Let's Do SCIENCE

Primary 6

Textbook B

The 5E Model – Guided Inquiry

The Let's Do Science series is based on the Biological Sciences Curriculum Study (BSCS) 5E teaching and learning instructional model. The 5E model is centered on the idea that students understand science concepts best by using prior knowledge to pose questions and find answers through guided inquiry.

This hands-on approach, integrated with engineering and design skills, has students learn science by doing science. Teachers guide the learning process and are able to assess student performance by evaluating student explanations and the application of newly acquired knowledge and skills.

Engage

The Engage phase of the 5E model provides students with the opportunity to demonstrate their prior knowledge and understanding of the topic or concept. Students are presented with an activity or question which serves to motivate and engage students as they begin the lesson. Teachers identify and correct any misconceptions and gather data from students which will guide informed teaching and learning.

Essential to stimulating and engaging students is the use of mixed media such as colorful photos, illustrations and diagrams found throughout the textbooks and activity books. Let's Do Science also includes extensive digital resources such as narrated videos, interactive lessons, virtual labs, slideshows and more.

Explore

This phase encourages exploration of concepts and skills through hands-on activities and investigations. Students are encouraged to work together and apply various process skills while gaining concrete, shared learning experiences. These experiences provide a foundation for which students can refer to while building their knowledge of new concepts. This student-centered phase comes before formal explanations and definitions of the concept which are presented by the teacher.

Explain

This phase follows the exploration phase and is more teacher-directed. Students are initially encouraged to draw on their learning experiences and demonstrate their understanding of the concept through explanations and discussion. After the students have had the opportunity to demonstrate their understanding of the concept, the teacher then introduces formal definitions and scientific explanations. The teacher also clarifies any misconceptions that may have emerged during the Explore phase.

Elaborate

In the Elaborate phase, students refine and consolidate their acquired knowledge and skills. Opportunities are provided for students to further apply their knowledge and skills to new situations in order to broaden and deepen their understanding of the concept. Students may conduct additional investigations, share information and ideas, or apply their knowledge and skills to other disciplines.

Evaluate

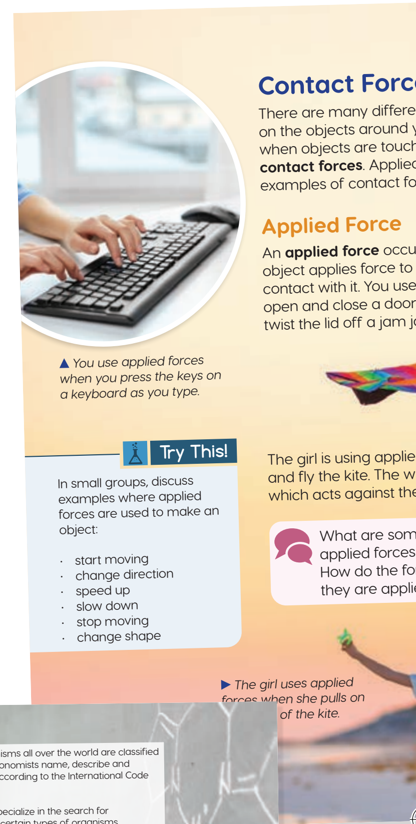
This final phase includes both formal and informal assessments. These can include concept maps, physical models, journals as well as more traditional forms of summative assessment such as quizzes or writing assessments. Students are encouraged to review and reflect on their own learning, and on their newly acquired knowledge, understanding and skills.

Let’s Do Science

Let’s Do Science is based on the United States Next Generation Science Standards (NGSS). The series consists of full-color textbooks and full-color activity books for Grades K to 6.

Let’s Do Science engages students with a highly visual presentation of the disciplinary core ideas in the textbooks and places an emphasis on applying scientific knowledge using NGSS practices through numerous scientific investigations. Let’s Do Science sees engineering as an essential element of science education and as such is tightly integrated into both the textbooks and activity books.

The Let’s Do Science textbooks include the following features:



Think Deeply

Topic-related questions for group discussion aimed at deepening students’ understanding of the topic.

Engineer It!

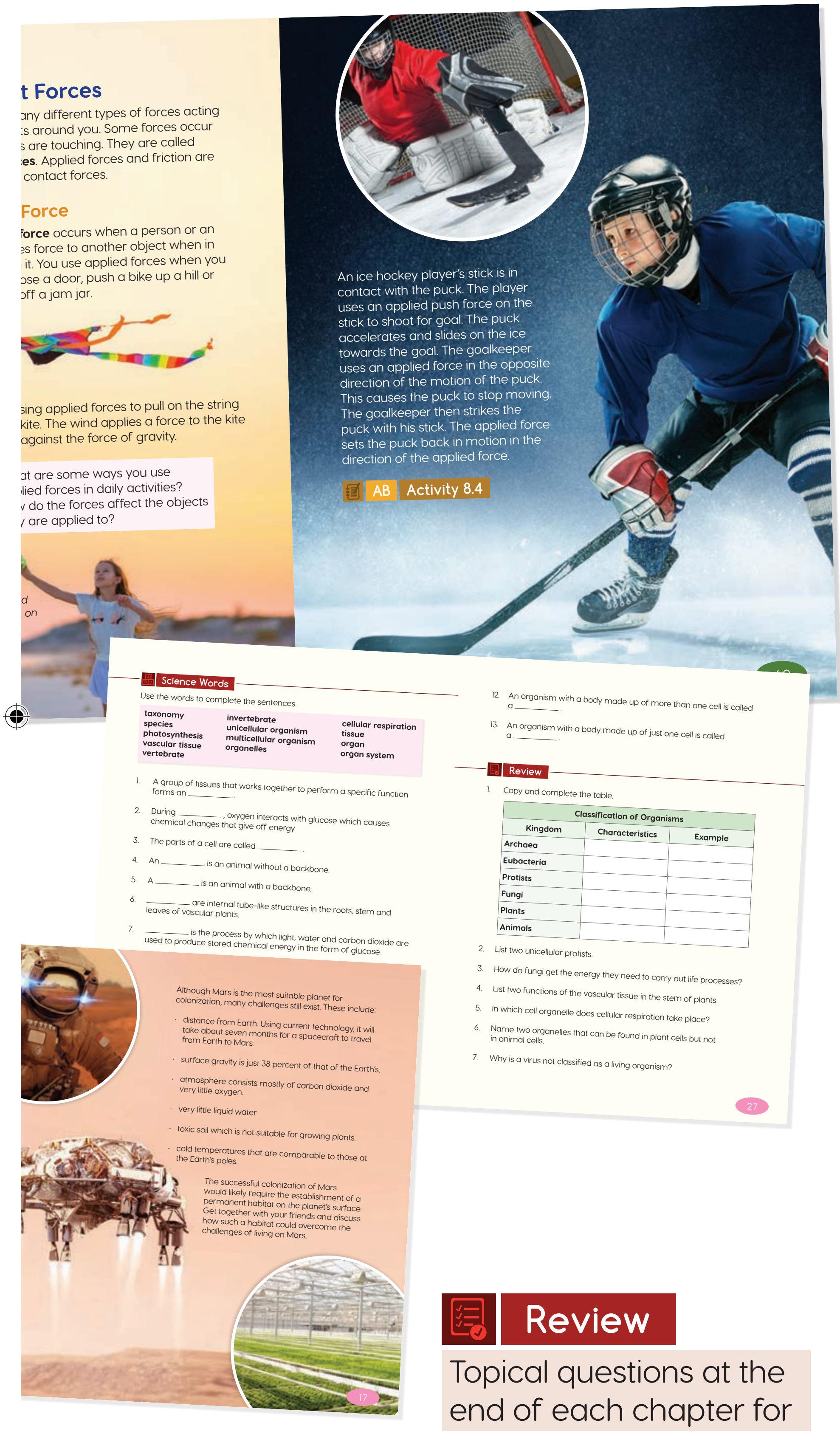
Goes beyond inquiry by encouraging students to design, model and build to engineer solutions to defined problems.

In the Field

Inspirational science-related professions to stir interest in science-related careers.

A Closer Look

Invokes enthusiasm in science by presenting interesting topics beyond the syllabus.



Amazing Fact!

Interesting facts to build interest and enthusiasm.

Did You Know?

Extra information to build students' knowledge base of the current topic.

Try This!

Optional hands-on activities to be conducted in groups or at home.

AB Activity

Links students to the Let's Do Science Activity Book at the appropriate juncture.

Discussion

Topic-related questions and situations for class discussion to build a deeper understanding of topics.

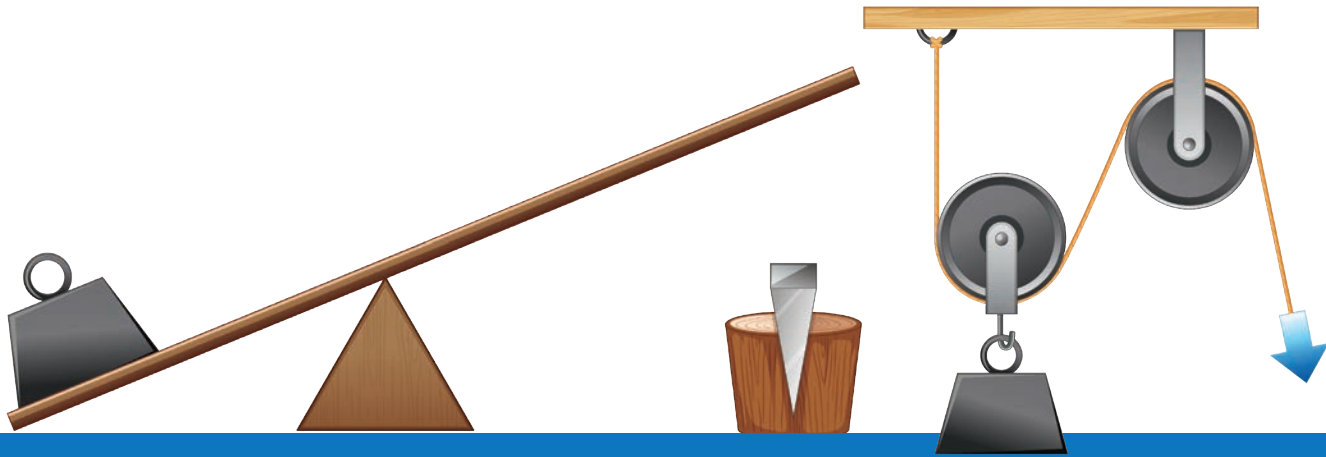
Review

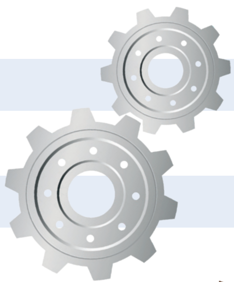
Topical questions at the end of each chapter for formative assessment.

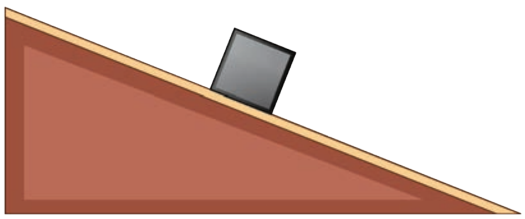
Science Words

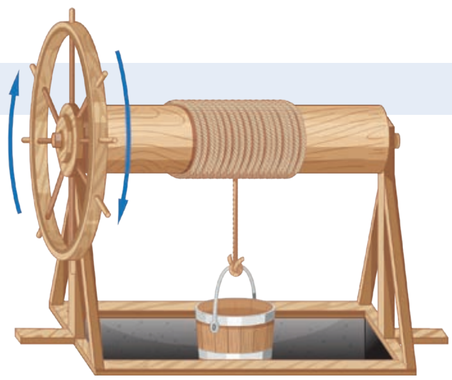
Lists the essential science vocabulary covered in each chapter.

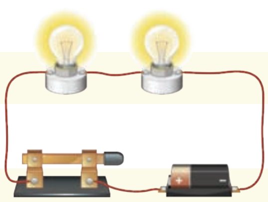
Contents

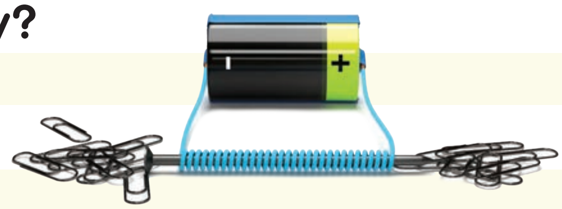












6 The Universe

In this chapter you will ...

- support an argument that the apparent brightness of the Sun and stars is due to their relative distances from the Earth.
- distinguish between solar systems, galaxies and the universe.
- list and describe the general characteristics of the inner and outer planets.
- describe the ways in which humans explore space and list some historic space missions and achievements.

What lies beyond our solar system?

What are the characteristics of stars?

Go Online!

Access interactive content relating to this topic on the NGScience website.
ngscience.com

What objects lie in our solar system? How can we classify the objects?

What Is the Universe?

Think about the place where you live. If you zoom out from your town or city, you'll see that it is located within a country. Zoom out again and you'll see your country is part of our planet – Earth. Continuing to zoom out reveals that the Earth is one of eight planets that, along with the Sun and its orbiting objects, make up our solar system. The solar system is part of a galaxy – the Milky Way, which consists of billions and billions of stars.

Scientists are uncertain about the number of galaxies in the universe. Some scientists estimate there could be more than a trillion galaxies.

What makes up the universe?
Where is Earth located in the universe?

Go Online!

Journey into deep space and discover Earth's place in the Milky Way in a video on the NGScience website.
QuickCode: **R1U2**

Galaxies

If you observe the night sky on a clear night, you might be lucky enough to see a band of light consisting of many stars. The band of light you see is our galaxy – the Milky Way. A **galaxy** is an enormous group of stars, planets, dust and gas clouds that are held together by gravity.

The universe is home to billions of galaxies that all contain billions of stars. However, galaxies beyond our own Milky Way are very faint in the night sky.

Despite their extremely large size and the billions of stars contained within them, most galaxies cannot be seen with the naked eye at night. This is because they are such a great distance from the Earth.

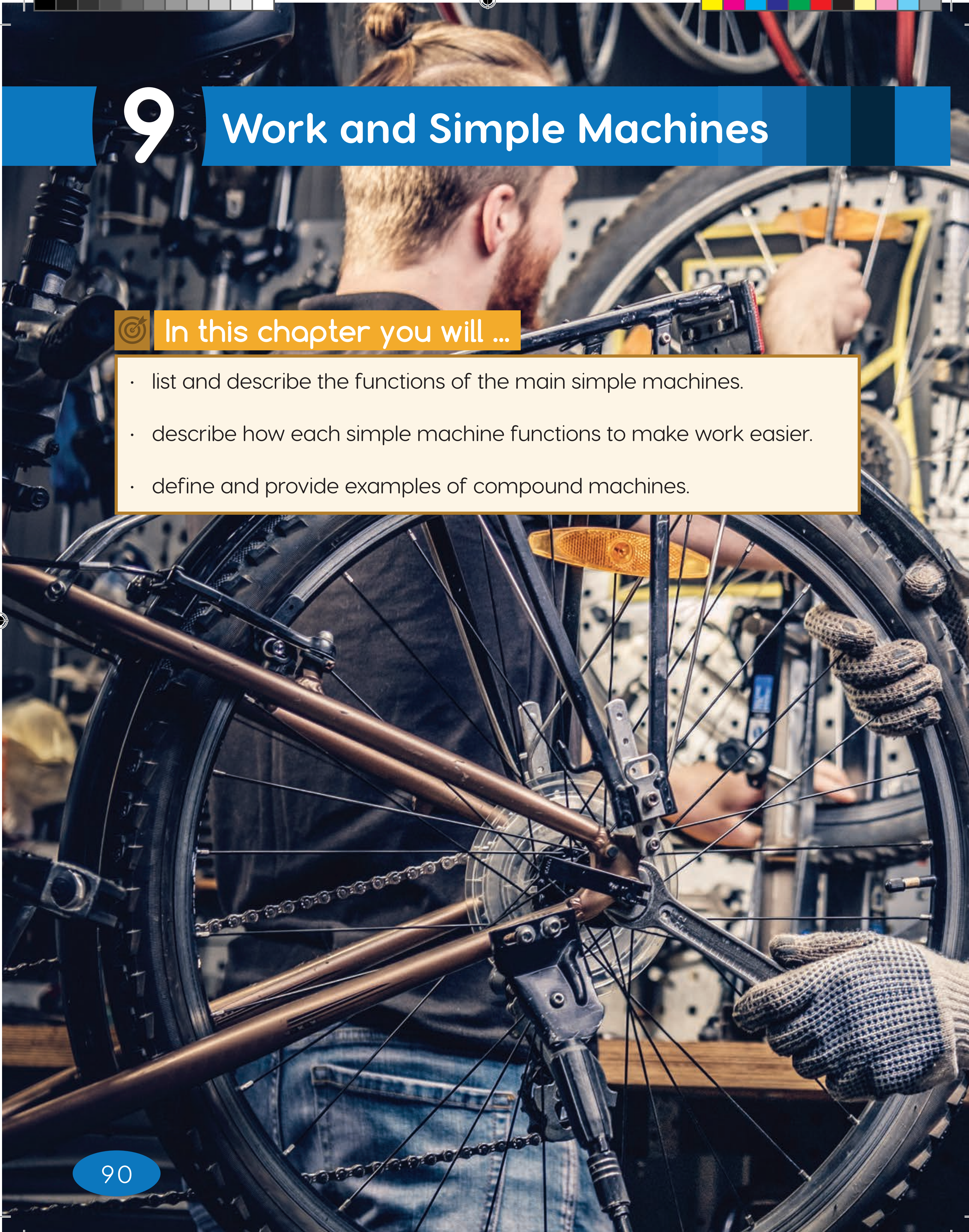
Galaxies come in different shapes and sizes. Our own Milky Way is a spiral galaxy. Spiral galaxies are made up of a flat, rotating disk of stars, dust and gas. Most of the matter is concentrated in the center with arms extending out. Our solar system is located on one of the arms of the Milky Way galaxy which contains younger stars than those in the center of the galaxy.

Some galaxies have an egg-like, elliptical shape. Such galaxies usually contain older stars. Galaxies can also have an irregular shape and contain stars of many different ages.

AB Activity 6.1

Try This!

On a clear night, go outside and give your eyes time to adjust to the darkness. Observe the objects in the night sky. Are you able to see the Milky Way? What other objects are observable to the naked eye?



9 Work and Simple Machines

In this chapter you will ...

- list and describe the functions of the main simple machines.
- describe how each simple machine functions to make work easier.
- define and provide examples of compound machines.

What are simple machines?
How are they used?

How do simple machines make work easier?

Go Online!

Access interactive content relating to this topic on the NGScience website.
ngscience.com

What Is Work?

We use the word 'work' to describe many activities in everyday life. You might help your family to do work in the garden, or help out with housework. In science, the word 'work' has a different and very specific meaning.

Put simply, **work** is defined as force moving an object a certain distance. Work has been done when a force (effort) is applied to an object (load) and it moves a given distance.

Consider a box of toys on your bedroom floor. The force of gravity is acting on the box but it is not in motion so no distance is being covered. No work is being done on the box. Now consider bending down, picking up the box and raising it above your head. You apply a force to the box as you lift it against the force of gravity to a higher position. A force has been applied and the box has moved a distance – work has been done.

The amount of work done relates to the magnitude of the force and the distance moved. A heavier box would require more force to move the same distance. More work would be done. Similarly, moving the same box to a higher position on the shelf would result in more work done as the distance covered is greater.

Let's look at some more examples of work in everyday life.

A weightlifter does work on a barbel as they lift it a distance from the ground to above their head. When they release the barbel, the force of gravity pulls the barbel back to the floor and more work is done.

The force of gravity acts on a coconut in a tree. The forces acting on the coconut are balanced and no work is being done. The stalk of the coconut breaks and the coconut falls to the ground under the force of gravity. The force of gravity pulled the coconut through a distance equal to the height of the tree – work was done. When doing work, the force acting on the object can be contact or non-contact.

What two things must happen for work to occur?

AB Activities 9.1 – 9.2

Think Deeply

Imagine trying to lift a heavy weight into the air. You try with all your might, but are unable to move the weight. Has work occurred? Explain your answer.

▼ *Work is done when a coconut is pulled by the Earth's gravity covering a distance from the top of the tree to the ground.*

A Closer Look

Calculating Work

Imagine going shopping with your parents. To help out, you offer to push the shopping trolley. In doing so, you apply a push force to the trolley and it moves in the direction of the applied force. You are doing work. The magnitude of a force is measured in units called Newtons – named after the famous scientist Sir Isaac Newton. The distance an object moves can be measured in meters. To calculate work, we multiply the magnitude of the force by the distance the object moved.

work = force x distance

The standard units for measuring work are Newton meters (N · m), which can also be expressed in joules (J).

Suppose you push the shopping trolley with a force of 100 N for a distance of 10 meters. How much work has been done?

work = 100 N x 10 m = 1,000 N · m = 1,000 J

If work is calculated by multiplying force by distance, what factors will increase or decrease the amount of work done?

Let's look at the work done when a bucket of water attached to a rope is pulled from the ground to a tree house.

If the weight of the bucket of water is 50 N, then it will need to be pulled with an upward force of 50 N in order to be raised. If the distance from the ground to the tree house is four meters, we can calculate the work needed to move the bucket of water to the tree house by multiplying the required force by the distance.

work = 50 N x 4 m = 200 N · m = 200 J

So when the bucket moves from the ground to the tree house, 200 J of work will be done.

If your weight is 400 N, how much work will be done if you climb the ladder to the tree house?

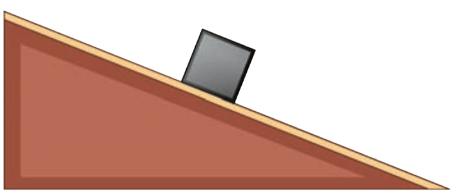
Simple Machines

Imagine hammering a nail into a piece of wood. As you hit the nail, it bends and needs to be replaced. How could you remove the nail? You probably would not be able to apply enough force using only your fingers and hands. If you use the claw of the hammer, much less force is required and the nail can be removed easily.

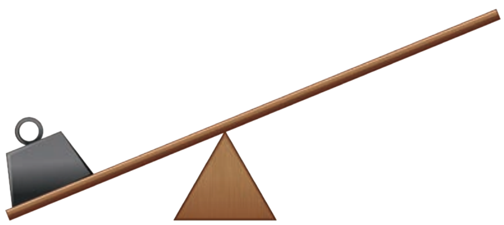
A hammer is an example of a simple machine. **Simple machines** are devices, usually with one moving part, that make work easier. They make work easier by performing one or more of the following:

· multiplying the applied force by increasing the distance of the effort.
· multiplying speed.
· changing the direction of the applied force.

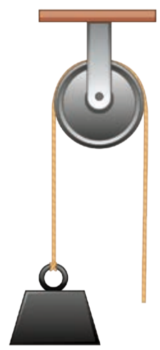
The main types of simple machines are shown below.



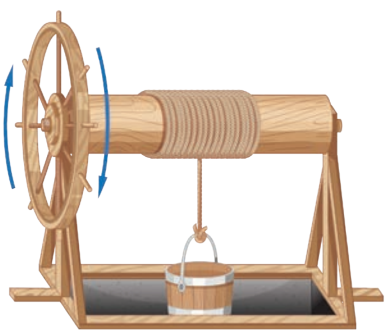
▲ *inclined plane*



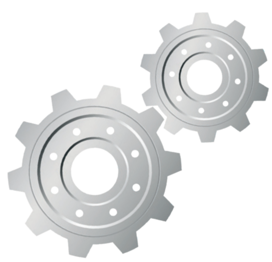
▲ *lever*



▲ *pulley*



▲ *wheel and axle*



▲ *gears*

▲ *wedge*

AB Activity 9.3

Inclined Plane

An **inclined plane**, commonly called a ramp, is a flat surface that is tilted at an angle so that one end is higher than the other. An inclined plane makes work easier when we need to move a load to a higher or lower position. It does this by reducing the effort required, but increasing the distance the load moves.

Inclined planes are used in many ways in everyday life, particularly when we need to move heavy loads over vertical distances. Common examples include a ramp used to load a truck or wheelchair, pedestrian ramps, and the ramps in a multistory car park.

Although not a single, flat surface, staircases are examples of inclined planes. They allow us to move to higher or lower positions using much less effort.

How does an inclined plane function to make work easier?

Did You Know?

A screw is an object that consists of a cylinder with an inclined plane wrapped around it. This helps the screw sink into wood and other surfaces when it is turned.

AB Activities 9.4 – 9.5

Levers

A **lever** is a simple machine that includes a bar that is free to move about a fixed point called a **fulcrum**. Levers make work easier by reducing the effort required to move the load, but increasing the distance moved by the effort. This can be achieved by moving the fulcrum closer to the load or applying the effort further from the fulcrum.

There are three types of levers – first-class levers, second-class levers and third-class levers. Each type of lever makes work easier in different ways.

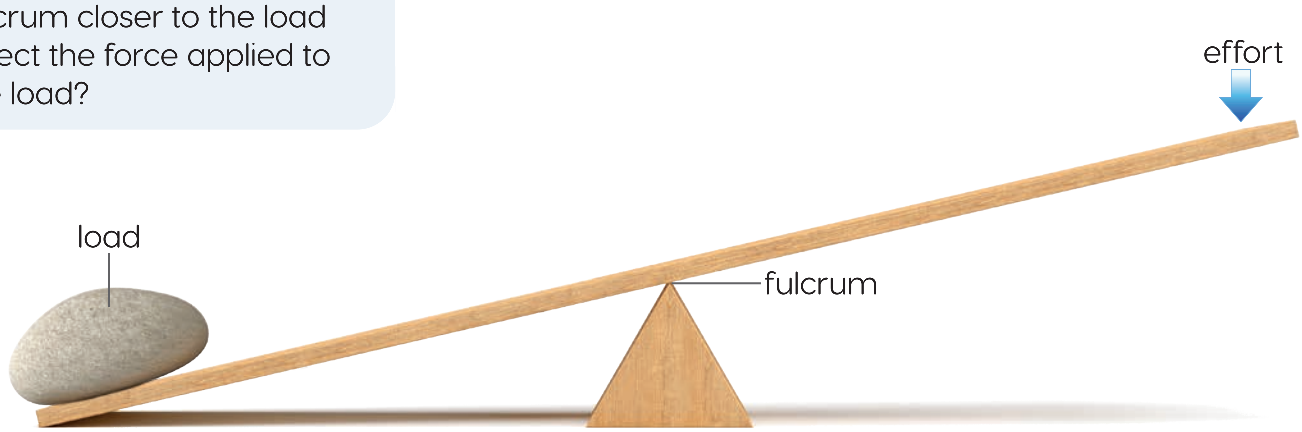
In a first-class lever, the fulcrum is between the load and the place on the bar where the effort is applied. This changes the direction of the effort. Work is the easiest when the effort is applied to the bar as far from the fulcrum as possible. The distance the effort moves is increased but the force applied to the load is multiplied.

▲ *A seesaw is a first-class lever.*

Try This!

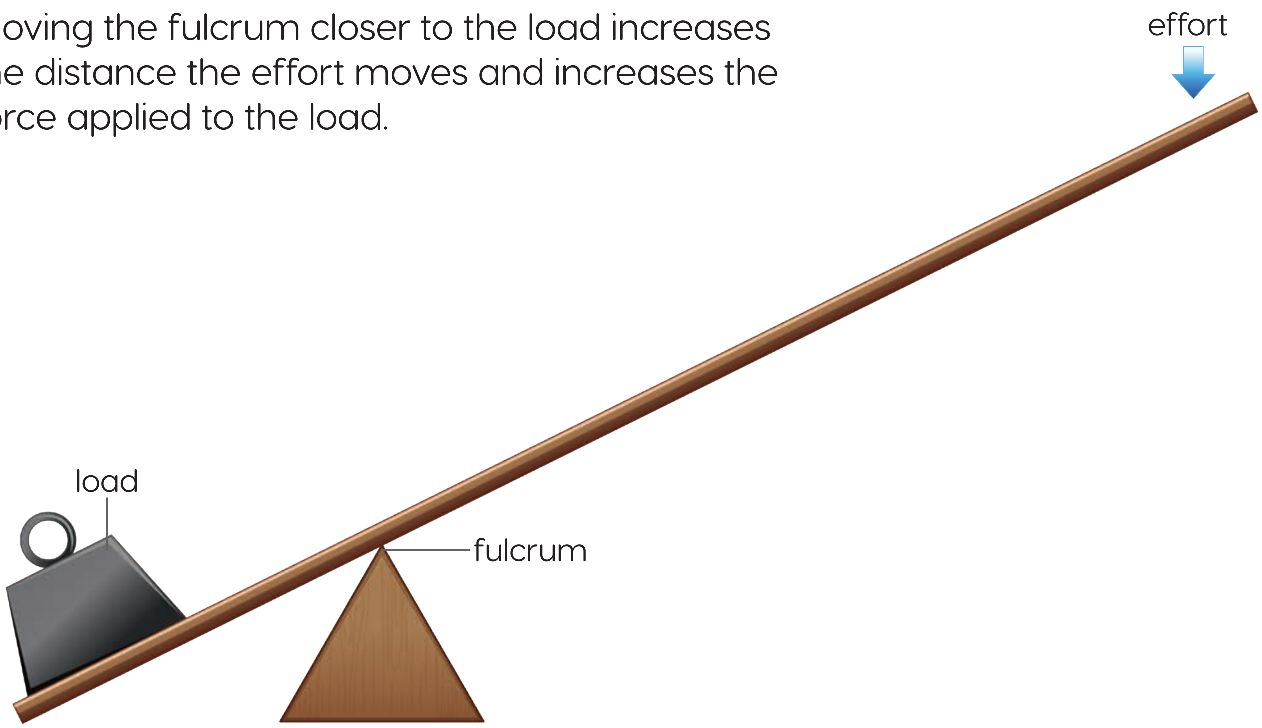
Create a first-class lever using a ruler and a piece of modeling clay as the fulcrum. Place a smaller piece of modeling clay on one end of the ruler. Launch it into the air by applying a push force to the other end. How does moving the fulcrum closer to the load affect the force applied to the load?

How does a first-class lever function to make work easier?



▲ *first-class lever*

Moving the fulcrum closer to the load increases the distance the effort moves and increases the force applied to the load.



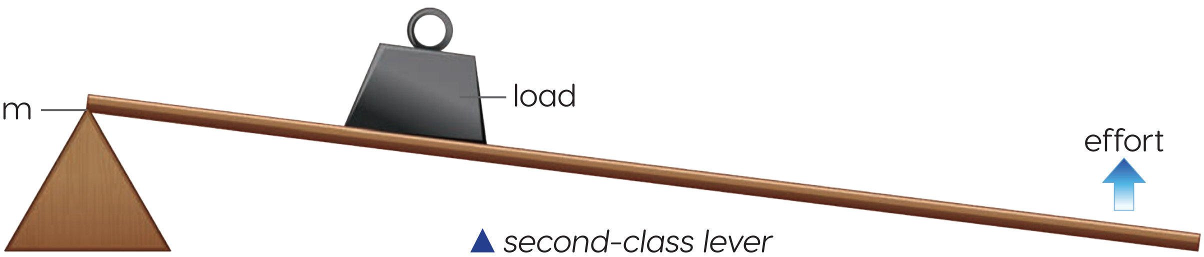
You use a first-class lever when you use a screwdriver to open a tin of paint. The rim of the paint tin is the fulcrum. The fulcrum is close to the load which increases the distance the effort moves and multiplies the force applied to the lid.

The back of a claw hammer, crowbars, seesaws and scissors are objects we use that function as first-class levers.

Think Deeply

Look at the crowbar in the photograph below. Identify the fulcrum, load and effort.

In second-class levers, the load is between the effort and the fulcrum. The effort moves over a larger distance to raise the load a smaller distance but with greater force. The closer the load is to the fulcrum, the larger the distance the effort moves and the greater the force applied to the load. Notice that in second-class levers, the effort applied is in the same direction as the force applied to the load.



▲ *second-class lever*

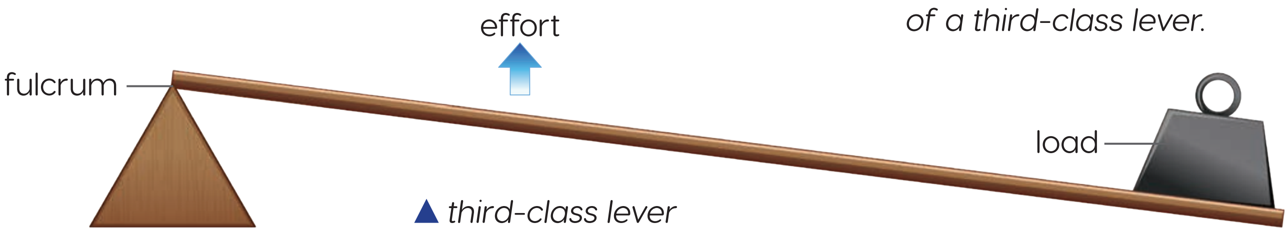
Wheelbarrows, nutcrackers and bottle-openers are objects we use that function as second-class levers.

How do first-class and second-class levers function to make work easier?

In both first-class and second-class levers, work is made easier by decreasing the effort required but applying the effort over a greater distance. In a third-class lever, the effort is between the fulcrum and the load. Greater effort is required to move the load, but the speed at which the load moves is multiplied. As in second-class levers, the direction of the effort and the force applied to the load is in the same direction.

▲ A fishing rod is an example of a third-class lever.

How does a third-class lever function to make work easier?



▲ third-class lever

Fishing rods, baseball bats and brooms are objects that function as third-class levers.

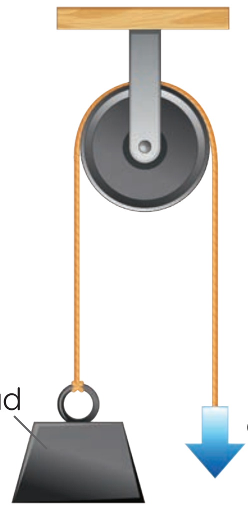
AB Activities 9.6 – 9.7

Pulleys

A **pulley** is a simple machine that is often used to raise or lower an object. A pulley consists of a wheel that rotates freely with a rope or chain that runs through and winds around the wheel. The load is usually attached to one end of the rope and the effort applied to the other.

There are two main types of pulleys – fixed pulleys and movable pulleys. In some cases, multiple pulleys can be used to create a pulley system.

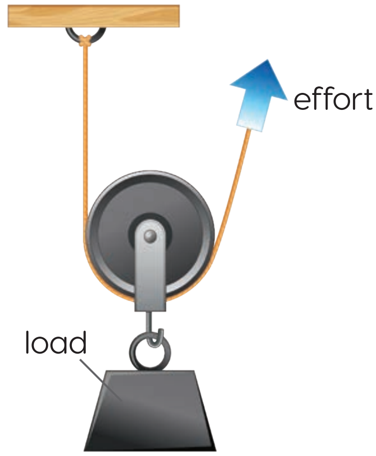
In a fixed pulley, the wheel is attached to a support in a fixed position. A fixed pulley does not change the magnitude of the effort or force applied to the load. It makes work easier by changing the direction of the effort. Fixed pulleys are often used when we need to raise an object. This is achieved by pulling down on the rope in order to raise the load. Work is made easier as the effort is in the same direction as the Earth's gravitational force. When a fixed pulley is used to raise an object, the effort and the load move the same distance.



▲ *fixed pulley*

A movable pulley is not attached to a fixed support. The pulley is often attached to the load and moves as the load moves. Unlike a fixed pulley, the effort and movement of the load is in the same direction.

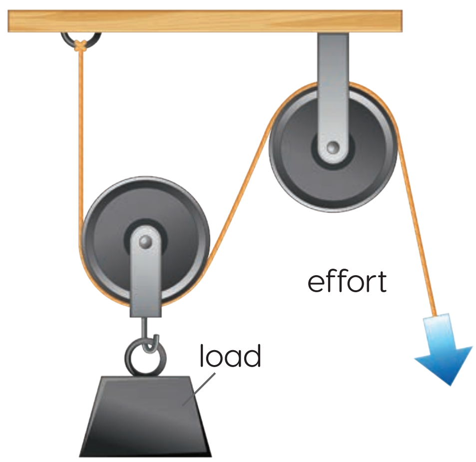
A movable pulley makes work easier by reducing the effort required, but increasing the distance over which it is applied.



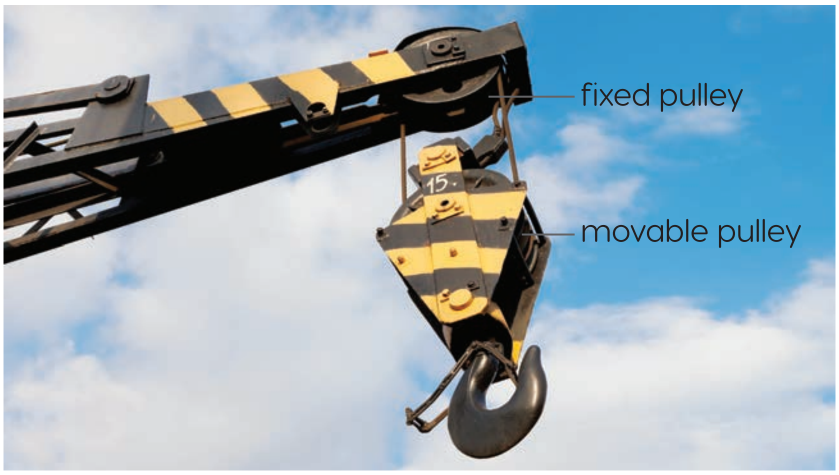
▲ *movable pulley*

How are fixed and movable pulleys different in terms of the effort required to move a load of the same mass?

A pulley system uses a combination of pulleys that function together. Pulley systems often contain both fixed and movable pulleys. They make work easier by changing the direction of the effort and also reducing the effort required by increasing the distance over which it is applied.



▲ *pulley system*



Think Deeply

How would adding another movable pulley to the pulley system above affect the amount of force needed to raise the load?

Compare and contrast fixed pulleys, movable pulleys and pulley systems in terms of how they make work easier.

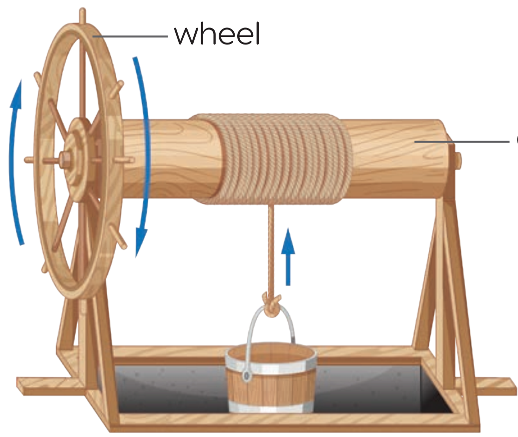
AB Activity 9.8

▲ *When effort is applied to a doorknob, the force applied to the axle is multiplied.*

Wheel and Axle

When you turn on a tap, you are using a simple machine called a wheel and axle. As its name suggests, a **wheel and axle** consists of a wheel which is attached to a rod called the axle. The radius of the wheel is greater than the radius of the axle.

When the wheel is turned, the axle also turns. The effort applied to the wheel results in less effort required to turn the axle as the effort to turn the wheel is applied over a greater distance.



Try This!

In small groups, discuss some other objects that make use of a wheel and axle. For each object, identify which part is the wheel and which part is the axle. How does each object function to make work easier?

Generally, the function of a wheel and axle is to multiply the force on the axle. Steering wheels, cranks, hand drills and doorknobs all make use of this function of a wheel and axle to make work easier.

AB Activity 9.9

In some cases, such as the wheel and axle in a rolling pin, the effort is applied to the axle in order to multiply the distance the wheel moves.

Gears

Gears are simple machines that consist of two or more wheels that fit together with interlocking teeth. When one gear is turned, the other interlocked gear turns in the opposite direction.

▲ *Connected gears turn in opposite directions.*

Gears function in different ways. They change the direction of the applied force. They can multiply the applied force when the effort applied to a larger gear moves over a greater distance than a connected smaller gear. They can also multiply speed when a smaller gear turns a larger gear.

Bicycles, fishing reels, analog watches and can openers are objects that make use of gears.

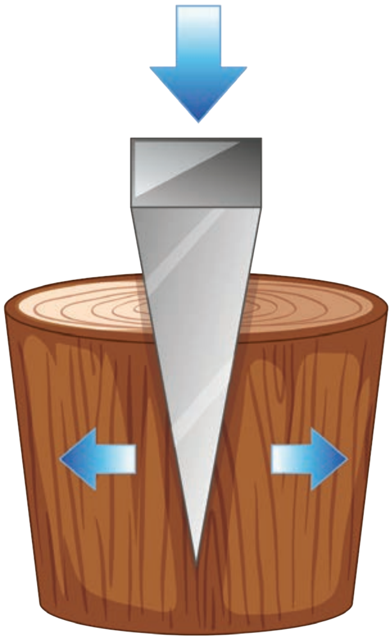
Think Deeply

Many bicycles have a rear wheel fitted with gears of different sizes which are attached to a front gear by a chain. How does using larger and smaller rear gears affect the effort required and the distance the wheel moves?

AB Activity 9.10

▼ *gears inside an analog watch*

▼ *can opener with gears*



▲ *A wedge changes the direction of the applied force.*

Wedge

A **wedge** is a simple machine that is triangular in shape, much like an inclined plane or, in some cases, two inclined planes joined back-to-back. A wedge makes work easier by changing the direction of the applied force.

The head of an axe is a wedge. To split a piece of wood, a downward force is applied to an axe. As the wedge enters the wood, it presses sideways, pushing the wood apart.

Knives, needles, saws, scissors and doorstops are examples of objects that make use of wedges. Wedges are useful in many ways. They can be used to cut and slice, separate objects or hold them in place.

How does a wedge function to make work easier?

AB Activity 9.11

Compound Machines

Many objects we use from day to day consist of two or more simple machines that work together to achieve a common function. An object that consists of two or more simple machines is called a **compound machine**.

Scissors are an example of a compound machine. Scissors consist of two levers held together by a pivot which is the fulcrum. Each blade of the scissors is a wedge. The levers and wedges function together to make the work easier when you cut an object.

▲ *Scissors consist of two types of simple machines – levers and wedges.*

A bicycle is a compound machine. The handle bars and pedals are wheel and axle machines. A chain connects gears on the bicycle frame to gears on the rear wheel. The brakes and brake handles are levers. All of the simple machines that make up a bicycle function together to form a compound machine.

AB Activity 9.12

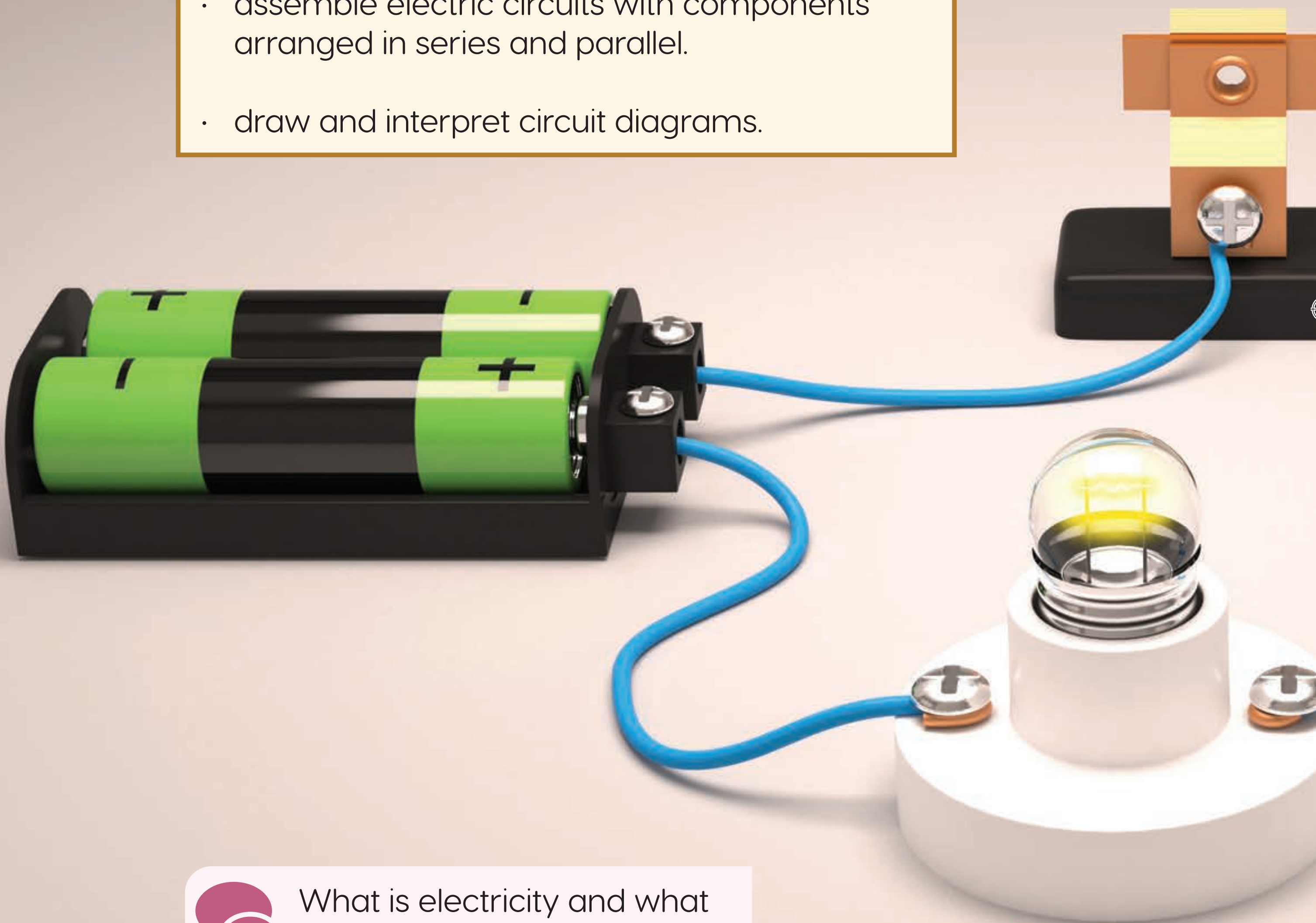
Think Deeply

You have learned that a wheelbarrow is an example of a second-class lever. Why is a wheelbarrow an example of a compound machine?

10 Electricity and Circuits

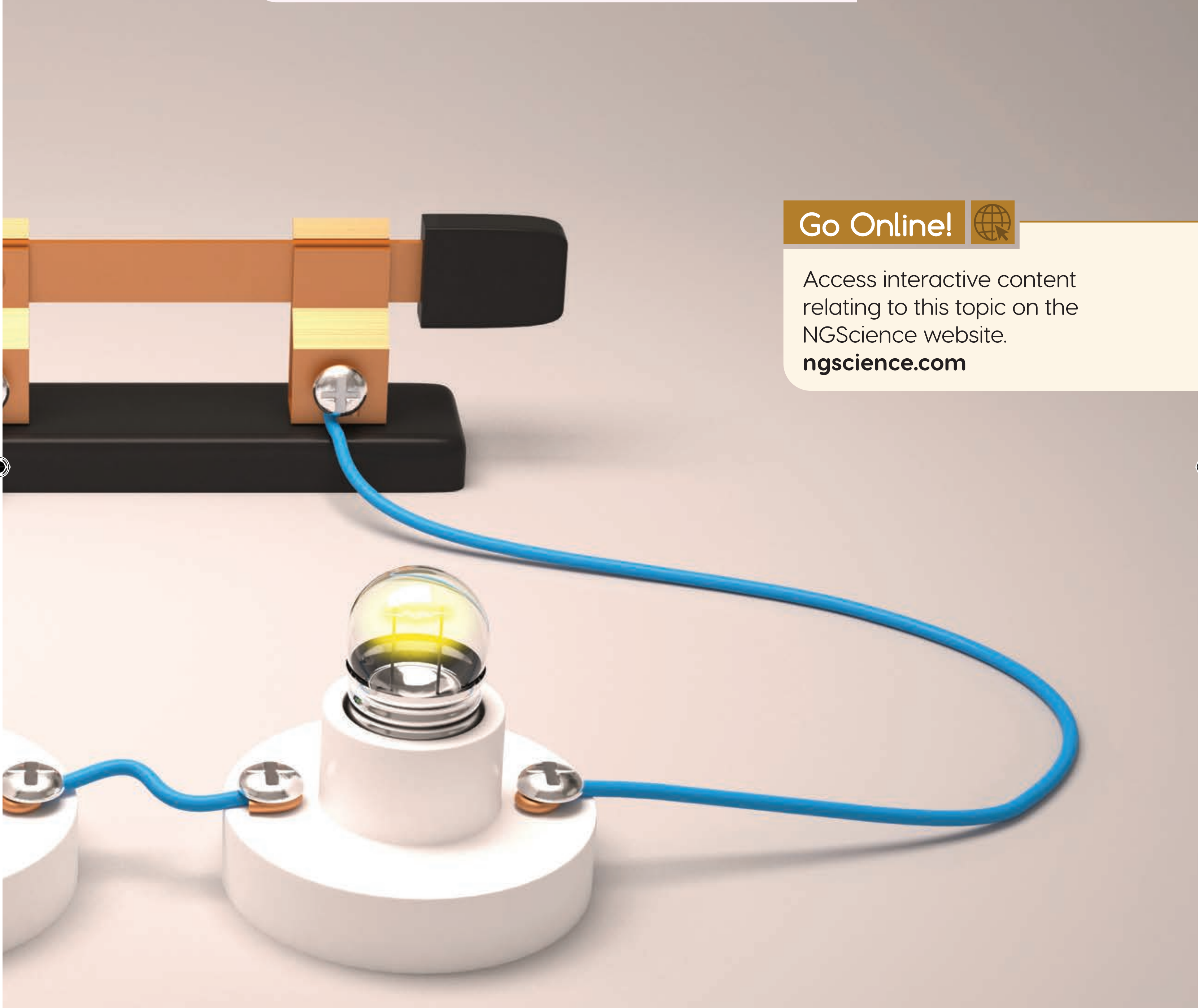
In this chapter you will …

- define and distinguish between electric charge, electric discharge and electric current.
- list the ways in which people use electricity.
- assemble electric circuits with components arranged in series and parallel.
- draw and interpret circuit diagrams.



What is electricity and what makes it so useful to people?

How can components be assembled to create an electric circuit?



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How does arranging circuit components in series and parallel affect the devices in a circuit?

What Is Electricity?

All matter is made up of tiny particles called atoms. An atom is made up of much smaller particles called protons and electrons. Protons have a positive charge and electrons have a negative charge.

Most objects contain a balanced number of positive and negative charges. The charges cancel each other out.

Sometimes electrons can move from one atom to another. When this occurs, the atom that lost the electron becomes positively charged and the atom that gained the electron becomes negatively charged. The energy associated with these exchanges and movement of charge is called **electricity**.

Understanding how charge moves between and within materials allows us to generate and control electricity in different ways.

What happens to an atom when it loses an electron?

Think Deeply

What are the different ways people produce electricity? What are the advantages and disadvantages of each type of electricity production?

◀▼ Electricity is produced at power stations and travels through an interconnected grid to our home and cities.

▲ *Electricity powers our homes and cities.*

Electricity can be easily converted into other forms of energy, such as mechanical energy, light, heat and sound. Electricity is used by people in many ways. It is used to power lights, electric motors and many household appliances. Devices such as phones, flashlights and electric cars use electricity that is stored as chemical energy in batteries.

Why is electricity useful to people?
What are some ways we use electricity?

AB Activity 10.1

Amazing Fact!

Electric cars are gaining popularity all over the world as they do not produce any of the harmful emissions that fuel-powered cars do. Scientists and engineers are continually improving electric car designs and developing new technologies that allow electric cars to travel further and faster than many fuel-powered cars.

▲ *Electric cars use batteries that convert stored chemical energy into electricity.*

Electric Charge

▲ *Unlike charges between the balloons and the boy's hair cause them to attract each other.*

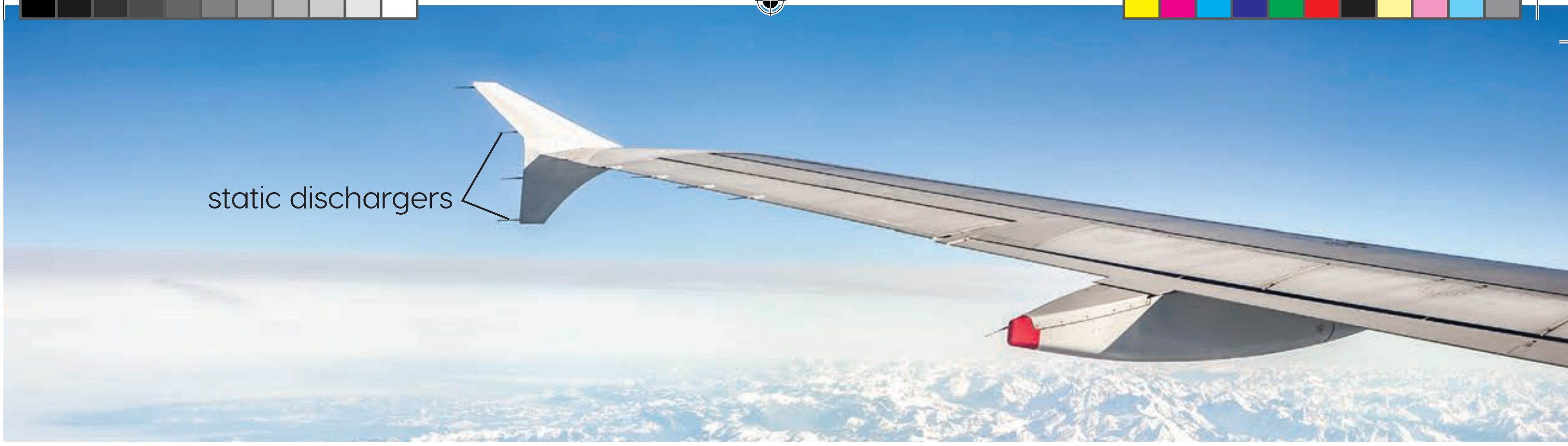
When an electron separates from an atom, the atom becomes positively charged. When the electron joins a new atom, that atom will become negatively charged. This movement of charge occurs constantly within matter. If the movement of charge is within the same object, the overall charge of the object remains the same as the charges cancel each other out.

Sometimes electrons from atoms in one object are transferred to the atoms of another object. When this occurs, the object that loses electrons will become positively charged and the object that gained electrons will become negatively charged. As unlike charges attract, the two objects experience a force of attraction. This property of particles that causes them to attract or repel one another is called **electric charge**.

Have you ever opened the clothes dryer and discovered that some of the clothes are stuck together? This happens because some clothes gain or lose charge as they tumble in the dryer. The clothes stick together when the positively-charged clothes are attracted to the negatively-charged clothes.

AB Activities 10.2 – 10.3

▶ *Unlike charges between the balloon and the cat causes them to attract each other.*



Electric Discharge

Have you ever received an electric shock when touching a metal doorknob? An electric shock is an example of an electric discharge. **Electric discharge** is the movement of the buildup of electric charge from one place to another.

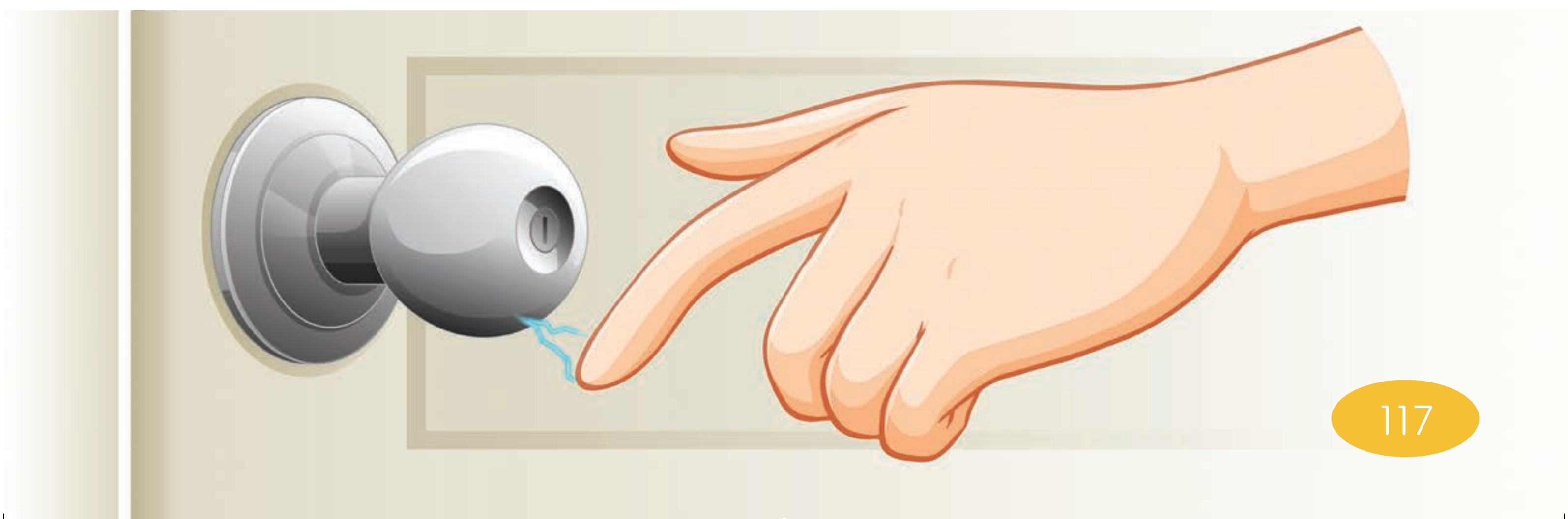
When you walk on a surface such as carpet, you gain negatively-charged particles – your body becomes slightly negatively charged. As you reach for the doorknob, the negative charges in your hand attract the positive charges in the metal. At a close enough distance, the buildup of charge can cause the air between your hand and the doorknob to become electrically charged. This creates a path for the charges to move from your hand to the doorknob.

The electric shock you experience is the movement of electrons from your hand, through the air and into the doorknob. This electric discharge occurs rapidly and excites the air around it – creating a flash of light.

Did You Know?

On an airplane, electric discharge can be dangerous as it can interfere with the plane's electronics and communication equipment. To prevent the build up of electric charge, airplane wings are fitted with static dischargers. These conducting rods gradually release charge from within the plane into the air.

▼ *Electric discharge occurs as electrons rapidly move from your hand to the metal doorknob.*



Lightning is an example of an electric discharge. During a storm, small bits of ice and raindrops bump into each other as they move around within a cloud. This creates an electric charge within the cloud. Normally the top of the cloud becomes positively charged and the bottom of the cloud becomes negatively charged.

As opposite charges attract each other, the negative charge at the bottom of a cloud causes the ground beneath it to become positively charged. Eventually the buildup of charge is so great that the negative charges race to the positively-charged ground. When the electric charge discharges, we see a bright flash in the sky – lightning.