Unit 1 Design and Function

How can technology make our lives easier?

Lesson Plan

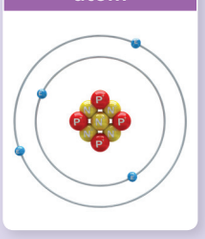
Unit Opener & Lesson 1 How does technology mimic living things?			
	Activity	**Pages**	**Time**
Engage	• Unit Opener: Think! *What do you think robots will be used for…?*	SB p. 4	5 min
	• Unit Opener: Review the first five steps in the design process.	SB p. 4	10 min
	• Unit Opener: Identify problems robots were invented to solve.	SB p. 4	10 min
	• Think! *Is a seeing-eye dog a kind of prosthetic? Why or why not?*	TB p. 6	10 min
	• Think! *In what other ways do you think nanotechnology might be useful?*	SB p. 8	10 min
Explore	• Digital Activity: *Did You Know: Robotics* (ActiveTeach)	TB p. 5	15 min
Explain	• How technology can mimic the human body and how prosthetic limbs work	SB p. 5–6	60 min
	• How machines or robots mimic animals and how nanotechnology works	SB p. 7–8	60 min
	• *Got it? 60-Second Video* (ActiveTeach)	TB p. 8	10 min
Elaborate	• Flash Lab: Lists	SB p. 5	10 min
	• Science Notebook: Prosthetic Limbs	TB p. 6	30 min
	• Science Notebook: Written Report	TB p. 6	25 min
	• At Home Lab: Machines and Technology	SB p. 7	25 min
	• Science Notebook: Robots That Mimic Animals	TB p. 7	30 min
Evaluate	• *Lesson 1 Check* (ActiveTeach)	TB p. 15a	10 min
	• Assessment for Learning	TB p. 8	10 min
	• Review (Lesson 1)	SB p. 15	10 min
	• *Got it? Self Assessment* (ActiveTeach)	TB p. 15b	10 min
	• *Got it? Quiz* (ActiveTeach)	TB p. 15b	10 min

Lesson 2 What is the design process?			
	Activity	**Pages**	**Time**
Engage	• Think! *Why are engineers important?*	TB p. 9	5 min
	• Think! *Are engineers scientists? Why or why not?*	TB p. 10	10 min
	• Think! *What might happen if you fail to document your design?*	SB p. 12	5 min
Explore	• Digital Lab: *How can the design of a model arm help you learn about how your arm works?* (ActiveTeach)	TB p. 9	20 min
Explain	• What the design process is	SB p. 9–10	60 min
	• How to design a prototype, communicate results, evaluate, and redesign	SB p. 11–12	60 min
	• How robotic arms developed	SB p. 13	30 min
	• *Got it? 60-Second Video* (ActiveTeach)	TB p. 13	10 min
Elaborate	• Science Notebook: Design a Process (1)	TB p. 10	20 min
	• Go Green: Everyday Solutions	TB p. 11	20 min
	• Science Notebook: Design a Process (2)	TB p. 12	20 min
	• Science Notebook: Flow Chart	TB p. 13	20 min
Evaluate	• *Lesson 2 Check* (ActiveTeach)	TB p. 15a	10 min
	• Assessment for Learning	TB p. 13	10 min
	• Review (Lesson 2)	SB p. 15	10 min
	• *Got it? Self Assessment* (ActiveTeach)	TB p. 15b	10 min
	• *Got it? Quiz* (ActiveTeach)	TB p. 15b	10 min
Lab	• *Let's Investigate! How can you make and redesign a model of a robotic arm?* (ActiveTeach)	SB p. 14	30 min

Flash Cards

sensor system

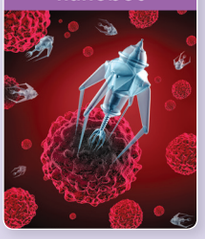
atom



bristle

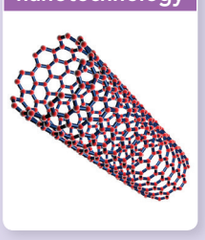
prosthetic limb

nanobot



plaque

nanotechnology



design process

robotic

Lesson 1

Key Words	ELL Support
sensor system, prosthetic limb, nanotechnology, atom, nanobot	**Vocabulary:** *technology, mimic, muscular, skeletal, invention, research, prototype, robot, android, structure, engineer, dangerous, joint, behavior, wiggle, flap (v), cholesterol, artery, cell*

Lesson 2

Key Words	ELL Support
design process, bristle, prototype, plaque, document, robotic	**Vocabulary:** *construct, communicate, transport, engineer, toothbrush, handle, gums, grip, thumb holder, expensive, strong, flexible, bend, requirement, measurement, record, communicate, manager, salespeople, verify, labeled, diagram, graphic organizer, pick up, stack*

Unit 1 Design and Function

Unit Objectives

Lesson 1: Students will learn how some technology can mimic muscular and skeletal systems.

Lesson 2: Students will learn how to use the design process.

Vocabulary: *technology, mimic, muscular, skeletal, invention, research, process, prototype, robot, android*

Introduce the Big Question

How can technology make our lives easier?

Build Background

Explain that, as students read the unit, they will learn about technology and how it can help them. Ask students to say what technology makes their lives easier. (Possible answers: *GPS maps on cellular phones, computers at school, barcode machines at the supermarket,* etc.)

Engage

Think!

What do you think robots will be used for in the future?

Have students look closely at the photograph, paying special attention to the android robot. *What is in the picture? A robot taking care of a patient.* Read the *Think!* question aloud and encourage students to discuss any experiences they have had with robots. Invite volunteers to share their experiences watching robots work. Discuss how robots move and what useful tasks they can perform.

1 With a partner, make a list of recent inventions and new technology.

Pair students. Read the instructions and allow students time to brainstorm a list of recent inventions and new technology. Monitor and provide vocabulary support as necessary. Allow pairs to share their ideas with the class. Write some of the more original ideas on the board.

2 With a partner, number the first five steps of the design process.

Activate prior knowledge about the design process. *What is a problem? What is a solution?* Point to the steps and invite five volunteers to read them aloud. Discuss the meaning of new vocabulary by asking students to provide simple definitions of the words.

Have students work with the same partner from exercise 1 and number the steps in the correct order. Review the answers by reading the texts and asking students to call out the answers chorally.

ELL Reading Strategy Support

Encourage students to use a dictionary to look up the meanings of key words that they don't understand and that cannot be guessed from context. Have students look up definitions for the following words and copy them into their notebooks: *process, inventions, research, prototype.*

3 What problems were these robots invented to solve? Discuss with a partner.

Ask students to look at the pictures. Invite students to discuss with a partner what the robots do. (Possible answers: *The first robot cleans the floor. The second robot is a nurse/doctor.*) *How do these robots solve problems/make our lives easier?*

Think! Again!

Revisit the question *What do you think robots will be used for in the future?* Ask *What things do you wish robots could do?* Allow students to discuss freely. Write students' ideas on the board and ask the class to group the types of tasks they wish robots could perform.

Lesson 1

How does technology mimic living things?

Objective: Learn how technology can mimic the human body.

Vocabulary: *structure, engineer, technology, dangerous, robot, joint, sensor*

Digital Resources: Flash Card (*sensor system*), *Explore My Planet!* Digital Activity

Unlock the Big Question

Write the following on the board: *I will learn how technology mimics living things.* Write *robotics* on the board. Brainstorm ideas about the word's meaning.

Think!

What are the advantages of robots?

Explain to students that technology can help people do many things, even speak. Ask students to share what they think some other advantages of robots are. Encourage students to speculate how robots can be useful in medicine.

Explore

Explore My Planet! Did You Know: Robotics

Objective: Learn about the use of robotics in the medical field.

Digital Resources: *Explore My Planet!* Digital Activity, *Explore My Planet! Activity Card* (1 per student)

- Show the *Explore My Planet!* Ask students to do the activities. Make sure they understand what function robotics has in medicine.
- Have students complete the *Activity Card.*
- Afterward, hold a discussion: *What is the definition of robotics? The study, design, construction, and use of robots. What does the catheter system in the Explore My Planet! do? It goes into areas of the heart that are hard for doctors to reach.*

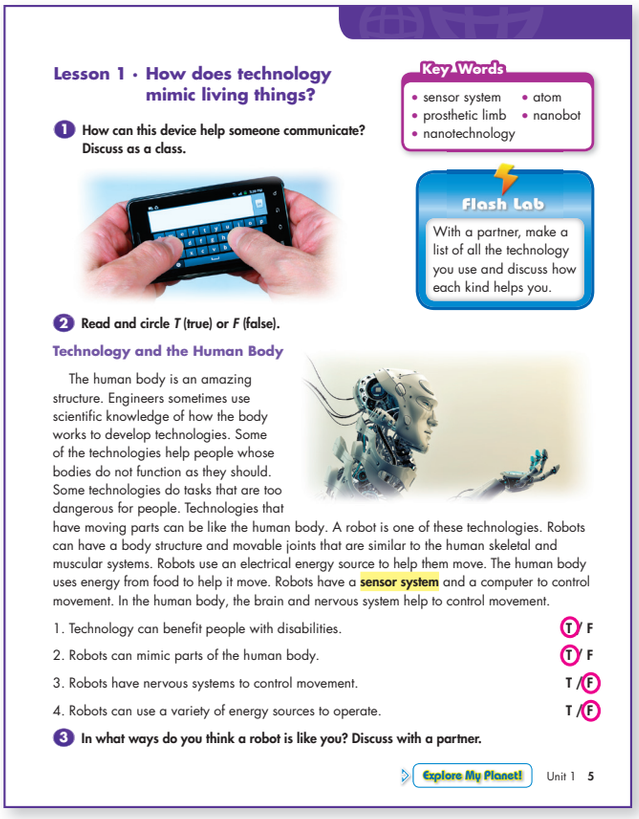
Explain

1 How can this device help someone communicate? Discuss as a class.

Point to the photograph and ask students to say what the device is and how it helps people communicate.

2 Read and circle *T* (true) or *F* (false).

Hold up the *sensor system* Flash Card to pre-teach the concept. Ask students to read the statements so they know what information they are looking for. Invite students to read the text on their own and circle the answers. Check the answers as a class.



Lesson 1 · How does technology mimic living things?

Key Words
- sensor system
- atom
- prosthetic limb
- nanobot
- nanotechnology

1 How can this device help someone communicate? Discuss as a class.

Flash Lab
With a partner, make a list of all the technology you use and discuss how each kind helps you.

2 Read and circle *T* (true) or *F* (false).

Technology and the Human Body

The human body is an amazing structure. Engineers sometimes use scientific knowledge of how the body works to develop technologies. Some of the technologies help people whose bodies do not function as they should. Some technologies do tasks that are too dangerous for people. Technologies that have moving parts can be like the human body. A robot is one of these technologies. Robots can have a body structure and movable joints that are similar to the human skeletal and muscular systems. Robots use an electrical energy source to help them move. The human body uses energy from food to help it move. Robots have a sensor system and a computer to control movement. In the human body, the brain and nervous system help to control movement.

1. Technology can benefit people with disabilities. T / F
2. Robots can mimic parts of the human body. T / F
3. Robots have nervous systems to control movement. T / F
4. Robots can use a variety of energy sources to operate. T / F

3 In what ways do you think a robot is like you? Discuss with a partner.

Explore My Planet! Unit 1 5

3 In what ways do you think a robot is like you? Discuss with a partner.

Write *muscular system* and *skeletal system* on the board. Ask students to look at the photograph of the robot and the text and say how robots are like humans. (Possible answers: *They have moving parts and movable joints. The hand in the picture looks like a human hand. It looks like it can pick things up.*)

Elaborate

Flash Lab

Lists

Read the instructions and invite students to work in pairs to make their lists and discuss.

Invite pairs to share their ideas with the class.

Lesson 1

How does technology mimic living things?

Objective: Learn how prosthetic limbs work.

Vocabulary: *prosthetic, limb, muscle, enable*

Digital Resources: Flash Card (*prosthetic limb*), *I Will Know…* Digital Activity

Materials: pictures of prosthetic limbs

Build Background

Have students look up *prosthetic* and *limb* in the dictionary. Ask students to write the definitions in their notebooks. Encourage them to write a sentence with each of the two words to demonstrate they have understood their meanings.

Explain

4 How is the runner's prosthetic leg similar to the legs of the other runners? Discuss as a class.

Point to the photograph and ask students to discuss how the prosthetic leg is similar to the human legs. (Possible answers: *It looks like the prosthetic leg has a knee. The man with the prosthetic leg can run.*)

5 Read and, with a partner, discuss the questions below.

Hold up the *prosthetic limb* Flash Card to review the meaning. Ask students to work in pairs to read the first paragraph and underline the parts of the human body for which people might need a prosthetic limb (*arm, hand, leg, foot*).

Ask pairs to read the rest of the text and discuss the questions. Review the answers with the class.

ELL Reading Strategy Support

Ask students to summarize the main ideas of the text in their notebooks. Explain that they should only write the key ideas of the text. Tell them that writing summaries is a good way to make sure they have understood the most important content of a text.

6 What does this man's prosthetic hand enable him to do? Look and discuss with a partner.

Ask students to look at the picture and discuss what the prosthetic hand can enable the man to do.

Optional: Give students pictures of prosthetic limbs and have them draw the parts of the human body the limbs might replace.

4 How is the runner's prosthetic leg similar to the legs of the other runners? Discuss as a class.

5 Read and, with a partner, discuss the questions below.

Prosthetic Limbs

Robotic technology can also be used to make a prosthetic limb move. A **prosthetic limb** is an artificial arm, hand, leg, or foot that replaces a missing one. Modern prosthetic limbs can be controlled by electrical signals from the brain.

In the past, prosthetic hands had few fingers and could not do many things. Today, they have a thumb and four fingers that are controlled individually. These prosthetic hands can turn a key, pick up small objects, and hold a glass.

Current prosthetic legs and feet allow their users to walk and even run. As technology advances, prosthetic legs and feet work more like real legs and feet. The latest prosthetic limbs also look more like real limbs.

1. How do prosthetic limbs help people?
2. How are prosthetic hands different today compared with those of the past?

6 What does this man's prosthetic hand enable him to do? Look and discuss with a partner.

6 Unit 1 I Will Know...

Elaborate

Science Notebook: Prosthetic Limbs

Hold up the *prosthetic limb* Flash Card to review the meaning. Assign a part of the human body to groups of four students. Have students draw a potential prosthesis for that part of the body. Tell students to label the analogous parts of the body and the prosthesis (e.g., fingers, knuckles, etc.). Monitor students' work and provide support as needed. Ask groups to present their drawings to the class.

Science Notebook: Written Report

Have students choose one type of prosthesis mentioned in this lesson and research how it has been improved over time. Have students write a short report on what they learned about their device.

Think!

Is a seeing-eye dog a kind of prosthetic? Why or why not?

Draw students' attention to the pictures on page 6 and then to the picture of the man with the dog on page 8. Ask the question and have students debate.

I Will Know...

Have students do the *I Will Know…* Digital Activity.

Lesson 1

How does technology mimic living things?

Objective: Learn how machines and robots mimic animals.

Vocabulary: *muscular, skeletal, mimic, behavior, wiggle, flap* (v), *fly* (v), *bat, squirrel, fish*

Build Background

Remind students that they have been learning about robots and how they mimic living things. Ask students what robotic toys they have seen that imitate animals. Encourage students to describe the toys and what animal behaviors they mimic.

Explain

7 Read. With a partner, list the characteristics of each machine or robot that mimics the real animal.

Review the word *mimic* with the class by asking students to say what they have learned so far about robots mimicking human bodies. Explain that now they will read about how robots mimic animals. Ask students to scan the text and look for animal words and say them aloud. (Answers: *fish, bat, squirrel*)

Invite students to read the text in pairs and complete the information in the chart. Copy the chart on the board while they are working. Invite volunteers to write the answers on the board.

What can a robotic bat do that a person cannot? Go places where people cannot. How are airplane wings and tails similar to birds' wings and tails? They can be adjusted to control how the plane moves.

8 As a class, discuss how animal robots can be used.

Point to the pictures and invite two students to read the titles underneath. Invite students to describe how squirrels and fish move. *Do you think a robot could move like a squirrel or fish? Yes! What could you do with the robotic fish?* (Possible answers: *You could make it swim with real fish. If it had a video camera, it could take pictures underwater.*) Invite students to share their ideas about how other animal robots could be used.

ELL Content Support

Ask *If you were a scientist studying snakes, how would you use a robot in your studies?* (Possible answers: *I would build a robot that looks and moves like a snake. I would put a camera on it. I would put my snake robot where real snakes live and observe them.*)

7 Read. With a partner, list the characteristics of each machine or robot that mimics the real animal.

Animals and Technology

Some technologies mimic the muscular and skeletal systems of animals. These systems help animals to move in different ways. The wings and tails of birds help them fly. Fish have muscular and skeletal systems that help them swim.

Airplanes have parts that mimic the wings and tails of birds. Like the wings and tails of birds, airplane wings and tails can be adjusted to control how the airplane moves.

Some robots can also fly. The robotic bat flaps its wings and flies like a bat. It can search collapsed buildings and other areas people cannot get to. Some robots that are used to explore the ocean have parts that mimic the muscular and skeletal systems of fish.

Scientists use robotic animals to study the behavior of real animals. A robotic squirrel makes noise and moves its tail like a real squirrel. It can be placed in an area where real squirrels live. A real squirrel may wiggle its tail and make noises at the robotic squirrel. Scientists can use this information to learn how squirrels communicate with one another.

airplane/bird	robotic bat/bat	robotic squirrel/squirrel
Possible answers: wings and tails	wings	makes noise and moves its tail

8 As a class, discuss how animal robots can be used.

Unit 1 7

Elaborate

At-Home Lab

Machines and Technology

Do this activity as a class and walk around near school with students or ask students to do the activity as homework. Remind students that technologies in the neighborhood may not seem like technologies. Tell students to pay attention to machines and think about what they are used for. Explain that each machine's use can provide clues as to how it might mimic the muscular or skeletal systems of humans and animals. Remind students to use plenty of descriptive words when they write their notes.

Science Notebook: Robots That Mimic Animals

Organize the class into five groups. Have each group search the Internet or books for information on one kind of robot that mimics the form and movements of animals. Encourage them to choose one of the following: robotic dog, bat, dragonfly, housefly, cockroach. Ask each group to find out who developed the robot, what it does, and its potential uses. Have each group make a poster or computer presentation about its robot and share it with the class.

Lesson 1

How does technology mimic living things?

Objective: Learn about the uses of nanotechnology.

Vocabulary: *tiny, nanotechnology, atom, nanobot, cholesterol, artery, cell*

Digital Resources: Flash Cards (*nanotechnology, atom, nanobot*), *Lesson 1 Check* (print out 1 per student), *Got it? 60-Second Video*

Build Background

In order to present key concepts for this lesson, hold up the *nanotechnology*, *atom*, and *nanobot* Flash Cards. Review the meaning of *atom* (*the smallest component of an element*). Explain that *nano-* means *tiny* or *extremely small*. Discuss possible meanings of the two words on the Flash Cards with *nano-* in them. Write students' ideas on the board, but don't confirm whether they are right or wrong at this stage.

Explain

9 **Read and circle *T* (true) or *F* (false).**

Point to the text and ask students to identify the three highlighted words they discussed the meanings of at the beginning of the class. Ask them to look at the text quickly and check whether they guessed the meanings correctly by reading the words in context.

Ask students to look at the pictures relating to nanotechnology on the page and read the text individually before answering the questions. Review the answers with the whole class. Invite students to read sentences from the text that support the answers.

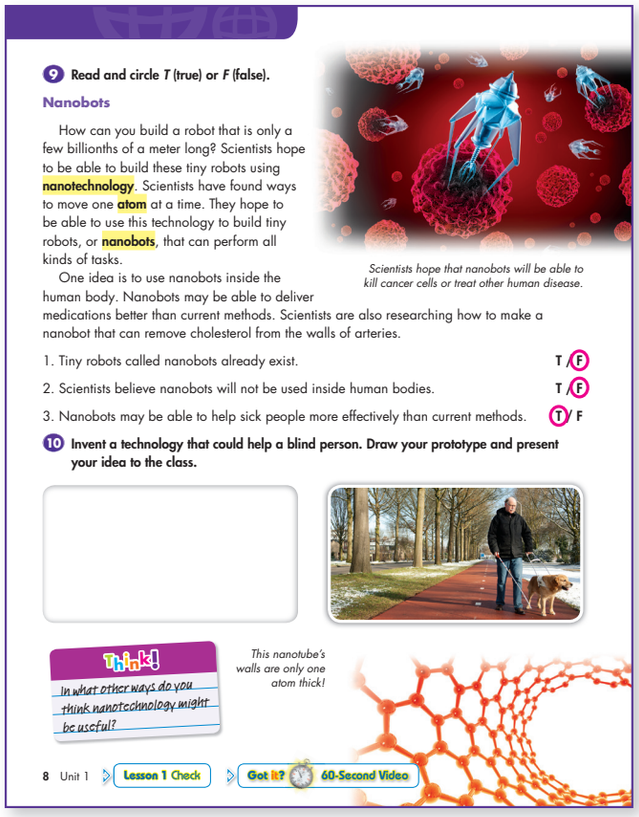
Ask further comprehension questions: *How could nanobots be used inside the human body? To deliver medications or remove cholesterol from arteries. What skill allows scientists to build nanobots? Being able to move one atom at a time.*

ELL Content Support

If students are having difficulty understanding the size of a nanobot, have them write a list of metric units of length from meter (1.0) to nanometer (0.000000001) vertically aligned to the decimal points.

10 **Invent a technology that could help a blind person. Draw your prototype and present your idea to the class.**

Pair students. Invite them to describe the picture. Ask them to discuss their ideas for technology to help a blind person and to draw the prototypes.



9 Read and circle *T* (true) or *F* (false).

Nanobots

How can you build a robot that is only a few billionths of a meter long? Scientists hope to be able to build these tiny robots using **nanotechnology**. Scientists have found ways to move one **atom** at a time. They hope to be able to use this technology to build tiny robots, or **nanobots**, that can perform all kinds of tasks.

One idea is to use nanobots inside the human body. Nanobots may be able to deliver medications better than current methods. Scientists are also researching how to make a nanobot that can remove cholesterol from the walls of arteries.

Scientists hope that nanobots will be able to kill cancer cells or treat other human disease.

1. Tiny robots called nanobots already exist. T / F
2. Scientists believe nanobots will not be used inside human bodies. T / F
3. Nanobots may be able to help sick people more effectively than current methods. T / F

10 **Invent a technology that could help a blind person. Draw your prototype and present your idea to the class.**

Think!

In what other ways do you think nanotechnology might be useful?

This nanotube's walls are only one atom thick!

8 Unit 1 Lesson 1 Check Got it? 60-Second Video

Elaborate

Think!

In what other ways do you think nanotechnology might be useful?

Read the question and invite students to discuss what nanotechnology may be good for. (Possible answers: *electronics, medicine, fuel,* etc.)

Evaluate

Lesson 1 Check Assessment for Learning

Distribute the *Lesson 1 Check* and guide students as they complete it. Check answers as a class. Then ask students to grade their progress on the topic of how technology mimics living things from 1 to 3: 3 = *I understand how technology mimics living things*; 2 = *I need to study more*; 1 = *I need help!* Encourage students giving themselves a 1 or a 2 to say what they found difficult and what they need to study more.

Got it? 60-Second Video

Review the Key Words for Lesson 1 (see Student's Book page 5). Play the *Got it? 60-Second Video* to review the lesson material.

Lesson 2

What is the design process?

Objective: Learn how people use the design process to develop technology.

Vocabulary: *design, process, technology, construct, communicate, transport, engineer*

Digital Resources: Flash Card (*design process*), *Let's Explore!* Digital Lab

Unlock the Big Question

Read the question and allow students to share their ideas. Hold up the *design process* Flash Card. Allow students to share their ideas about what the design process is.

Build Background

Ask students what technology they have learned about so far in this unit. Ask them what other technology they want to learn about. Explain that they will learn more about how technology is designed.

Why are engineers important?

Discuss with students different types of things engineers do and why they are important. (Possible answer: *They help develop new technologies.*)

Explore

Let's Explore! Lab **How can the design of a model arm help you learn about how your arm works?**

Objective: Learn how a model arm works in a similar way to your own.

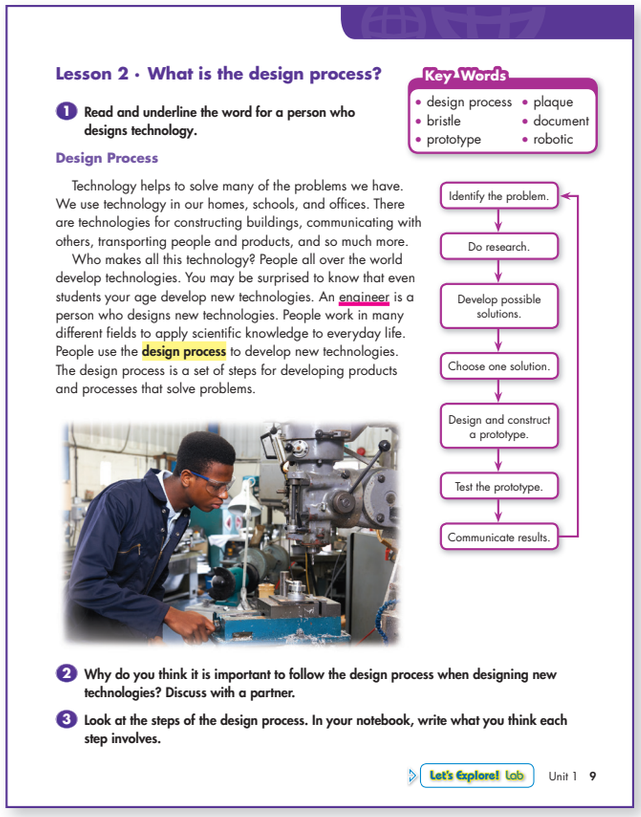
Digital Resources: *Let's Explore!* Digital Lab, *Let's Explore! Activity Card* (1 per student) (*Optional:* Do the lab in class; refer to the *Activity Card* and Model Arm Pattern for materials and steps.)

- Show the Digital Lab.
- Have students complete the *Activity Card*. Check answers as a class.

Explain

1 **Read and underline the word for a person who designs technology.**

Point to the picture and ask students to say what job the man has and what they think he is designing. Allow them to share their ideas freely. Invite students to read the text quickly in pairs and underline the word. Review the answer with the class. Discuss the meaning of *prototype* with the class (*original or first model of something*).



Lesson 2 · What is the design process?

Key Words
- design process
- bristle
- prototype
- plaque
- document
- robotic

1 Read and underline the word for a person who designs technology.

Design Process

Technology helps to solve many of the problems we have. We use technology in our homes, schools, and offices. There are technologies for constructing buildings, communicating with others, transporting people and products, and so much more.

Who makes all this technology? People all over the world develop technologies. You may be surprised to know that even students your age develop new technologies. An engineer is a person who designs new technologies. People work in many different fields to apply scientific knowledge to everyday life. People use the design process to develop new technologies. The design process is a set of steps for developing products and processes that solve problems.

Identify the problem.
Do research.
Develop possible solutions.
Choose one solution.
Design and construct a prototype.
Test the prototype.
Communicate results.

2 Why do you think it is important to follow the design process when designing new technologies? Discuss with a partner.

3 Look at the steps of the design process. In your notebook, write what you think each step involves.

Let's Explore! Lab Unit 1 9

Ask students to read the text more slowly and in detail and to answer these questions: *What is the design process? A set of steps for developing products and processes that solve problems. Why might engineers change the order of the steps? There might be trouble with one step or the usual order might not solve the problem.*

2 **Why do you think it is important to follow the design process when designing new technologies? Discuss with a partner.**

Hold up the *design process* Flash Card again and review the meaning. Ask students to work in pairs and look at the design process flow chart next to the text and discuss why it is important to follow the process.

Optional: Demonstrate a process in the classroom. Point out the steps of the process. Have volunteers demonstrate a process of their own. (Refer back to the design of the model arm from the *Let's Explore!* Digital Lab as necessary.)

3 **Look at the steps of the design process. In your notebook, write what you think each step involves.**

Ask students to work in the same pairs and revisit the flowchart about the design process. Ask them to write ideas about what each step involves. Review the ideas with the whole class.

Lesson 2

What is the design process?

Objective: Learn more about the stages in the design process.

Vocabulary: *toothbrush, handle, bristle, gum, grip, thumb holder*

Digital Resources: Flash Card (*bristle*), *I Will Know...* Digital Activity

Materials: *optional:* students' toothbrushes

Build Background

Draw a toothbrush on the board and ask students to name it. Invite some students to describe their toothbrushes. (Possible answers: *soft, hard, big, small, traditional, electric,* etc.) If students have brought in their toothbrushes, allow them to show and describe them for the exercise.

Explain

4 Read and write the heading for each stage of the design process.

Point to the headings in the box and explain that students have to read the text and insert the headings. Allow students a few minutes to read the text and write the headings. Have volunteers read the three headings in order to check answers.

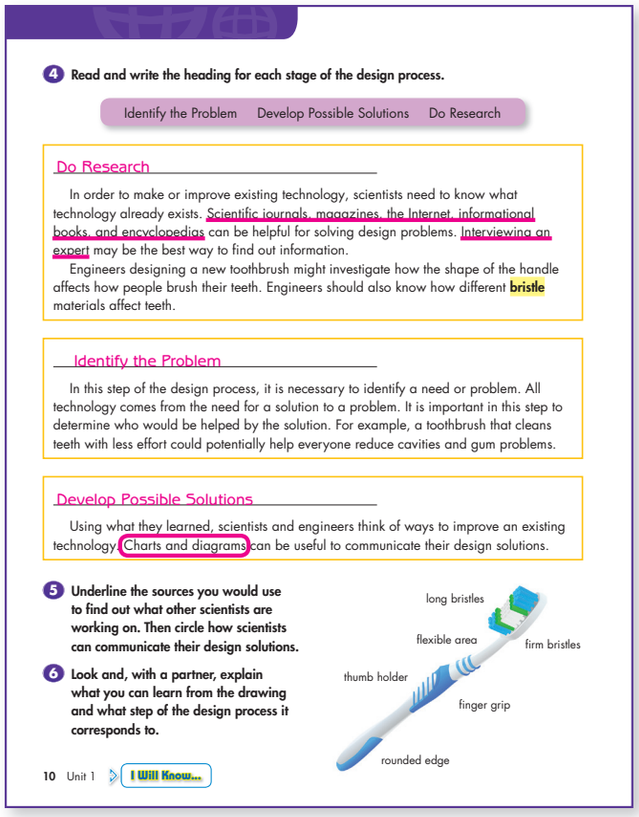
5 Underline the sources you would use to find out what other scientists are working on. Then circle how scientists can communicate their design solutions.

Ask students to underline the sentences in the text that show what sources scientists would use and circle the words that show how they communicate their design solutions. Hold up the *bristle* Flash Card and explain the meaning.

Have students read the text slowly and in detail to answer the following questions: *What information might toothbrush designers research? The shape of the handle, how people brush their teeth, and different bristle materials. Where does technology come from? From the need for a solution to a problem.*

6 Look and, with a partner, explain what you can learn from the drawing and what step of the design process it corresponds to.

Point to the picture of the toothbrush. Ask pairs to read the names of the different parts together. Allow them time to say which step of the process the drawing refers to and what they have learned from it about the shape of the handle, the way people brush their teeth, and the bristle materials.



4 Read and write the heading for each stage of the design process.

Identify the Problem | Develop Possible Solutions | Do Research

Do Research

In order to make or improve existing technology, scientists need to know what technology already exists. Scientific journals, magazines, the Internet, informational books, and encyclopedias can be helpful for solving design problems. Interviewing an expert may be the best way to find out information.

Engineers designing a new toothbrush might investigate how the shape of the handle affects how people brush their teeth. Engineers should also know how different **bristle** materials affect teeth.

Identify the Problem

In this step of the design process, it is necessary to identify a need or problem. All technology comes from the need for a solution to a problem. It is important in this step to determine who would be helped by the solution. For example, a toothbrush that cleans teeth with less effort could potentially help everyone reduce cavities and gum problems.

Develop Possible Solutions

Using what they learned, scientists and engineers think of ways to improve an existing technology. Charts and diagrams can be useful to communicate their design solutions.

5 Underline the sources you would use to find out what other scientists are working on. Then circle how scientists can communicate their design solutions.

6 Look and, with a partner, explain what you can learn from the drawing and what step of the design process it corresponds to.

10 Unit 1 I Will Know...

ELL Reading Strategy Support

Explain to students that people have used tools for cleaning their teeth for thousands of years. For example, the ancient Babylonians used twigs as chewing sticks. Explain that the bristles on a modern toothbrush clean the teeth by rubbing particles off the surfaces of the teeth.

Elaborate

Science Notebook: Design a Process (1)

Have students write the steps of the design process from Student's Book page 10 in their Science Notebooks, leaving several lines of space between each step. Have small groups brainstorm a problem to solve with a new technology. Have them fill in the steps with the information relating to their problem.

Think!

Are engineers scientists? Why or why not?

Activiate prior knowledge about how scientists observe, hypothesize, and test. Then ask the question and hold a class discussion.

I Will Know...

Have students do the *I Will Know...* Digital Activity.

Lesson 2

What is the design process?

Objective: Learn details about the design process.

Vocabulary: *solution, expensive, prototype, strong, flexible, bend, requirement, measurement*

Digital Resources: Flash Cards (*bristle, prototype, plaque*)

Build Background

Pair students and ask them to say what they remember about the design process from earlier in the lesson. Then ask them to open their Student's Book to page 9 and check how well they remembered the process.

Think!

Why do people need different types of toothbrushes?

Ask students to say why different people need different types of toothbrushes. Ask them to describe the difference between their toothbrush and a grandparent's toothbrush.

Explain

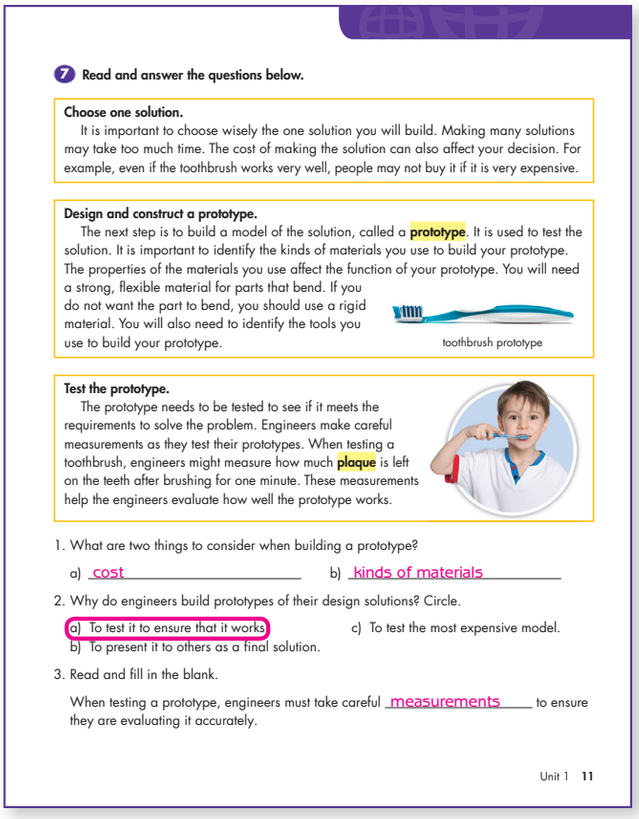
7 Read and answer the questions below.

Hold up the *bristle* Flash Card and review the meaning. Then hold up the *prototype* and *plaque* Flash Cards to pre-teach or review the words. Ask students to read the text in pairs and answer the questions. Review the answers with the class.

Ask comprehension questions: *Why is it important for engineers to choose just one solution? It would probably take too long and be too expensive to work on more than one. What is important in choosing materials for a prototype? The materials' properties. What other kinds of tests could engineers do on a toothbrush prototype? Have people use it to find out how long the bristles last. What are two properties that are important for the materials used in a toothbrush? The handle should be a material that doesn't bend too much. The bristles should be materials that will clean the teeth without scratching them or hurting the gums.*

ELL Vocabulary Support

Have students refer back to their definition of the word *prototype*. Have volunteers read aloud their definitions. Then have students write two sentences using the word *prototype*.



7 Read and answer the questions below.

Choose one solution.
It is important to choose wisely the one solution you will build. Making many solutions may take too much time. The cost of making the solution can also affect your decision. For example, even if the toothbrush works very well, people may not buy it if it is very expensive.

Design and construct a prototype.
The next step is to build a model of the solution, called a **prototype**. It is used to test the solution. It is important to identify the kinds of materials you use to build your prototype. The properties of the materials you use affect the function of your prototype. You will need a strong, flexible material for parts that bend. If you do not want the part to bend, you should use a rigid material. You will also need to identify the tools you use to build your prototype.

toothbrush prototype

Test the prototype.
The prototype needs to be tested to see if it meets the requirements to solve the problem. Engineers make careful measurements as they test their prototypes. When testing a toothbrush, engineers might measure how much **plaque** is left on the teeth after brushing for one minute. These measurements help the engineers evaluate how well the prototype works.

1. What are two things to consider when building a prototype?
   a) cost b) kinds of materials
2. Why do engineers build prototypes of their design solutions? Circle.
   a) To test it to ensure that it works
   b) To present it to others as a final solution.
   c) To test the most expensive model.
3. Read and fill in the blank.
   When testing a prototype, engineers must take careful measurements to ensure they are evaluating it accurately.

Unit 1 11

ELL Content Support

Tell students that prototypes don't necessarily have to be complicated to be useful. Explain that some prototypes are simple. Say that there are also computer and mathematical models and that these are often used instead when the materials for a physical prototype are very expensive.

Elaborate

Go Green

Everyday Solutions

Explain to students that a green activity is one that does not hurt the environment. Explain that, in daily life, people often leave the water running from the faucet while they brush their teeth. Ask students what technological solutions might solve this problem (Possible answer: *Place a sensor on the faucet that stops the flow of water if the toothbrush is not right under the water flow.*)

Pair students and have them plan a design for a solution for another activity from their daily lives that harms the environment. Allow pairs to share their designs with the class.

Lesson 2

What is the design process?

Objective: Learn about communicating results from tests of designs.

Vocabulary: *document, record, communicate, manager, salespeople, verify, labeled, diagram, graphic organizer*

Build Background

Write the word *results* on the board. Ask students to say how they think the results of tests relate to the design process and why they are important. Talk about what happens when results are good and what happens when they are bad.

Think!

What might happen if you fail to document your design?

Make sure students understand the meaning of *document* (*to make a record of information*). Ask students to think about what could happen if someone doesn't record their design. Encourage them to share their ideas.

Explain

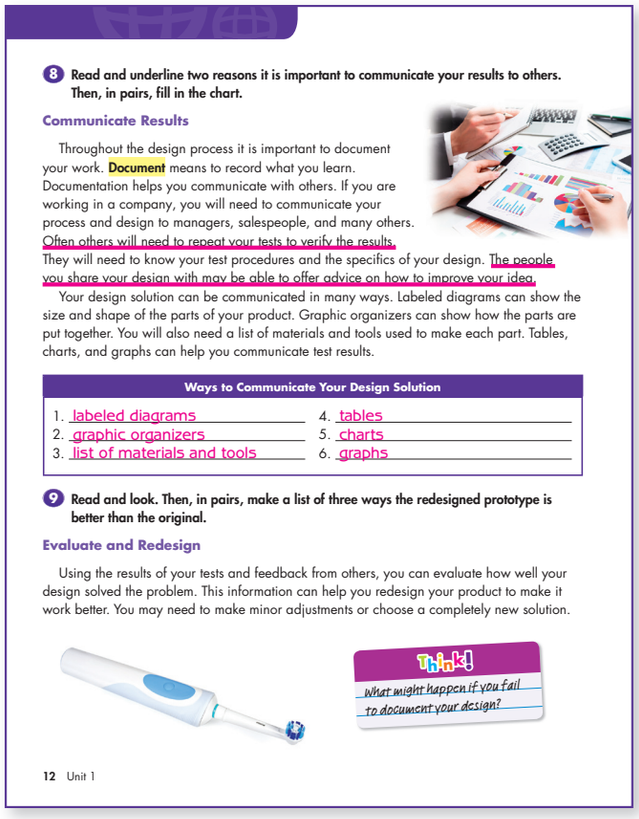
8 Read and underline two reasons it is important to communicate your results to others. Then, in pairs, fill in the chart.

Point to the text and ask students to scan it to find the information that belongs in the chart. Have students complete the chart. Copy the chart on the board for six volunteers to write in the answers.

Then ask students to read the text on their own, but, this time, in detail. Ask further comprehension questions: *What is documentation? A record of what you learn. Why is it important for scientists and engineers to communicate their solutions to others? Others will be able to understand the solution, repeat the tests, and verify the results.*

ELL Reading Strategy Support

Tell students that we can sometimes understand more complicated texts better by first looking for the specific information we need before reading the whole text in more detail.



8 **Read and underline two reasons it is important to communicate your results to others. Then, in pairs, fill in the chart.**

Communicate Results

Throughout the design process it is important to document your work. **Document** means to record what you learn. Documentation helps you communicate with others. If you are working in a company, you will need to communicate your process and design to managers, salespeople, and many others. Often others will need to repeat your tests to verify the results. They will need to know your test procedures and the specifics of your design. The people you share your design with may be able to offer advice on how to improve your idea.

Your design solution can be communicated in many ways. Labeled diagrams can show the size and shape of the parts of your product. Graphic organizers can show how the parts are put together. You will also need a list of materials and tools used to make each part. Tables, charts, and graphs can help you communicate test results.

Ways to Communicate Your Design Solution	
1. labeled diagrams	4. tables
2. graphic organizers	5. charts
3. list of materials and tools	6. graphs

9 **Read and look. Then, in pairs, make a list of three ways the redesigned prototype is better than the original.**

Evaluate and Redesign

Using the results of your tests and feedback from others, you can evaluate how well your design solved the problem. This information can help you redesign your product to make it work better. You may need to make minor adjustments or choose a completely new solution.

Think!
What might happen if you fail to document your design?

12 Unit 1

9 Read and look. Then, in pairs, make a list of three ways the redesigned prototype is better than the original.

Ask students to look at the picture and read the text before making their lists individually. Students compare their lists in pairs. Review the answers with the class.

To encourage students to analyze further, ask the following question: *If a scientist or engineer evaluates the results of a design process and it does not solve the problem, what should she do next? She should begin to redesign the product or look at the earlier steps of the process to determine whether the process and/or product can be improved.*

Elaborate

Science Notebook: Design a Process (2)

Have students look back at their ideas in their Science Notebooks about designing a process (see Teacher's Book page 10). Ask students to develop a presentation of their ideas. Remind students they can use communication tools such as graphic organizers, lists of materials, and labeled diagrams to show the steps of their design processes. Invite students to present their ideas to the class.

Lesson 2

What is the design process?

Objective: Learn about the development of robotic arms.

Vocabulary: *robotic, pick up, stack*

Digital Resources: Flash Card (*robotic*), *Lesson 2 Check* (print out 1 per student), *Got it? 60-Second Video*

Materials: construction paper (1 large sheet per group)

Build Background

Ask students to describe what they can see in the pictures on the page. Hold up the *robotic* Flash Card and discuss the meaning (*something that works like a robot*). Activate prior knowledge about human body parts and joints.

Explain

10 Read and complete the answers. Then match the answers with their questions.

Have students read the information on designing robotic arms and answer the questions that follow. Review the answers with the class.

Ask *How does a robotic arm mimic a human arm? Rigid materials are like the skeletal system and form a structure for the robotic arm. Joints in the robot are like human joints, such as shoulders and elbows. Wires attached to the robotic arm move around like muscles.*

11 Look and label the parts of this modern robotic arm that are like a human arm.

Point to the picture and ask students to label the parts on the robotic arm. Ask the class *What improvements would you make to the robotic arm in the picture?* (Possible answer: *Give it something more like a hand at the end of its arm.*)

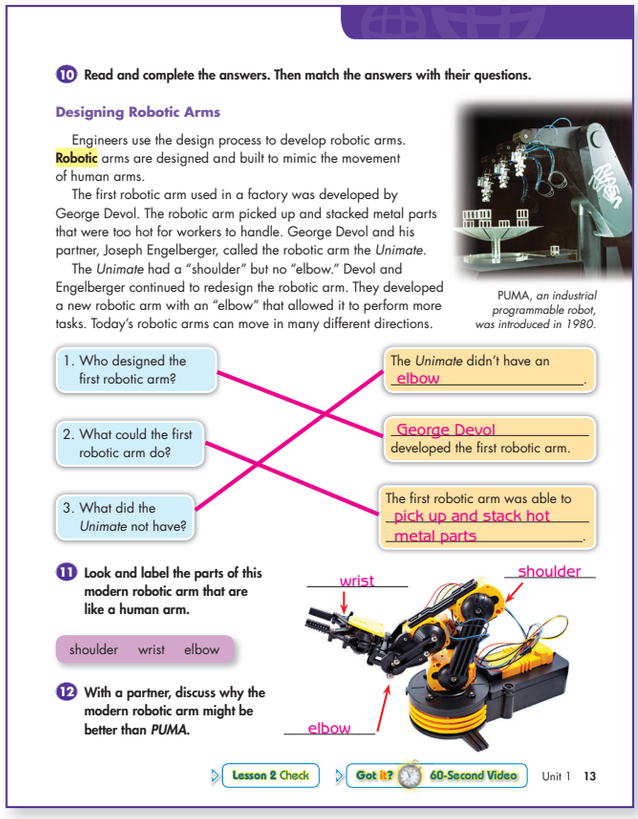
12 With a partner, discuss why the modern robotic arm might be better than *PUMA*.

Point to the picture at the top of the page to remind students what PUMA is. Pair students and have them discuss why the modern arm might be better. Allow pairs to share their ideas with the class.

Elaborate

Science Notebook: Flow Chart

Ask students to work in small groups and make a flow chart on construction paper of the developments in robotic arms. Monitor groups while they work. Ask groups to share their charts and ideas with the class. Allow students time to copy their flow charts in their notebooks.



10 Read and complete the answers. Then match the answers with their questions.

Designing Robotic Arms

Engineers use the design process to develop robotic arms. **Robotic** arms are designed and built to mimic the movement of human arms.

The first robotic arm used in a factory was developed by George Devol. The robotic arm picked up and stacked metal parts that were too hot for workers to handle. George Devol and his partner, Joseph Engelberger, called the robotic arm the *Unimate*.

The *Unimate* had a "shoulder" but no "elbow." Devol and Engelberger continued to redesign the robotic arm. They developed a new robotic arm with an "elbow" that allowed it to perform more tasks. Today's robotic arms can move in many different directions.

PUMA, *an industrial programmable robot, was introduced in 1980.*

1. Who designed the first robotic arm? — The *Unimate* didn't have an elbow.
2. What could the first robotic arm do? — George Devol developed the first robotic arm.
3. What did the *Unimate* not have? — The first robotic arm was able to pick up and stack hot metal parts.

11 Look and label the parts of this modern robotic arm that are like a human arm.

shoulder wrist elbow

12 With a partner, discuss why the modern robotic arm might be better than *PUMA*.

wrist shoulder elbow

Lesson 2 Check | Got it? 60-Second Video | Unit 1 13

ELL Content Support

Tell students that the first robotic arm in space was actually a crane originally intended to move equipment from NASA's space shuttle's cargo bay into space. But, thanks to zero gravity in space, the famous robotic arm can perform both heavy lifting and delicate maneuvers.

Evaluate

Lesson 2 Check **Assessment for Learning**

Distribute the *Lesson 2 Check* and guide students as they complete it. Check answers as a class. Then ask students to grade their progress on the topic of the design process from 1 to 3: 3 = *I understand the design process*; 2 = *I need to study more*; 1 = *I need help!* Encourage students giving themselves a 1 or 2 to describe what they found difficult and what they need to study more.

Got it? 60-Second Video

Review Key Words for Lesson 2 (see Student's Book page 9). Play the *Got it? 60-Second Video* to review the lesson material.

Let's Investigate!

In this unit, students learn about the design process and how technology can mimic human and animal body parts. In this lab, students will make and improve upon the design of a model of a robotic arm.

Let's Investigate! Lab **How can you make and redesign a model of a robotic arm?**

Objective: Students will observe and redesign a model of a robotic arm.

Materials: per group: hole punch, 3 poster board strips, clay ball with paper clip, rubber band, metric ruler, 3 fasteners, large paper clip, dowel with eye hook, string

Digital Resources: *Let's Investigate!* Digital Lab, *Let's Investigate! Activity Card* (1 per group)

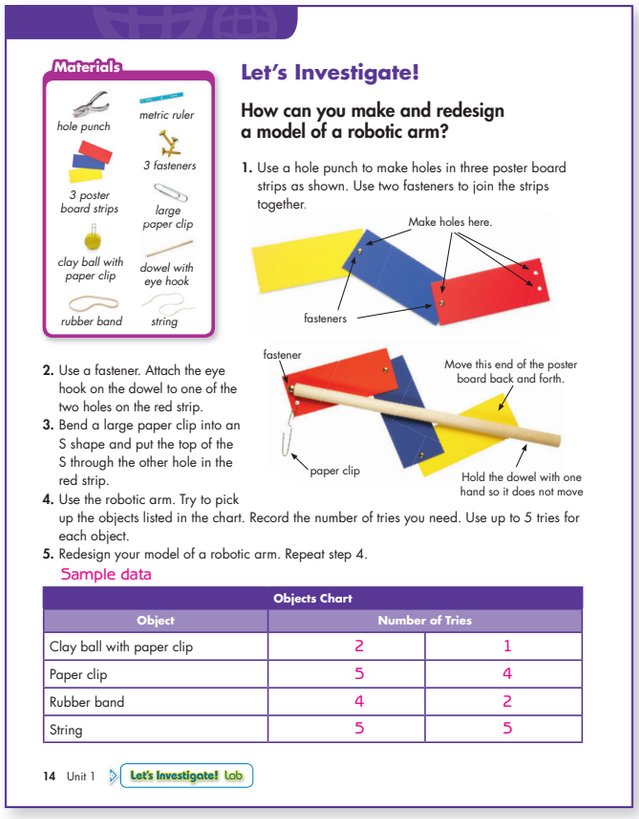
Advance Preparation: Screw one eye hook into one end of each dowel.

- Divide the class into small groups and distribute materials.
- Have students follow the instructions to put together the robotic arm model.
- Ask students to try to pick up the objects listed in the chart and record the number of tries they need.
- Ask students to compare their results with another group.
- Then have students plan how to redesign their models and follow their plan. Students then repeat step 4 and record their results.
- Have students compare their results with another group.
- Ask students to complete the *Activity Card*.

Teacher Time-Saving Option: Show the *Let's Investigate!* Digital Lab as an alternative to the hands-on lab activity.

Unlock the Big Question

Have students refer to the Big Question on the Unit Opener page. In pairs, have them recall what they have learned about technology. Have pairs complete Questions 6 and 7 on the *Activity Card*.



Materials

hole punch; metric ruler; 3 fasteners; 3 poster board strips; large paper clip; clay ball with paper clip; dowel with eye hook; rubber band; string

Let's Investigate!

How can you make and redesign a model of a robotic arm?

1. Use a hole punch to make holes in three poster board strips as shown. Use two fasteners to join the strips together.

Make holes here.

fasteners

fastener

Move this end of the poster board back and forth.

paper clip

Hold the dowel with one hand so it does not move

2. Use a fastener. Attach the eye hook on the dowel to one of the two holes on the red strip.
3. Bend a large paper clip into an S shape and put the top of the S through the other hole in the red strip.
4. Use the robotic arm. Try to pick up the objects listed in the chart. Record the number of tries you need. Use up to 5 tries for each object.
5. Redesign your model of a robotic arm. Repeat step 4.

Sample data

Objects Chart		
Object	Number of Tries	
Clay ball with paper clip	2	1
Paper clip	5	4
Rubber band	4	2
String	5	5

14 Unit 1 Let's Investigate! Lab

Class Project: Prosthesis

Divide the class into groups. Explain that they are going to design a prosthesis. Have groups brainstorm what kinds of prostheses for an animal or human they want to make. Students decide what their design should be like, what materials it should be made of, what tools they might need, and the steps they will need to make it. Groups should record the materials and steps. Students can draw individual pictures of their prostheses. Have groups share their ideas with the class. Students should explain what problem their prosthesis solves, how their prosthesis is meant to work, how they selected the materials it should be made of, and so on. Encourage creativity. Students may wish to make prosthetic noses, tails, or wings for people or animals, prosthetic fingers for animals, and so on.

Unit 1 Review

How can technology make our lives easier?

Digital Resources: Print out 1 of each per student: *Got it? Self Assessment, Got it? Quiz*

Evaluate

Strategies for Targeted Review

The following are strategies for providing targeted review for students if they encounter challenges with the content.

Lesson 1 How does technology mimic living things?

Question 1

If… students are having difficulty circling the correct answer, then… remind students about the definitions they found and sentences they wrote. Have students refer back to their definitions and sentences.

Question 2

If… students are having difficulty writing the correct answer, then… direct students to Lesson 1 to review what body systems the fish uses to swim.

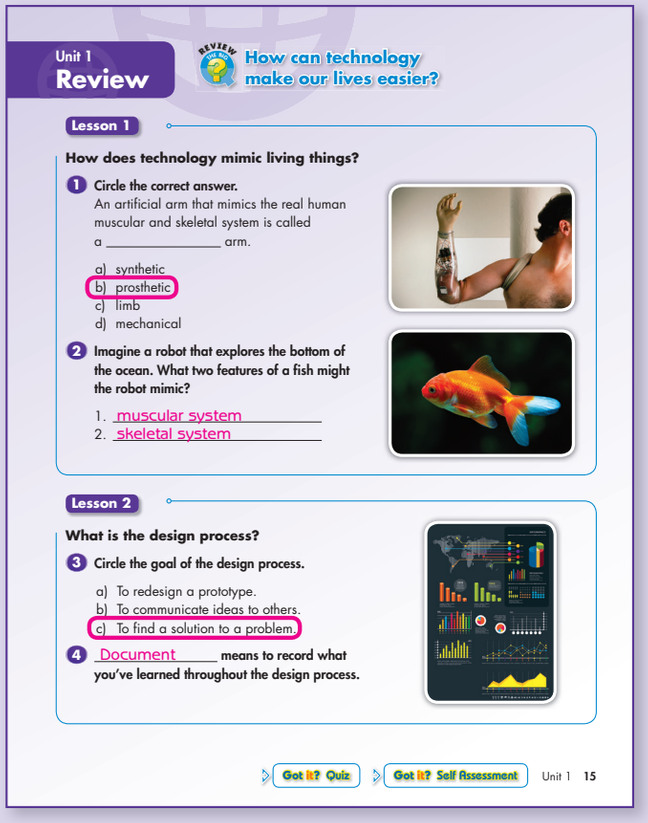
Lesson 2 What is the design process?

Question 3

If… students are having difficulty answering what the goal of the design process is, then… discuss with students some examples of technology and the problems they solve.

Question 4

If… students are having difficulty answering what *document* means, then… direct students to page 12 to review the paragraph on communicating results.



Unit 1 Review

How can technology make our lives easier?

Lesson 1

How does technology mimic living things?

1 Circle the correct answer.
An artificial arm that mimics the real human muscular and skeletal system is called a _____ arm.

a) synthetic
b) prosthetic
c) limb
d) mechanical

2 Imagine a robot that explores the bottom of the ocean. What two features of a fish might the robot mimic?

1. muscular system
2. skeletal system

Lesson 2

What is the design process?

3 Circle the goal of the design process.

a) To redesign a prototype.
b) To communicate ideas to others.
c) To find a solution to a problem.

4 Document means to record what you've learned throughout the design process.

Got it? Quiz | Got it? Self Assessment | Unit 1 15

ELL Language Support

Before students start working on the Review activities, have them read each question aloud along with you.

Got it? Self Assessment

Immediately after students have completed the Review activities, distribute a *Got it? Self Assessment* to each student. Have students complete the *Stop! Wait!* and *Go!* statements for each lesson, allowing them to look back through the lesson material if necessary.

Got it? Quiz

Distribute a Unit 1 *Got it? Quiz* to each student. Quizzes may be used for assessing students' understanding of unit concepts as well as for grading purposes.

Lesson 1 Check

Name _____ Date _____

Words to Know

Match each word with its definition.

muscular system	skeletal system	prosthetic limb

1. skeletal system — the body structure that includes the bones connected by joints
2. muscular system — the body system that uses energy from food to move the body
3. prosthetic limb — an artificial hand, leg, arm, or foot that replaces a missing hand, leg, arm, or foot

Explain

Write whether each statement is true or false. Explain your answer.

4. A prosthetic hand looks exactly like the hand it replaces.
   This statement is false because a prosthetic limb is not made of real muscles and bones, but is made of metals and plastics that often do not look like a person's real hand.
5. A modern prosthetic leg can mimic the actions of a real leg.
   This statement is true because a modern prosthetic leg can bend and is movable to help a person walk and even run.

Apply Concepts

6. Explain how prosthetic limbs mimic the human muscular and skeletal systems.
   Prosthetic limbs have parts that allow people to move them in ways they would move a real limb. Modern prosthetic limbs also can be made to look more like real limbs.

Lesson 2 Check

Name _____ Date _____

Words to Know

Write descriptions of the terms below.

1. prototype an early version or model of a product
2. design process the steps for developing products and processes that solve problems

Explain

Write whether each statement is true or false. Explain your answer.

3. The testing step in the design process of a new product makes sure that everyone can use the product.
   This statement is false because testing shows whether a product does what it is supposed to do.
4. Engineers and scientists redesign a prototype if it does not work correctly.
   This statement is true because engineers and scientists will get information from testing their prototype that tells them how it could be improved and what people might not like about it.

Apply Concepts

5. Why might you need to repeat some steps in the design process?
   Possible answer: If a step does not result in the expected outcome, that step needs to be repeated to find out if the outcome will be the same or if the step needs rethinking.

Lesson 1 Explore My Planet! Activity Card

Name _____ Date _____

Did You Know: Robotics

Robotics is the study, design, construction, and use of robots. New Lutheran Hospital in Fort Wayne, Indiana is using robotics to help save lives. The Sensei X Robotic Catheter System looks like a thin, flexible tube. The design allows it to go into areas of the heart that are hard for doctors to reach. A video camera connects to the robot. This allows doctors to see inside a patient's body. The video camera also helps doctors control the robot's movement.

What is the need for robotics in the medical field?

Possible answer: Robotic technology can perform functions that doctors cannot. It could help save lives.

Using computer-controlled robotics in surgery is sometimes called minimally invasive surgery. Use the Internet to learn more about minimally invasive surgery. Write three facts you learned.

Possible answers: Patients get out of the hospital faster. They have less pain after surgery. The equipment is very expensive. Not all doctors do it.

Lesson 2 Let's Explore! Activity Card

Name _____ Date _____

Materials

- *Let's Explore!* Digital Lab
- fasteners
- yarn
- Model Arm Pattern

How can the design of a model arm help you learn about how your arm works?

1. Make a model of an arm as shown in the Digital Lab.
2. Pull on Yarn A and observe what happens. Pull on Yarn B and observe what happens.
3. Bend the arm pieces together. What happens to the yarn.
   Possible answer: Yarn A loosens. Yarn B tightens.

Explain Your Results

4. In your model, what do the yarn, the cardboard, and the fastener represent?
   Possible answers: The yarn represents the muscles in the arm. The fastener represents the elbow joint. The cardboard represents the bones.
5. How can people use models to help them learn about the human body?
   Possible answers: People can study models to understand how the body works. They can use them to see how bones and muscles connect.

Based on this activity, what conclusions can you draw about having strong arm muscles?

Possible answer: Strong arm muscles will help me lift heavier items. If the muscles in my arm are weak, I will not be able to lift heavy objects well.

Unit 1

Let's Investigate! Activity Card

Name _____ Date _____

Let's Investigate!

Analyze and Conclude

6. What design change did you make to your model?

Possible answer: I changed the shape of the hook.

7. Describe two ways in which the model is not like a real robotic arm?

Possible answers: It has only one function. It is not motorized. It is made of wood and poster board.

Unit 1

Lessons 1 & 2 Got it? Self Assessment

Name _____ Date _____

Got it? Self Assessment

Complete the statements for each lesson.

Lesson 1 How does technology mimic living things?

Stop! I need help with _____

Wait! I have a question about _____

Go! Now I know _____

Lesson 2 What is the design process?

Stop! I need help with _____

Wait! I have a question about _____

Go! Now I know _____

Unit 1

Got it? Quiz

Name _____ Date _____

Got it? Quiz

Circle the best answers.

1. Which of the following is the best description of the design process?

A making new inventions
B building superhighways
C designing nanobots
D a set of steps for developing products and processes that solve problems

2. In the design process, what is the next step after developing possible solutions?

A choose one solution
B identify the problem
C do research
D test the prototype

3. What TWO systems of the human body does a robotic arm mimic?

A muscular system
B respiratory system
C skeletal system
D digestive system

4. In what ways are robots like humans?

A They are made of the same materials as humans.
B They have emotions like humans.
C They make movements like humans.
D They have respiratory systems like humans.

Unit 1

Got it? Quiz

Name _____ Date _____

5. What might nanobots be used for?

A constructing buildings
B working in the engine of a car
C investigating squirrel behavior
D killing cancer cells

6. An engineer watching people use a computer keyboard is doing which of the following?

A making a model
B identifying a problem
C documenting a design
D presenting design evidence

7. What are three kinds of reference materials that product designers use?

Possible answers: scientific magazines, the Internet, informational books, encyclopedias

8. Describe how a robotic squirrel might mimic a real one.

Possible answers: A robotic squirrel might make noises and move its tail like a real squirrel. It might walk or run like a real squirrel.

9. Describe three tasks that a prosthetic hand should be able to do.

Possible answer: A prosthetic hand should be able to move in different directions, close around an object and open again, and pick up objects and put them down again.

10. Why do engineers evaluate a prototype?

Possible answers: They do it to see how well the design solved the problem or to redesign the prototype to make it better.

Unit 1 Study Guide

How can technology make our lives easier?

Lesson 1

How does technology mimic living things?

- Technology can mimic the muscular and skeletal systems of humans and animals.
- Prosthetic limbs mimic parts of the human body.
- Scientists hope to build tiny robots using nanotechnology.

Lesson 2

What is the design process?

- Engineers use the design process to solve problems.
- The design process has several steps.
- Designing, constructing, and testing a prototype are steps in the design process.
- Engineers record and share results.

Review the Big Question

How can technology make our lives easier?

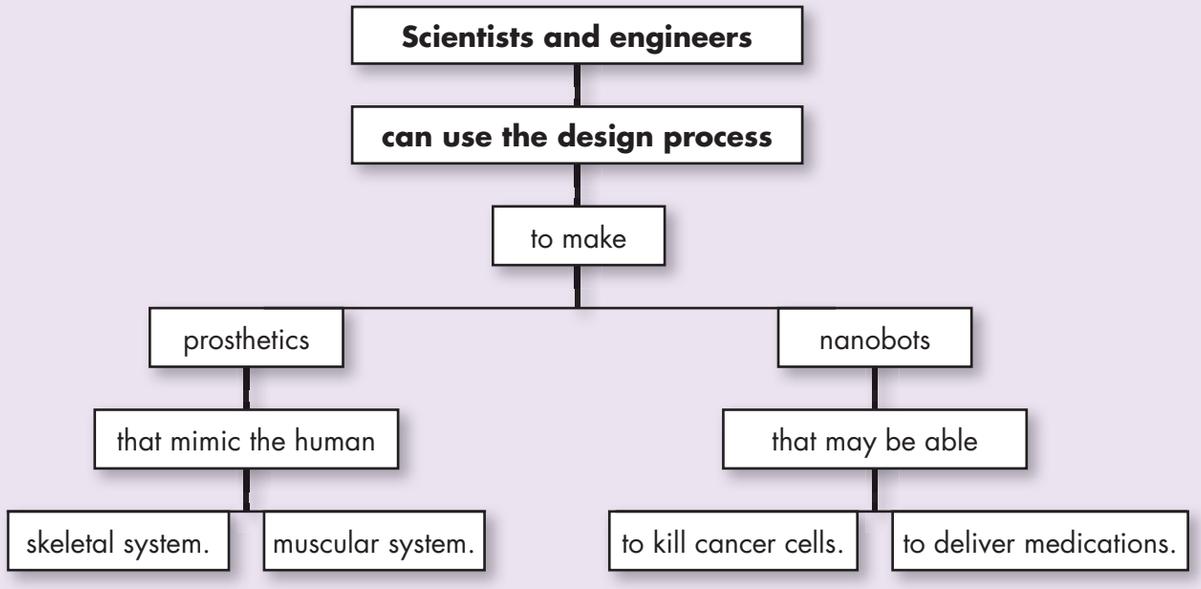
Have students use what they have learned from the unit to answer the question in their own words.

How has your answer to the Big Question changed since the beginning of the unit? What are some things you learned that caused your answer to change?

Make a Concept Map

Have students make a concept map like the one shown on this page to help them organize key concepts.

Unit 1 Concept Map



Students can make a concept map to help review the Big Question.

Teacher's Notes