Let's Do SCIENCE

Primary 5

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

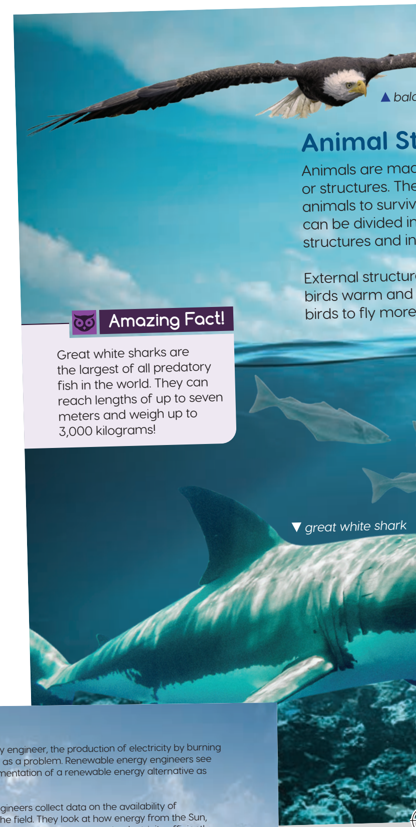
In the Elaborate phase, students refine and consolidate their acquired knowledge and skills. Opportunities are provided for students to further apply their knowledge and skills to new situations in order to broaden and deepen their understanding of the concept. Students may conduct additional investigations,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

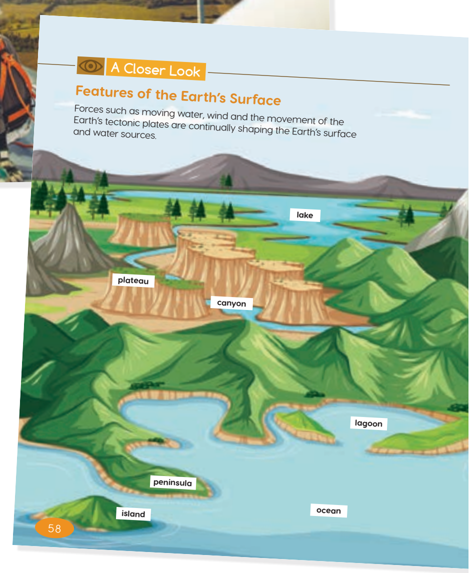
The Let’s Do Science textbooks include the following features:

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.

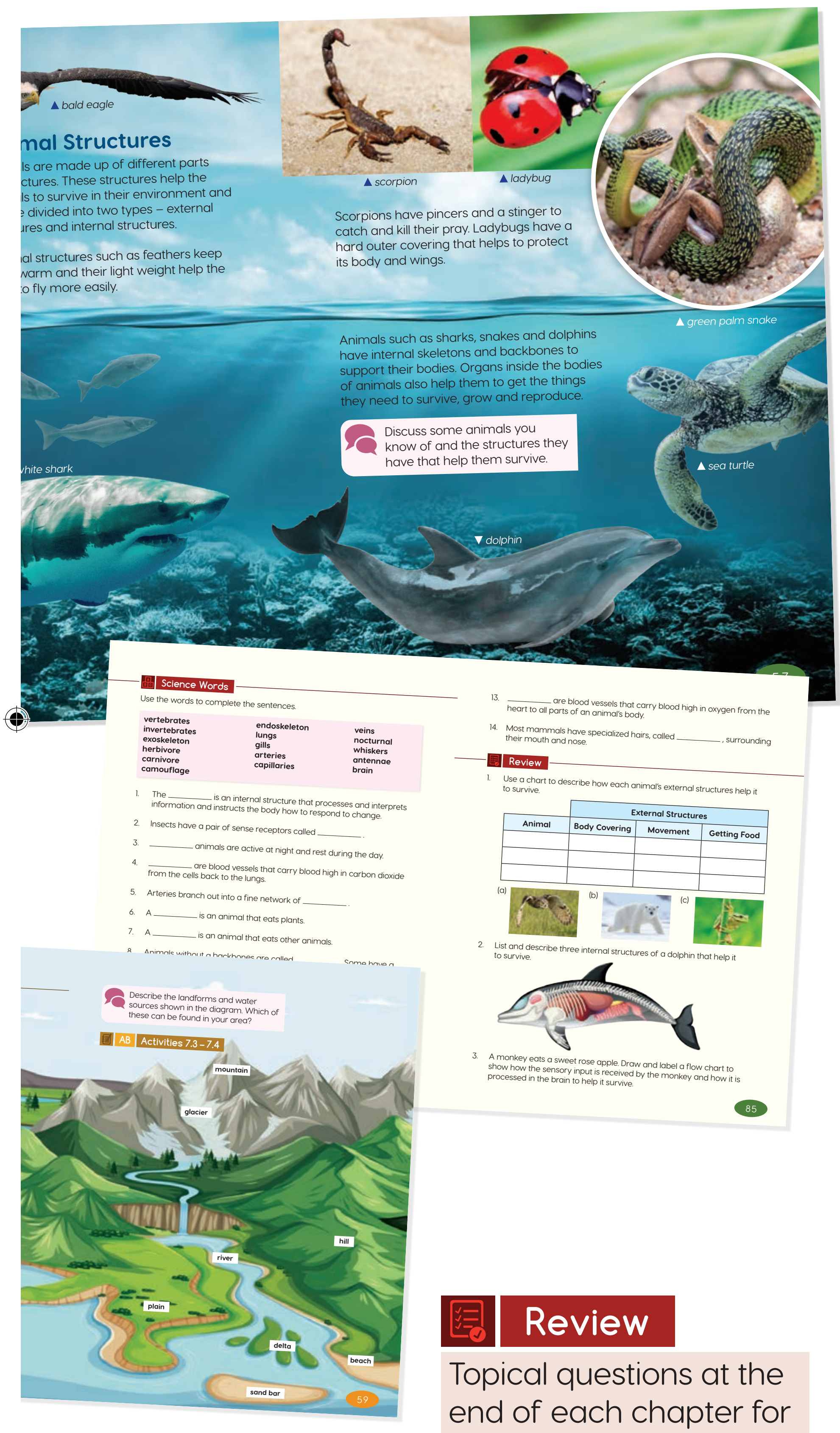


In the Field

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.

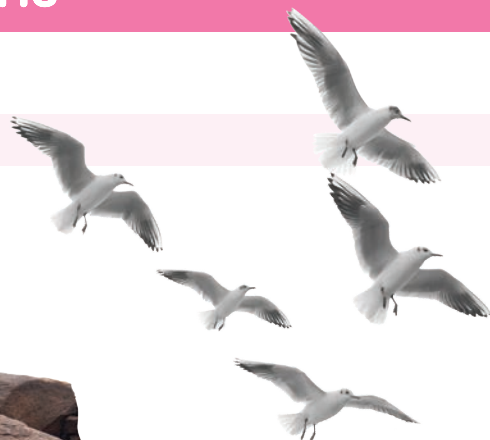
Review

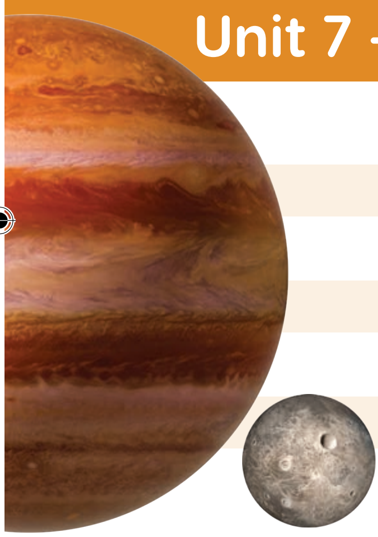
Topical questions at the end of each chapter for formative assessment.

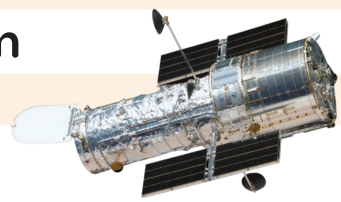
Science Words

Lists the essential science vocabulary covered in each chapter.

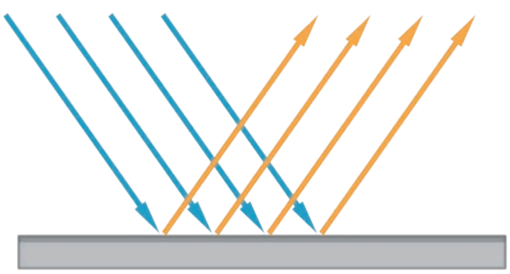
Contents












6 Earth's Systems

In this chapter you will ...

- list and describe the Earth's four main spheres.
- use models to describe how parts of an individual Earth sphere work together to affect the functioning of that Earth sphere.
- identify and describe relationships within and between the Earth's main spheres.
- develop models to describe the interactions that occur between the Earth's spheres.

What are Earth's main spheres?
What makes up each sphere?

What interactions occur between Earth's main spheres?

Go Online!

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

Earth's Spheres

The Earth is a complex system. Interactions are continually occurring between the land, water, air and its organisms. Scientists divide the Earth into four subsystems, called spheres. The four main spheres are the geosphere, hydrosphere, atmosphere and biosphere.

The **geosphere** consists of all of the rock on Earth. This includes the interior of the Earth and its rocky surface.

All of the water on Earth makes up the **hydrosphere**. This includes all of the salt water, fresh water, groundwater, ice and water vapor in the air.

The layer of gases surrounding the Earth is called the **atmosphere**. The atmosphere stretches from the Earth's surface to a height of about 10,000 kilometers (6,214 mi). It is the barrier between the Earth and outer space.

Go Online!

Watch an introductory video about Earth's main spheres on the NGScience website.
QuickCode: **D5H3**

All of the organisms on Earth, from bacteria and other microorganisms to the great variety of plants and animals, make up the **biosphere**.

AB Activity 6.1

8 Forces and Interactions

In this chapter you will …

- describe and distinguish motion, speed, velocity and acceleration.
- describe the different ways in which forces can affect the motion of an object.
- support an argument that the gravitational force exerted by Earth on objects is directed down.
- describe Newton's three laws of motion.

How can forces affect the motion of objects?

How can we describe and measure the motion of objects?

Go Online!

Access interactive content relating to this topic on the NGScience website.
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How does the Earth's gravitational force affect the things on its surface?

Describing Motion

What Is Motion?

The things around us move in different ways. When something is moving, we say it is in **motion**. An object is in motion when it is continually changing position in relation to other objects. We can describe motion in different ways.

You can describe the motion of a child on a swing as a back and forth motion. The people on a carousel move round and round. An airplane is in motion as it moves down a runway. It moves in a straight line, then up into the air.

▲ *The people on the carousel are in motion as they spin round and round.*

Try This!

In small groups, list some objects you see in motion from day to day. Take turns to describe the motion of the objects.

AB Activity 8.1

Speed, Direction and Velocity

When describing the motion of an object, we often talk about the speed and direction it is moving. **Speed** describes how fast or slow something is moving. It describes the distance an object travels in a certain time. To calculate the speed of an object, we need to divide the distance it travels by the time taken to cover that distance.

$$\textbf{speed} = \frac{\textbf{distance}}{\textbf{time}}$$

Let's calculate the speed of a cyclist that covers a distance of 28 kilometers in one hour.

$$\textbf{speed of cyclist} = \frac{\textbf{28 km}}{\textbf{1 hour}}$$

$$= \textbf{28 km/h}$$

We can say the speed of the cyclist was 28 kilometers per hour.

A car covers a distance of 210 kilometers in three hours. Let's find the speed the car was traveling.

$$\textbf{speed of car} = \frac{\textbf{210 km}}{\textbf{3 hours}}$$

$$= \textbf{70 km/h}$$

We can say the speed of the car was 70 kilometers per hour.

Most objects in motion are not traveling at a constant speed. During a race, a motorcycle speeds up as the race starts. It may reach a top speed of 150 kilometers per hour on the straight parts of the track and slow down to 50 kilometers per hour as it turns corners.

The speed of the motorcycle over the entire race is its average speed. **Average speed** is calculated by dividing the total distance covered by the total time taken to cover that distance. If the motorcycle race was 60 kilometers and the motorcycle completed the race in half an hour, we can say its average speed for the race was 120 kilometers per hour.

Try This!

In small groups, use a trundle wheel to mark the start and finish line on a 100-meter running track. Take turns to run the length of the track and measure your average speed over 100 meters.

What is average speed? How is it calculated?

Direction is the course or line from one object to another. The four cardinal directions of north, east, south and west are often used to describe motion.

Denver is about 3,200 kilometers to the east of San Fransisco. An airplane completes the flight in four hours. To describe the motion of the airplane, we can say it travels at a speed of 800 kilometers per hour in an easterly directly.

When we use speed and direction to describe the motion of an object, we are describing its **velocity**.

When we know the velocity of an object in motion at a certain position, we can predict where the object will be in the future if it maintains that velocity. We can also predict the time it will take for an object to arrive at a certain position.

How does knowing an object's velocity allow us to predict its motion?

AB Activities 8.2 – 8.3

Third Law of Motion

Newton's third law of motion states that for every action, there is an equal and opposite reaction. This means forces always act in equal but opposite pairs.

Let's look at Newton's third law using the example of a diver on a diving board. When standing on the diving board, the force of gravity pulls the diver down. This is an action force. At the same time, the diving board is pushing the diver up. This is a reaction force. When the diver jumps and pushes down on the diving board, the board pushes the diver up with an equal and opposite force.

In athletics, sprinters use special blocks to secure their feet before the race begins. When the race begins, the sprinters exert an action force onto the blocks behind them. The blocks exert a reaction force in the forward direction and propel the sprinter forward.

Go Online!

Watch the laws of motion in an animated video on the NGScience website.
QuickCode: **J7R3**

AB Activity 8.15

Science Words

Use the words to complete the sentences.

motion	**force**	**air resistance**
speed	**contact force**	**non-contact force**
average speed	**applied force**	**magnetic force**
direction	**friction**	**electric force**
velocity	**water resistance**	**gravitational force**
acceleration	**streamlined**	**inertia**

1. A force that can act at a distance is called a ____________ .
2. ____________ occurs in an object due to the motion of electrically-charged particles.
3. ____________ is the tendency of objects to continue at their current velocity.
4. A ____________ object is shaped in a way to reduce drag.
5. ____________ is drag that occurs when objects move through water.
6. ____________ is drag that occurs when objects move through air.
7. The distance an object travels in a certain time is its ____________ .
8. A ____________ is a push or a pull.
9. Any change in the velocity of an object is called ____________ .
10. A force that occurs when objects are touching is a ____________ .
11. ____________ is a force that opposes motion when the surfaces of objects rub together.
12. ____________ is the course or line from one object to another.

13. The speed and direction of an object is its ____________ .

14. ____________ is the total distance covered and the total time taken to cover that distance.

15. A force created when there are unbalanced electrical charges inside an object is called an ____________ .

16. An object is in ____________ when it is in the process of changing position.

17. ____________ is an invisible force that pulls on other objects.

18. An ____________ occurs when a person or object applies force to another object when in contact with it.

Review

1. How can you calculate the average speed of an object?

2. What is the difference between velocity and acceleration?

3. Provide an example of:
   (a) balanced forces acting on an object.
   (b) unbalanced forces acting on an object.

4. List five ways forces can affect the motion of an object.

5. Provide an example where people intentionally increase friction.

6. Provide an example where people intentionally decrease friction.

7. Why do people make objects that are streamlined?

8. What is the difference between mass and weight?

9. Why do the people on a bus move forward when it stops abruptly?

10. Use Newton's third law of motion to describe how a rocket is launched into space.

10 Energy

In this chapter you will ...

- list and describe different forms of energy.
- describe the ways in which thermal energy moves within an object or between objects.
- provide evidence that energy can be transferred from place to place by heat.
- describe the ways in which heat moves through conduction, convection and radiation.

What are some different forms of energy? How do we use different forms of energy?

What is thermal energy?
How does thermal energy move between objects?

Go Online!

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

▲ *The city of Hong Kong during the day.*

What Is Energy?

Energy is all around us. We cannot see energy, but we can see the things that energy does. Energy makes things move. It powers the machines we use. It can make things get hotter or produce sound. Energy is used to light up our homes and cities and power the vehicles we use.

All organisms need energy to grow, reproduce and carry out life processes. Plants use the light energy from the Sun to make food in the form of sugar. This energy is passed to animals and people when they eat plants and other animals.

Scientists define **energy** as the ability to do work or cause change. The work or change caused by energy can be measured and observed.

Discuss the different ways energy affects your daily life.

▼ *The city of Hong Kong at night.*

Forms of Energy

Energy cannot be made and cannot be destroyed. It exists in many forms and can be transformed from one form to another. Let's take a brief look at some forms of energy.

Kinetic energy is the energy of movement. A car speeding along a motorway has kinetic energy. The faster the car moves, the more kinetic energy it has.

An object does not have to be moving to have energy. An object can have energy due to its position or structure. This energy is called potential energy. A roller coaster car at rest at the top of a track has potential energy. The potential energy is converted to kinetic energy when the car speeds down the track.

All matter is made up of tiny particles. The movement of these particles is called thermal energy. All objects have thermal energy. The faster the particles in matter move, the more thermal energy it has.

Try This!

Gravitational potential energy is the energy stored in an object due to its height above the Earth's surface. Discuss some situations where an object loses kinetic energy and gains potential energy and vice versa.

▲ *The greater the speed of the car, the greater its kinetic energy.*

▲ *Plants use light energy to make food. The energy is passed to animals when they eat plants.*

Chemical energy is energy that is stored. It is a type of potential energy. Energy is released when chemical reactions take place. Food is a form of chemical energy. When we eat food, a chemical reaction converts the chemical energy into kinetic energy that enables us to move about, keep warm and carry out life processes.

Think Deeply

Why is chemical energy a form of potential energy?

Fuels such as gasoline, coal, gas and wood have chemical energy. A chemical reaction occurs when the fuels are burned and light and heat are released.

Electrical energy is generated by the movement of charged particles – electric current. Electrical energy is very useful to people as it allows energy to be moved from place to place or be converted into other forms of energy.

▼ *Electric current travels in transmission lines from power stations to our cities and homes.*

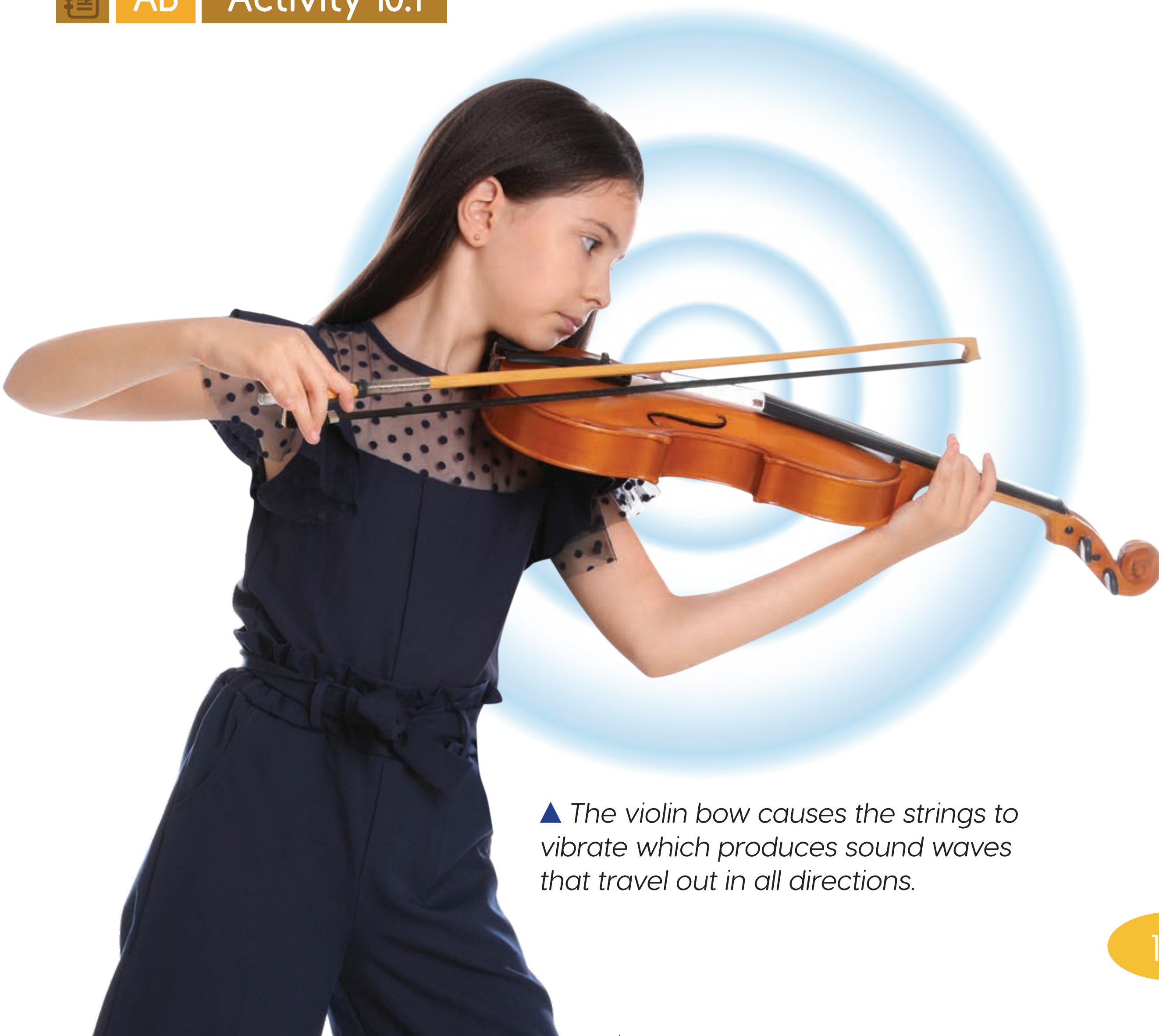
Light energy is a form of energy that travels in magnetic and electric fields. Visible light is the only form of energy that we can see. The light from the Sun is our most important source of light energy.

Sound energy is caused when something vibrates. The vibrations travel in waves. We hear sounds when sound waves reach our ears.

In this chapter, we are going to take a closer look at two types of energy – thermal energy and light.

▲ *A battery-powered flashlight converts chemical energy into electrical and light energy enabling the boy to see at night.*

AB Activity 10.1



▲ *The violin bow causes the strings to vibrate which produces sound waves that travel out in all directions.*

Thermal Energy

What Is Thermal Energy?

All matter is made up of tiny particles. Whether matter is in a solid, liquid or gas, these particles are always in motion. How much these particles move is called **thermal energy**.

The more thermal energy matter has, the higher its temperature. **Temperature** is how hot or cold matter is. It is a measure of the average kinetic energy of the particles in matter. The faster the particles mover, the greater the temperature.

When matter gains thermal energy, the particles that make up the matter move faster. Its thermal energy increases and its temperature also increases. When matter loses thermal energy, the particles that make up the matter move slower. Its thermal energy decreases and its temperature decreases.

Try This!

In small groups, place a glass of water in sunlight and use a thermometer to measure how its thermal energy changes throughout the day.

▲ *The particles in the hot coffee have more kinetic energy than the particles in the cold soda. The coffee has more thermal energy.*

So how does matter gain thermal energy? The movement of thermal energy is called **heat**. Heat occurs whenever there is difference in temperature.

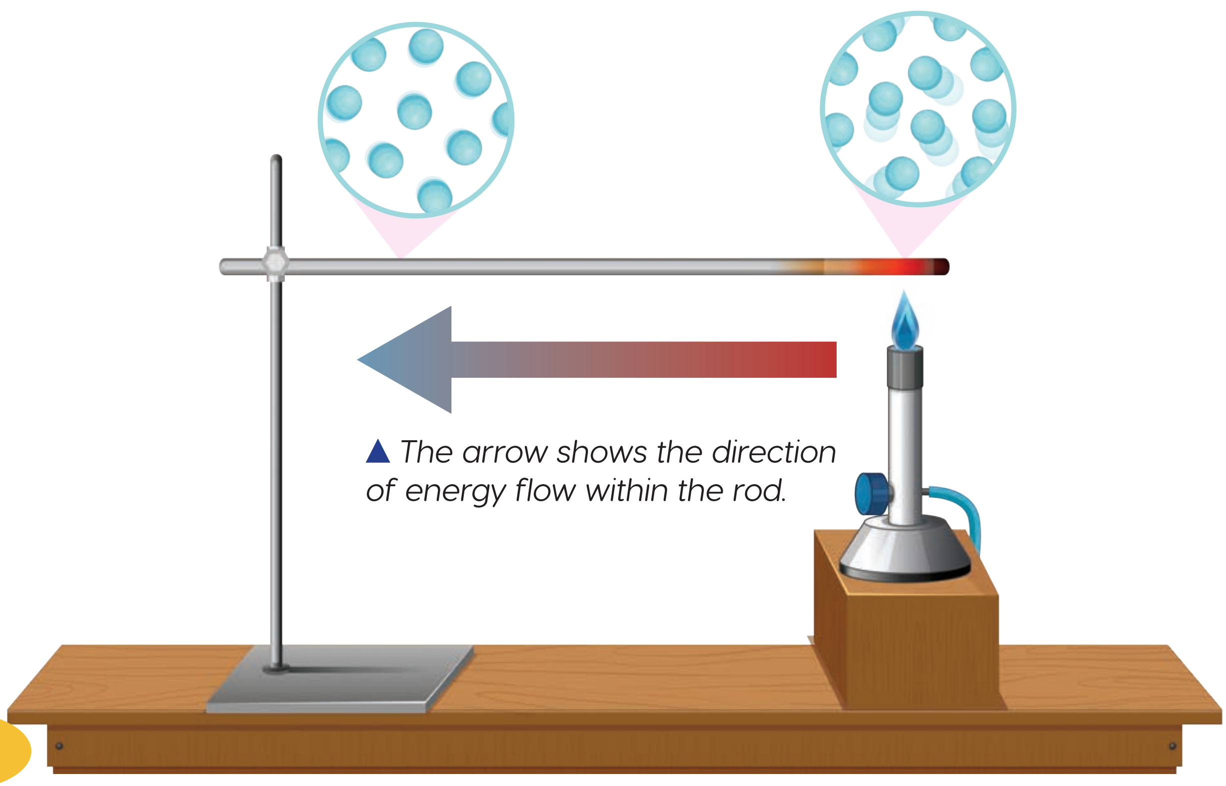
Let's look at an example of the heat that occurs when a hot object comes in contact with a cold object. In both objects, the particles are moving – they have kinetic energy. When the objects are touching, their particles collide with each other. As they collide, the hot object passes energy to the cold object. The hot object gets cooler and the cold object gets warmer. Heat will continue to move in this way until the temperature of both objects is equal.

When you place a cold metal spoon into a hot cup of tea, energy moves from the hot tea to the spoon. The tea loses thermal energy and gets cooler. The spoon gains thermal energy and gets hotter. The metal spoon will continue to gain thermal energy from the hot tea until the temperature of the tea and the spoon are equal.

How does heat move through the metal rod in the photograph above?

Just as heat moves from hot to cold between objects, it also moves in this way within objects. Let's look at an example of placing a metal rod over a fire. The heat from the fire will cause the particles at the tip of the rod to gain thermal energy and its temperature increases. These particles then collide with the particles adjacent to them. In this way, heat in transferred from the hot region to the cold region of the metal rod.

AB Activity 10.2



▲ *The arrow shows the direction of energy flow within the rod.*

What is the difference between temperature and thermal energy?

Temperature vs Thermal Energy

Temperature is a measure of the average kinetic energy of the particles in a given object. It is different from thermal energy – which is a measure of the total kinetic energy of an object's particles.

Consider a nail that has been heated until it glows white-hot. Its temperature is around 1,000°C. The particles inside the nail are moving back and forth with high kinetic energy.

Now consider a large steel beam that supports a bridge. On a winter morning, the temperature of the bridge is just 5°C – much colder than the metal nail. However the metal beam contains more thermal energy than the nail as it contains far more particles.

Similarly, a boiling pot of water has less kinetic energy than the water under an ice-covered lake.

▶ *The hot metal nail has a higher temperature, but less thermal energy than the cold steel beam.*

▲ *Heat is transferred from the pan to the salmon by conduction.*

Transfer of Thermal Energy

Thermal energy moves in three main ways – conduction, convection and radiation.

Think again how heat moved in the metal rod placed on a fire. The thermal energy moved from the hot part of the rod to the cooler part of the rod. This movement of heat within an object is called **conduction**. Conduction also occurs when objects are touching. If you were to hold the cool end of the rod, before too long it would feel warm as thermal energy moves by conduction to your hand.

Heat transfer from a hot cup to your hands and cooking a piece of fish in a pan are also examples of conduction.

▶ *Heat passes from the cup of hot chocolate to the girl's hand by conduction.*

Liquids and gases are similar in that they have no fixed shape. They are fluids. Thermal energy can be transferred from one region of a fluid to another due to movements within the fluid. This movement of thermal energy, called **convection**, is caused by hot parts of the fluid rising and the cooler parts of the fluid sinking.

Think about the water in a kettle as it is heated. The water touching the heating element is heated by conduction. The water becomes warm and rises. As it does so, the cooler water sinks and a current is created within the water. The current causes the thermal energy to spread through the water in the kettle.

The heating of air in a hot air balloon is also an example of convection.

Go Online!

Convection currents cause the heat in air to spread out in a hot air balloon. How does this result in the balloon lifting off the ground? Discuss with your classmates, then head to the NGScience website to find out.

QuickCode: **B6H1**

AB Activity 10.3

▶ *A convection current forms as warm water rises and cool water sinks.*

▲ *Radiant heat from the campfire warms the boy's hands.*

For thermal energy to move by conduction and convection it must travel through matter. Between the Sun and the Earth is empty space. How does the heat from the Sun warm the Earth and other planets in the solar system? The answer is radiation. **Radiation** is the transfer of energy through electromagnetic waves.

The warmth you feel when you place your hand near an electric heater or a campfire are examples of heat in the form of radiation.

Describe the three main ways thermal energy is transferred within and between objects.

Thermal Conductivity

What materials is the pot below made of? Why were the materials chosen?

When an object is heated, thermal energy moves from hot to cold. This occurs as the particles within the object collide. In order for heat to move from one region to another, it must pass through all of the particles in between. The time it takes for this to occur is different in different materials and different states of matter. The ability of a material or matter to transfer thermal energy is called **thermal conductivity**.

Some materials allow heat to pass through them more easily than others. Materials that allow heat to pass through them easily are called **good conductors of heat**. The metal used to make the pot is a good conductor of heat. It allows heat to flow easily from the hotplate to the food.

Think Deeply

A vacuum is empty space that contains no matter. A vacuum flask is an insulating container consisting of two solid layers separated by partially-evacuated air which creates a near-vacuum. Why does this make a vacuum flask a good heat insulator?