will not change if the net force is zero. If the net force is not zero, the object will move in the direction of the greater force.

Reading Check

4. **Explain** What do Newton's three laws explain? (Circle your answer.)
   - **a.** how forces cause objects to move
   - **b.** how an object moves when balanced forces act upon it

Think it Over

5. **Compare** two objects that you have moved recently. Which required more net force to move?