Science

Genre	Comprehension Skill	Text Features	Science Content
Nonfiction	Sequence	• Captions • Labels • Call Outs • Glossary	Motion

Scott Foresman Science 4.15

PEARSON
Scott Foresman
scottforesman.com

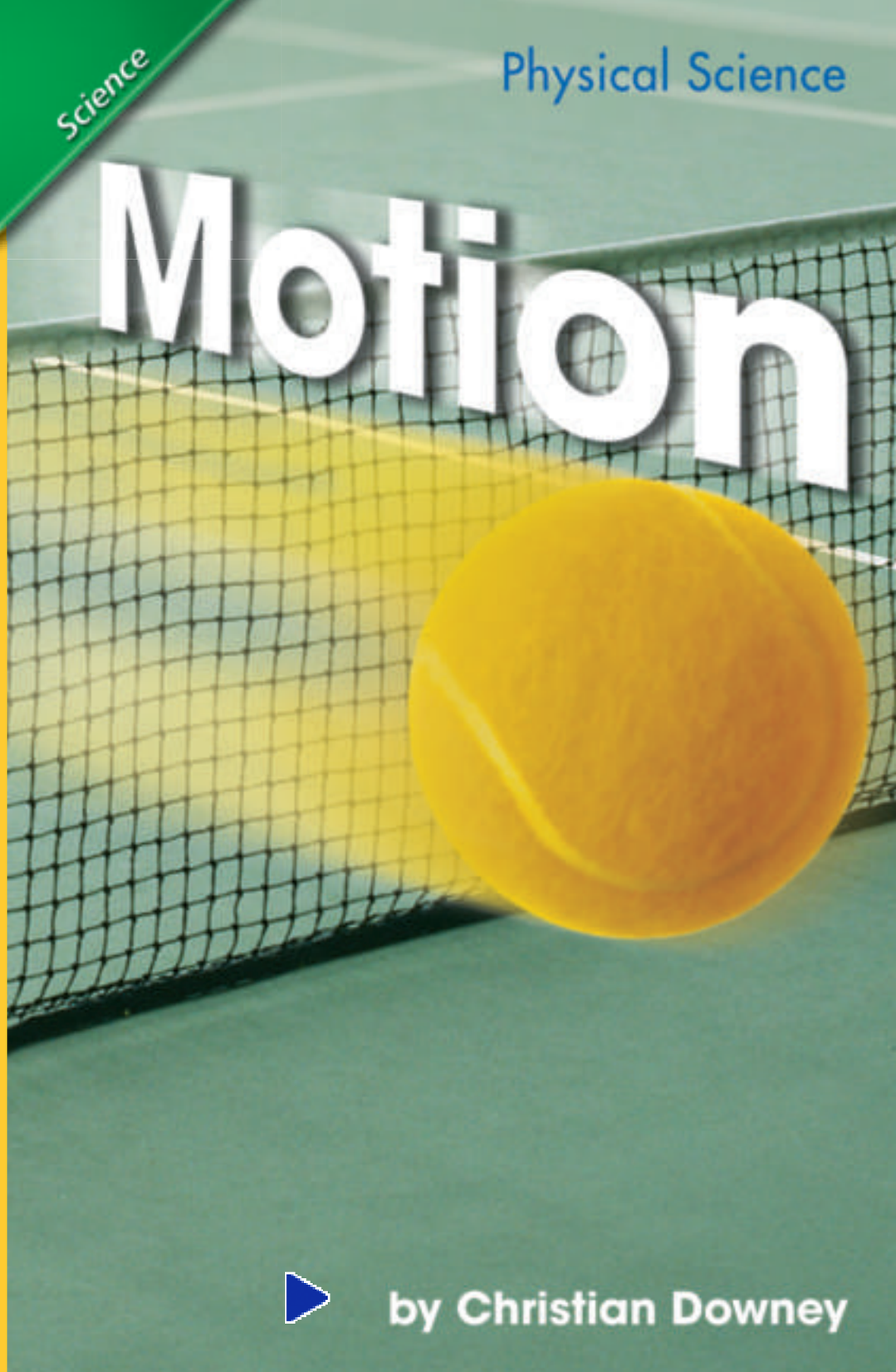
DK

ISBN 0-328-13902-5
9 780328 139026 90000

Science

Physical Science

Motion



by Christian Downey

Vocabulary

force
frame of reference
friction
gravity
kinetic energy
potential energy
relative motion
speed
velocity
work

Picture Credits
Every effort has been made to secure permission and provide appropriate credit for photographic material.
The publisher deeply regrets any omission and pledges to correct errors called to its attention in subsequent editions.

Photo locators denoted as follows: Top (T), Center (C), Bottom (B), Left (L), Right (R), Background (Bkgd).

2 Maximilian Weinzierl/Alamy Images; 5 Getty Images; 13 David Young-Wolff/PhotoEdit.

Unless otherwise acknowledged, all photographs are the copyright © of Dorling Kindersley, a division of Pearson.

ISBN: 0-328-13902-5

3 4 5 6 7 8 9 10 V010 13 12 11 10 09 08 07 06 05

Motion

by Christian Downey

PEARSON Scott Foresman
DK

How Objects Move

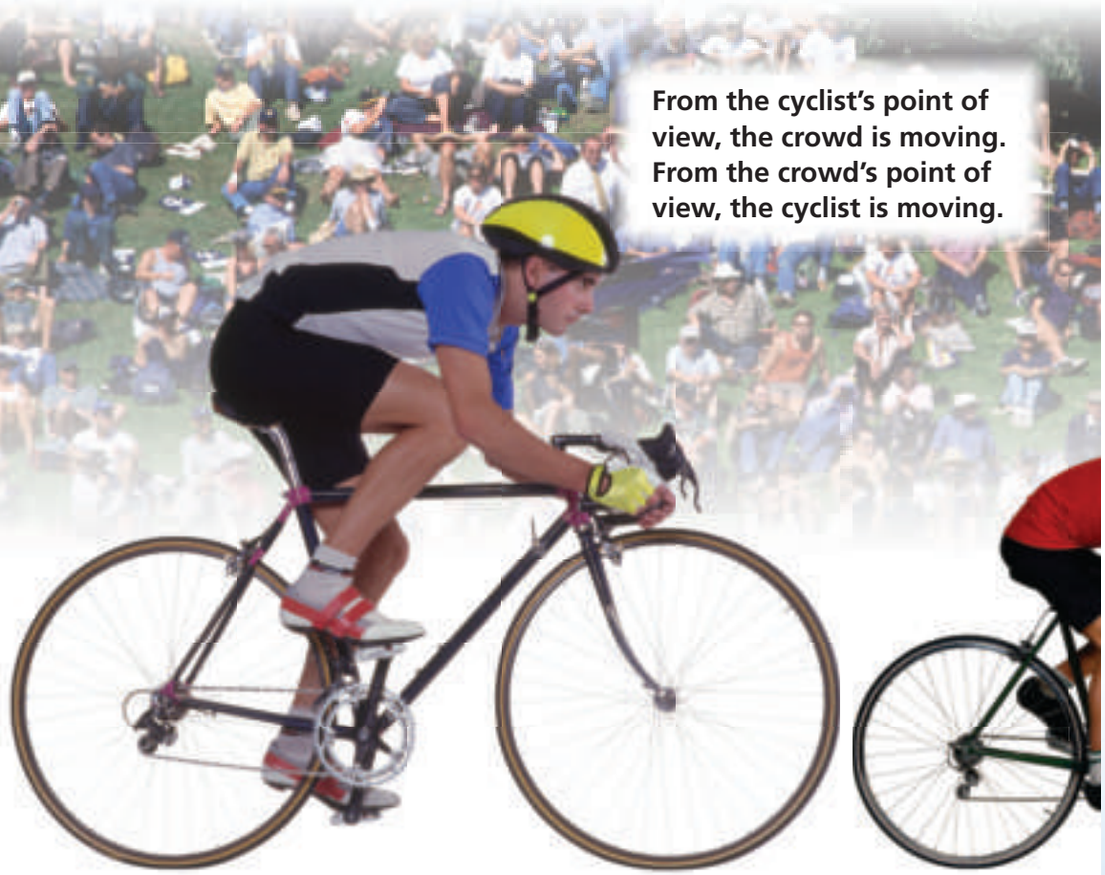
The riders on this giant swing move in a curved path.

A child runs to catch the school bus. A leaf falls from a tree. These things are moving. Objects can move in many ways. Some objects move in straight lines. You may walk down the street in a straight line. If you drop a ball, it falls to the ground in a straight line.

Some objects move in a curved path. People riding on a spinning carousel go around in circles. The Moon's path around Earth is curved.

Objects can also move back and forth. If you push a swing in the playground, it moves back and forth. There are many different ways to move. There are also many ways to observe and measure motion.

How can you tell if something is moving or standing still? You can compare objects to find out. **Relative motion** is the change in one object's position compared to another object's position. If you are in an airplane above a big city, you can see the buildings below you. They may seem to be moving. But, you know that the buildings are not moving. You are. If you stand still and a dog runs past you, then the dog is the moving object.



From the cyclist's point of view, the crowd is moving. From the crowd's point of view, the cyclist is moving.

Knowing What Is Moving

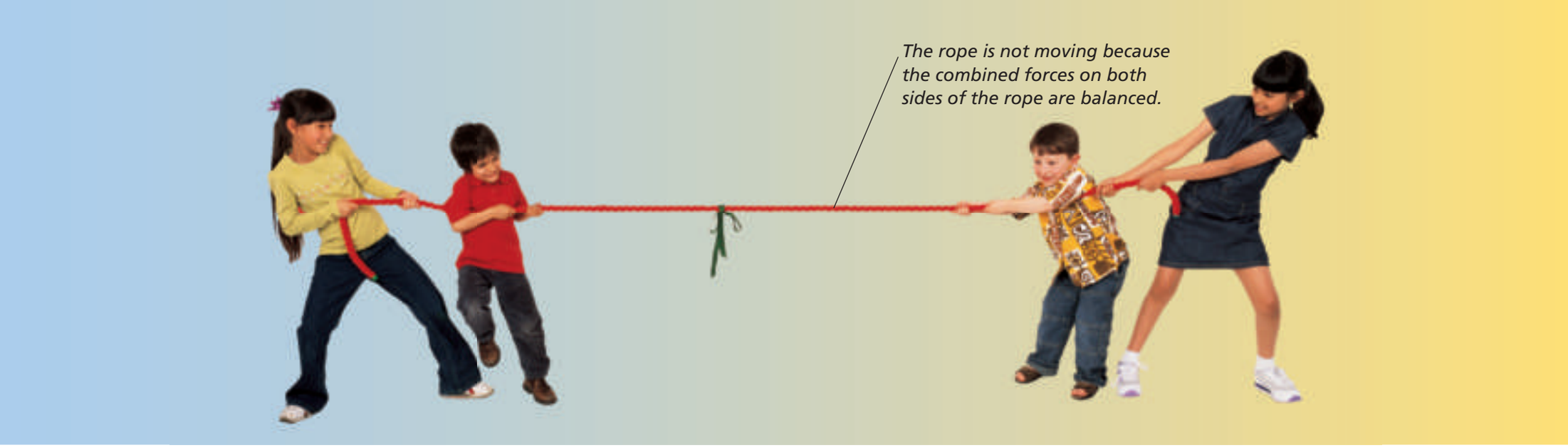
By comparing objects, it is possible to figure out what moves and what does not. It also depends on your **frame of reference,** or the objects you use to detect motion. Look at the cyclist above. To the cyclist, the bicycle he is riding does not seem to be moving. The bicycle is his frame of reference. But the people in the crowd see both the cyclist and the bicycle moving.

An airplane accelerates when it takes off. Its speed increases.

Speed and Velocity

Speed and velocity are two measurements of motion. **Speed** is the rate at which an object changes position. You can find an object's average speed by dividing the distance the object moved by the total time spent moving. If a plane traveled 1,800 kilometers in two hours, then its average speed was 900 kilometers per hour.

Velocity is a measure of the speed and direction an object is moving. *North*, *south*, *left*, and *right* are some direction words. As an airplane takes off from the ground, it rises up into the sky. If it starts to move faster or make a turn, its acceleration changes. Acceleration is any change in the speed or direction of an object's motion. Acceleration can be speeding up or slowing down.



Force and Motion

Force is a push or pull. Force can set in motion an object that is not moving. It can also make a moving object change direction, stop, slow down, or speed up.

Some forces take effect on contact. That means these forces must touch an object to have an effect on it. Hitting a ball with a bat is a contact force. The bat must touch the ball to make the ball move.

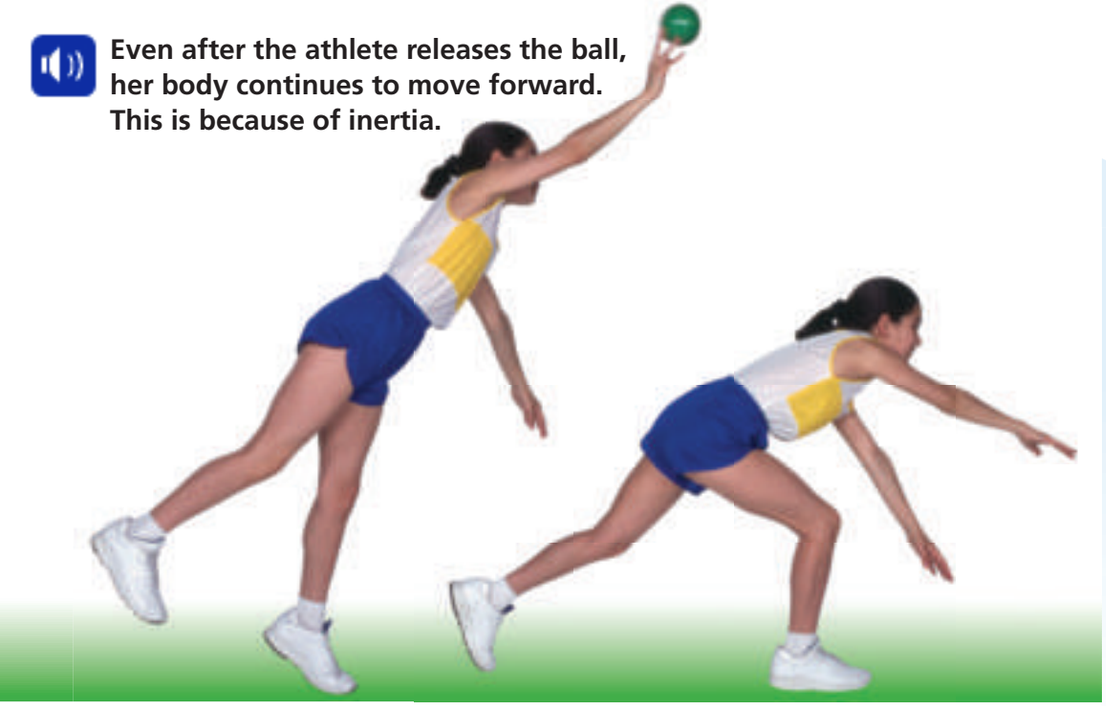
Other forces take effect from a distance. These forces do not have to touch an object to have an effect on it. The force of gravity on Earth pulls objects to Earth without touching them.

If you push or pull an object, you change its motion and position. How much the motion and position change depends on the strength of the push or pull. The harder you hit a ball with a bat, the farther and faster the ball will fly.

Combined Forces

Forces can be combined in different ways. If you pull on a rope, the force of that pull will move the rope in your direction. If you play tug-of-war with friends and both sides pull on the rope with equal amounts of force, both forces work against each other. The forces are combined but balanced. The rope does not move in either direction.

Not all forces are balanced. Suppose more people are pulling on one side of the rope than on the other. They will pull on the rope with more force than the people on the other side. The rope will move toward the side using more force.



Even after the athlete releases the ball, her body continues to move forward. This is because of inertia.

Motion and Force

Inertia is the resistance an object has to any change in its motion. Suppose you are riding in the bumper cars at an amusement park. What happens when you hit the brakes too fast or bump into another car? Your bumper car stops short, but your body continues to move forward. Your body has forward inertia, which keeps you moving after the car has stopped. The same thing happens if you trip while running. Your feet stop when they hit something, but the rest of your body continues moving in the direction it was going. You may even lose your balance or begin to fall forward. The body's resistance to the sudden stop is inertia. The more mass an object has, the more force is needed to change its direction.

The surface of snow is very smooth so it has little friction. This makes snow slippery—perfect for sledding!

Friction

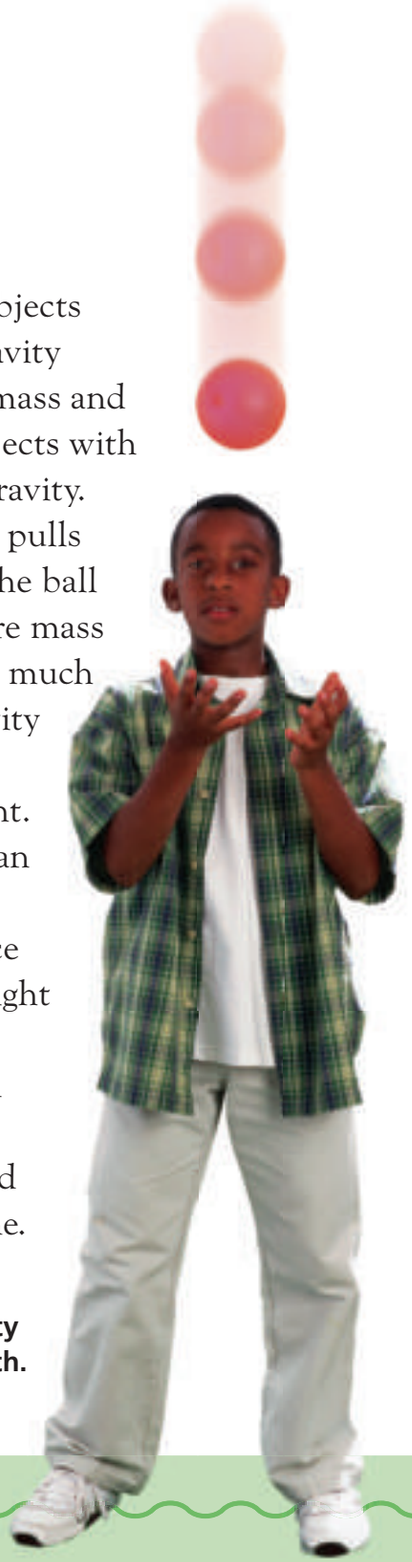
If you rub your hands together quickly, what happens? Your hands grow warm. This warmth is caused by **friction,** a force that acts when two surfaces rub together. Friction changes depending on the surfaces of the two objects in contact. Objects with smooth surfaces have less friction than objects with rough surfaces. Friction also changes depending on how hard the surfaces are pressed together.

If you ride down a snowy hill on a sled, you can go very fast. What would happen if more weight were added to the sled? The friction would increase. By adding weight, more friction is created because the sled is pressing harder against the snow. Friction can also be decreased. Smoother surfaces have less friction. If you waxed the bottom of the sled, the friction would be reduced. The sled would move more easily.

Force, Mass, And Energy

Gravity is the force that pulls objects toward each other. The force of gravity between objects depends on their mass and their distance from each other. Objects with more mass have greater forces of gravity. If you throw a ball in the air, Earth pulls the ball back down. Why doesn't the ball pull Earth up? Earth has much more mass than the ball has. This means it has much stronger gravity than the ball. Gravity gets weaker over a distance.

Gravity affects an object's weight. Mass is the amount of material in an object. Weight measures gravity's effect on an object's mass. The force of gravity can cause an object's weight to change. An object weighs more on Earth than it does on the Moon because Earth's gravity is stronger. Unless mass is added to or removed from the object, its mass is the same.

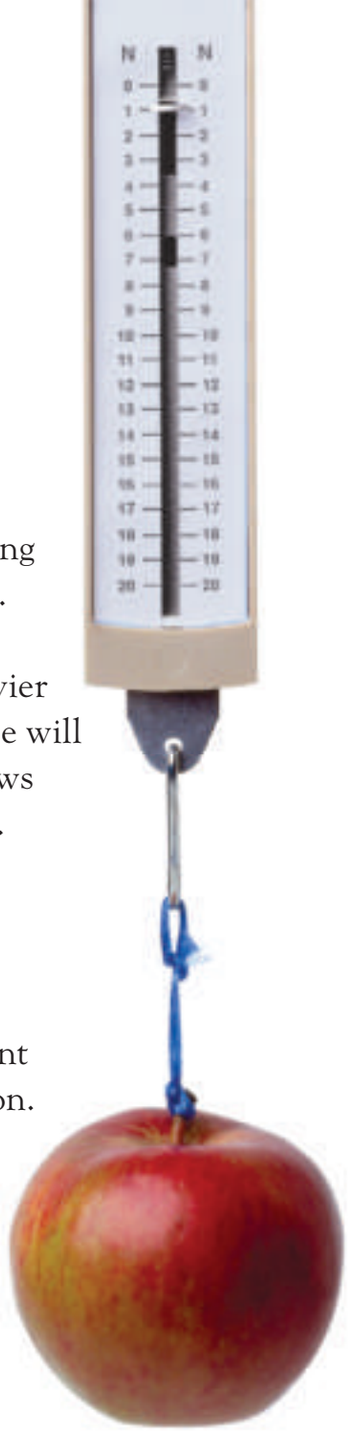


If you throw a ball upward, gravity causes it to fall back down to Earth.

How to Measure Force

One way to measure force is with a spring scale. You can hang an object from the hook at the bottom of a spring scale. This causes the spring to stretch. The weight of the object determines how much the spring stretches. A heavier object has more force. A stronger force will stretch the spring more. The scale shows the measurement of the object's force.

Force is measured in units called newtons. It takes the force of about one newton to lift a small apple. The newton was named after Sir Isaac Newton, a scientist who made important discoveries about both force and motion.



A spring scale is measuring the force of an apple.

This tennis ball has kinetic energy because it is in motion.

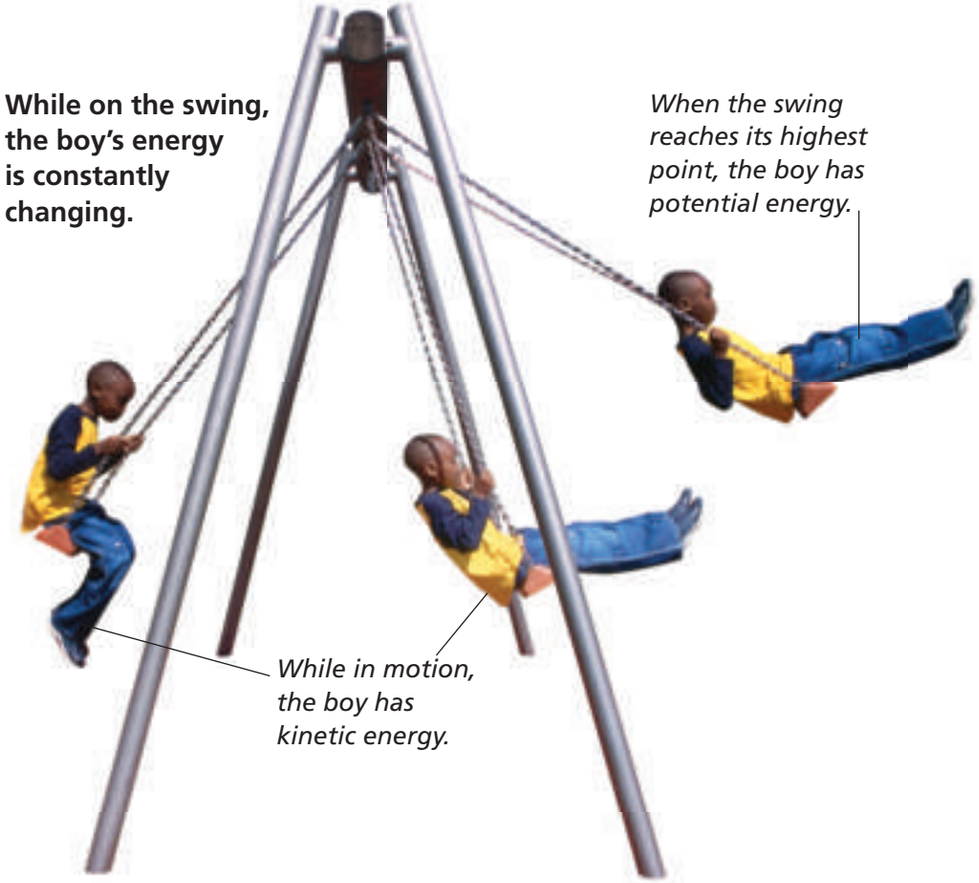
Motion and Energy

The ability to move something is known as **work.** Energy is required to do work.

Kinetic energy is the energy of motion. Everything that moves has kinetic energy. A tennis ball flying across a court looks much different from an airplane flying through the sky. What do they have in common? Both have kinetic energy. The plane has more kinetic energy than the tennis ball has. Objects with greater mass and faster speeds have more kinetic energy. Objects with less mass and slower speeds have less kinetic energy.

At the top of the slide, the boy has potential energy because he is about to move.

What do a stretched-out rubber band and a child at the top of a slide have in common? Both have potential energy. **Potential energy** is stored energy. Even though the rubber band and the child are not yet moving, both are ready to do so. They can release their stored energy at any time. Once they move, their potential energy changes to kinetic energy. It is no longer stored.



Changing Energy

The amount of energy an object has cannot change. However, the kind of energy can change. Objects can switch back and forth from kinetic to potential energy. Think of moving back and forth on a swing. As you move upward on the swing, you have kinetic energy. At the top of the swing's path, your kinetic energy changes into potential energy. As you begin to move again on the swing, the potential energy changes to kinetic energy.

All around you, everyday objects are in motion.

Motion can be affected by forces acting upon it. Forces can act on an object from direct contact or from a distance. Friction and gravity can cause changes in an object's motion. Energy can be kinetic or potential, depending on an object's movement and position. When motion changes, energy is always required.

Look at the objects around you. Notice what is moving. Notice what is fixed in place. Do you know what is making the objects move? Motion and energy play a big part in everyday life. Without them, we wouldn't go anywhere!

Glossary

force	a push or pull
frame of reference	the point of view from which you detect motion
friction	a force that acts when two surfaces rub together
gravity	a force that pulls objects toward each other
kinetic energy	the energy of motion
potential energy	stored kinetic energy
relative motion	the change in one object's position compared to another object's position
speed	the rate at which an object changes position
velocity	the measure of the speed and direction an object is moving
work	the ability to move something

What did you learn?

1. What is acceleration?

2. If two teams playing tug-of-war are pulling on the rope with the same force, what happens? Why?

3. How do mass and distance affect gravity?

4. **Writing in Science** Adding wax to the bottom of a sled helps reduce friction. Explain how this is possible. Use details from the book to support your answer.

5. **Sequence** Think of at least one object whose energy can change from potential to kinetic energy and back again. Explain when it has kinetic energy and when it has potential energy.