SPECTRUM®

Science

GRADE 4

CORRELATED TO
Current State Standards
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Focused Practice to Support Science Literacy

- Introduction to the scientific method
- Natural, earth, life, and applied science lessons
- Research extension activities
- Key word definitions
- Answer key

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Lesson 1.1 The Scientific Method

skeptics: people who are slow to believe something; they ask many questions

solutions: answers to problems

proof: evidence or facts that show something to be true or correct

opinions: beliefs that are based experience, but that aren't necessarily proven to be true

hypothesis: a statement that is assumed to be true so that it can be tested

community: a group of people who are interested in the same thing

"Somewhere, something incredible is waiting to be known."—Carl Sagan, astronomer

What is the difference between a theory and a law?

Without science, we wouldn't know why water freezes, where the sun goes at night, or how our bodies fight disease. We have the answers, though, because someone was curious. Science always begins with a question.

Scientists want to find answers, but a good scientist doesn't stop working until he or she has the only possible answer. This is because the best scientists are **skeptics**. They never say they've solved a scientific problem if other possible **solutions** can be found. Science is based on **proof**. Statements that don't have proof are guesses or **opinions**.

The scientific method is a tool scientists use to prove things. It begins with a question. For example, "Do birds like one color more than another?"

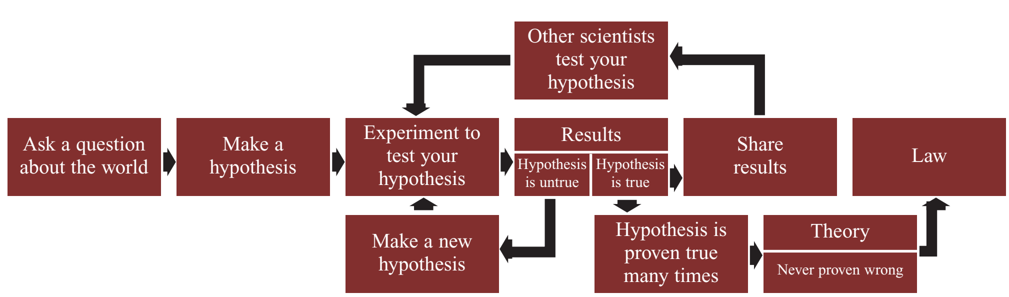
The next step is to answer the question. At this point, it's okay to make a guess or have an opinion. You need something you can test. In the scientific method, your answer is called the **hypothesis**. A hypothesis is a simple statement that can be proven right or wrong. "Birds will eat more food from a red birdfeeder than a blue one" is a good hypothesis.

Now, you can test the hypothesis using experiments and observation. The tests must be designed carefully, though. If too many parts can be changed, it will be hard to tell why you got one result and not another.

If a hypothesis is unable to be proven, the next step is to make a new hypothesis and test it. If the experiments show that a hypothesis is proven, you'll still want to test it again. For example, maybe birds don't see color at all. Something else might have been attracting them to the feeders.

After a scientist finishes experimenting, he or she writes a conclusion. Then, the scientist shares the results with other scientists. The scientific **community** looks closely at the results. This step is very important in the scientific method. Other scientists will try to get the same results. Scientists double- and triple-check each other's work.

A hypothesis must be proven true many times before the scientific community accepts it as true. They're skeptics, remember? If a hypothesis makes it through lots and lots of testing, it will become a theory. A theory might still be proven wrong, but the chances are less. Theories that last for many, many years—and are never proven wrong—become scientific laws.



Circle the letter of the best answer to each question below.

1. A ____________________ is a theory that has never been proven wrong.

a. hypothesis

b. solution

c. law

d. opinion

2. Which of the following would make a good hypothesis?

a. Trees grow better in soil than sand.

b. Do bees like some flowers better than others?

c. I think apple juice tastes better than orange juice.

d. Girls draw better than boys.

3. If an experiment fails to confirm your hypothesis, what is the next step?

a. Find another solution.

b. Make another hypothesis.

c. Keep trying the same experiment.

d. Use a different theory.

Write your answers on the lines below.

4. Explain why your answer to question 2 makes a good hypothesis.

____

5. Why should a scientist always share the results of his or her experiments?

____

____

6. Number the steps of the scientific method in the correct order.

________ hypothesis

________ question

________ experiment

________ law

________ theory

________ share results

Lesson 1.2 Scientific Detectives

research: the act of studying, observing, or collecting in order to gain knowledge

investigator: someone who closely examines evidence to reach a conclusion

facts: things that really exist or happen; things that can be proven true

evidence: facts that help prove something

artifacts: simple objects, like tools, that show evidence of a human culture

conclusions: decisions made with careful thought

Police detectives use science, too. Forensic science is the use of science in solving crimes. Fingerprinting and DNA tests can help identify people. Clothing can be tested to show chemicals used in making explosives. All sorts of electronic devices have been invented to help investigate crimes.

How does a scientist do his or her job?

When most people think of a scientist, they picture someone in a lab wearing a white coat. Of course, some scientists do work in labs, but just as many are out in the world doing their **research**. They wear jeans and dig through the dirt hoping to discover the bones of a new dinosaur. They wear snowsuits, gloves, and goggles as they trudge through the snows of Antarctica. Scientists go wherever the search for an answer takes them.

Like a detective, a scientist is an **investigator**. He or she looks for clues that will help solve the mysteries of our world. The most useful clues to a scientist are **facts**. Gathering facts is probably a scientist's most important job. Scientists collect samples, make observations, and perform experiments to get the facts they need.

The main kind of investigation a scientist does changes from one kind of science to another. For example, an archaeologist studies human history. He or she spends many hours outdoors, sifting through layers of ground looking for **evidence**. Pieces of bone, chips of clay pots, or the remains of an ancient campfire are all good clues. Archaeologists collect these **artifacts**, study them closely, and draw **conclusions** about our human ancestors.

Observation is another important method of investigation. Zoology is the science of animal life on Earth. Much of a zoologist's work is observing animals in their natural habitats. Dian Fossey was a famous zoologist who studied gorillas. For years, she lived in the mountain forests of Rwanda. The gorillas went about their lives while Fossey quietly observed them and took notes. Then, like any good scientist would do, she shared her information with the world.

Collecting and observing are both good ways of getting clues, but the scientists aren't really in charge. Instead, they must be in the right place at the right time to get the facts they need. With an experiment, though, the scientist is in control. He or she designs an experiment to test exactly what needs to be known. Experimenting is an important scientific tool. It lets the scientist be in control.

NAME ____________________

Circle the letter of the best answer to each question below.

1. A biologist who wants to know what kind of fish live in a lake would

a. design an experiment.

b. make observations.

c. collect all the fish from the lake.

d. None of the above

2. Which of the following is an example of collecting evidence?

a. a geologist gathering rocks from a mountainside

b. a paleontologist cleaning fossils

c. a botanist clipping leaves from plants

d. All of the above

3. A physicist wants to know whether salt water boils more quickly than tap water, so she

a. designs an experiment.

b. collects evidence from the ocean.

c. observes chefs cooking at a restaurant.

d. asks a detective.

Write your answer on the lines below.

4. What kind of scientist would you want to be?

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Unifying Concepts and Processes

Do you think each branch of science uses only one method of investigation? Explain your answer.

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Lesson 1.3 A Group Effort

system: any group of living or nonliving things that combine to work together

organisms: living plants and animals

interconnected: needing and relying on each other

You are part of many systems. Attending school makes you part of the educational system. If you play a sport, your team is a system. You all work together to score points and win the game. Being a member of a club makes you part of a system, as well.

Like any system, an ecosystem works best when all its parts work together. When one part doesn't cooperate, the entire system suffers. When an ecosystem is damaged, though, it isn't just the plants and wild animals that suffer. The human beings who live there are affected, too, even if they caused the problem.

What is a system?

The United States government has three branches—the executive, judicial, and legislative. They work together to run our country. It's a great **system**. The post office has thousands of people working together. They move millions of letters around the country every day. It's a great system, too. These are both examples of people working together to get something done. A system doesn't have to be just people, though. A system is anything with parts that work together.

Systems are everywhere. Your body is a system. Its organs, muscles, and bones work together to keep you alive and moving around. In fact, all living things are systems. Plants have leaves, stems, and roots to keep them alive. Insects have antennae, wings, and legs that move them around.

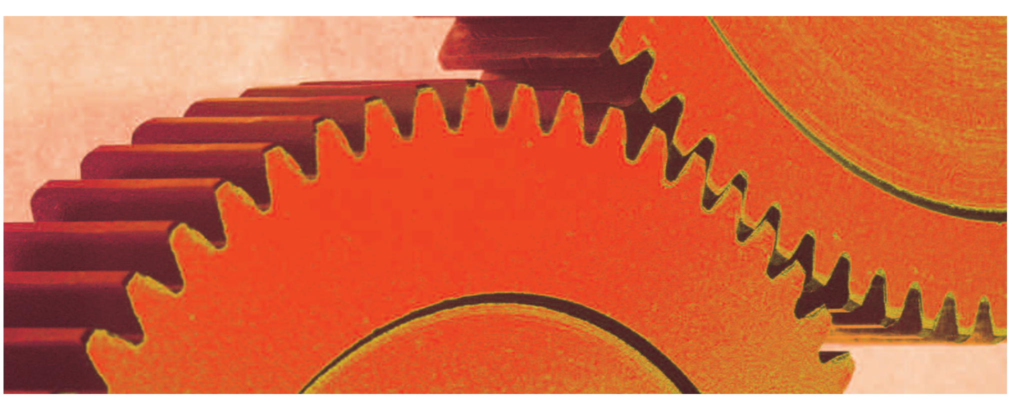
Systems come in all shapes and sizes. Tiny bacteria have even tinier parts that work together. An ecosystem is all the plants and animals living together in one place. It's a system because all the **organisms** are **interconnected**. Earth is part of a solar system. The sun, planets, moons, comets, and asteroids are linked together by gravity.

Systems can even be part of other systems. Your body has a nervous system, a digestive system, and a skeletal system. Our planet has many different ecosystems, but they all work together as a planetary system called *Earth*.

Cars, pencil sharpeners, and vending machines are mechanical systems. Computers, video games, and stereos are electrical systems.

So what isn't a system? A sheet of paper isn't a system. It has only one part—the sheet of paper. Coffee mugs, benches, and keys aren't systems. They don't have parts working together.

The most important thing to remember about systems is that every part has a role. If you remove a part, the system won't work as well—or might not work at all. Take the laser out of a CD player, and you won't hear any music. A plant won't live for long if you cut off all its roots. A system depends on its parts. When all the parts are working, a system runs smoothly and efficiently—just the way it should.



NAME ______________________

Circle the letter of the best answer to the question below.

1. Which of the following is not a system?

a. an ant colony

b. a cactus

c. a wooden board

d. a radio

Write your answers on the lines below.

2. List three systems that were not already mentioned in this selection.

______________________ ______________________ ______________________

3. A key is not a system, but it is part of a system. Explain why.

____

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4. Sometimes, one part of a system is more or less important than another. Think of a clock. What part could be missing, and still allow the clock to tell time? What part of a clock could not be missing? Explain your answers.

____

____

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5. Think of three systems that you are part of. What is your job in each system?

a. ____

b. ____

c. ____

Unifying Concepts and Processes

Some people think we don't need to worry about tiny insects or small fish becoming extinct. Scientists argue that every living thing, no matter how small it might be, needs to be protected. What do you think? Explain your answer.

____

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Under a Log

tally: to count and record

bar graph: a graph that shows rectangles of different lengths; used to make a comparison

Most of the insects that live among dead or rotting plant materials are decomposers. They help free stored energy from these materials. Over time, only small bits remain. These bits help nourish the next round of living things.

About 20% of woodland creatures make their homes in dead trees.

When eating wood, some termites make a ticking sound. Carpenter ants make more of a rustling sound as they eat wood.

What kinds of creatures make their homes under logs?

Austin and Alex walked to the far side of Alex's backyard. "How about this one?" asked Austin, pointing to a large, thick log that was covered with moss.

"That ought to work," replied Alex. He held up his notebook and pencil. "If you lift it up, I'll record what we see."

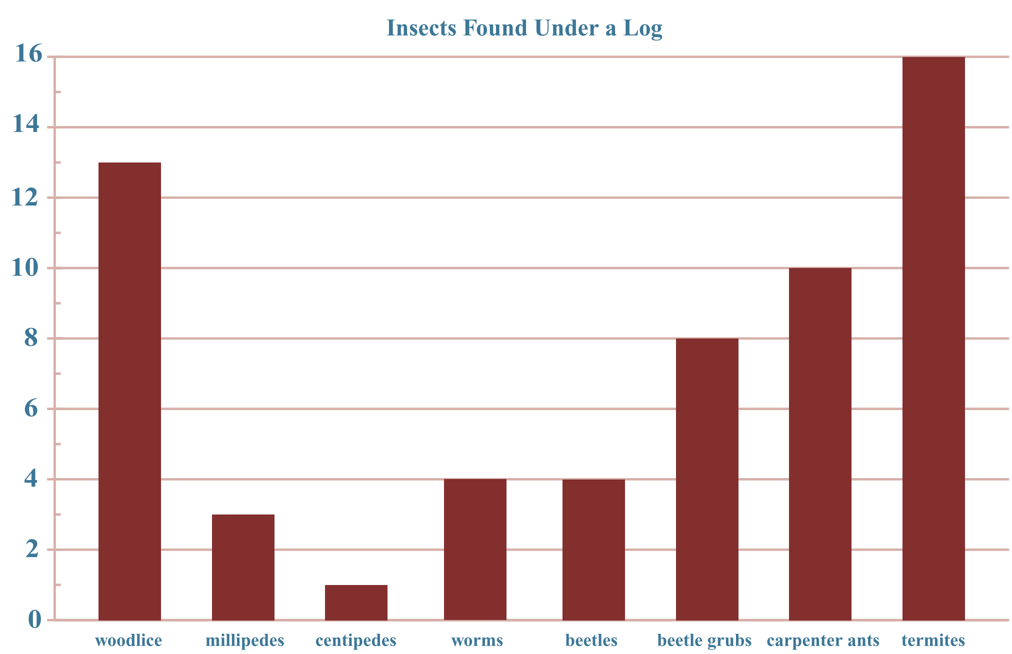
Austin lifted the log, and he and Alex peered beneath it. There was a great deal of scurrying as dozens of insects ran for cover. The boys tried to count the insects they could see, but quickly realized that many had already hidden themselves under a pile of dead leaves or another piece of wood.

"That didn't work out too well, did it?" asked Austin.

Alex shook his head. "Maybe we could try again and set the log on a sheet this time."

The second time the boys tried their project, they had better luck. They chose a medium-sized log and quickly set it on a large white sheet they had spread out in the yard. Alex counted the insects that were under the log. Austin recorded the insects that were on the log and on the sheet.

When they were finished, the boys put the log back exactly where they had found it. They gently shook out the sheet and went inside to **tally** their results. They spent the rest of the afternoon making a **bar graph** to use for their presentation to the class. They were sure that Ms. Yancy would give them an A+ for their project!



NAME ___________________________

Circle the letter of the best answer to the question below.

1. Which of the following is a question the boys might have been trying to answer when they began their project?

   a. Why do bugs live under logs?

   b. What causes tree limbs to die?

   c. What types of bugs live under logs?

   d. Why do ants, but not grasshoppers, live under logs?

Use the graph on page 12 to fill in the blanks below.

2. How many beetle grubs did Alex and Austin find? ____________________

3. The boys found the same number of ____________________ and ____________________.

4. The boys found more millipedes than ____________________.

5. There were more ____________________ under the log than any other type of insect.

Write your answers on the lines below.

6. How did using a bar graph help Alex and Austin organize the information they collected?

   ____

7. Why weren't the boys successful with the first log they tried?

   ____

8. How did they solve their problem?

   ____

9. When the boys examined their bar graph, Alex said, "Now we know that more termites live under logs than any other type of insect." Explain why Alex cannot draw this conclusion.

   ____

What's Next?

Bar graphs are only one kind of graphic organizer. Visit a library to find examples of other organizers, like pie charts, line graphs, or diagrams. Why are graphic organizers a helpful way to present information?

Lesson 1.5 Full of Air

funnel: a hollow cone with a narrow tube at one end

inflate: to fill with air

variables: in an experiment, something that can be changed

A mixture of baking soda and vinegar has many practical uses. The combination can clean out a clogged drain. It can be used to polish coins or kill weeds in the cracks of cement. Some people wash their hair with it, and others use it to get pet stains out of carpeting.

Baking soda and vinegar are often used to help model volcanoes "erupt" in science fair projects. Just add a little red or orange food coloring to the mixture, and it looks like hot lava is bubbling out of the volcano.

Is there more than one way to inflate a balloon?

Annie rummaged through the kitchen cupboards. "Here it is!" she said, setting the orange box on the counter.

"Great," said Kimiko. She checked the list she was holding. "Baking soda was the only material we were missing. We're ready to get started."

Annie held out a plastic soda bottle. "How much vinegar do I need?"

"About half a cup," replied Kimiko. As Annie poured the vinegar into the bottle, Kimiko used a **funnel** to put a tablespoon of baking soda into a balloon.

"Are you ready?" Kimiko asked Annie. Annie nodded, and Kimiko carefully fitted the balloon over the opening to the soda bottle. Annie held up the top of the balloon so that the powder inside would fall into the bottle. As the specks of baking soda hit the vinegar, it began to fizz. Tiny bubbles began filling the bottle. As the girls watched, the balloon started to **inflate**.

"Perfect!" cheered Annie. "That is exactly what we wanted to happen. When the baking soda mixed with the vinegar, it caused a chemical reaction to take place. Carbon dioxide was released. It's a gas, so it caused the balloon to fill."

"Now we need to experiment with some **variables**," said Kimiko. "We need to change one part of our experiment and see what kind of results we get. I wonder what would happen if we used an acid other than vinegar. What about orange juice?"

"We have a brand-new carton in the refrigerator," said Annie. "I'd also like to try using yeast. Sometimes, I help my dad bake bread. The first step is to add yeast to some warm water. The way it bubbles up reminded me of the baking soda. I'm curious to see what happens when we add it to vinegar. Will the yeast be able to inflate the balloon, too?"

"Sounds good to me," said Kimiko. "Let's just remember that we can change only one variable at a time. Otherwise, we won't know which part of the experiment has caused a change in our results."

"Got it," said Annie. She opened the refrigerator and pulled out the juice and a small packet of yeast. "Let's see what happens next!"

NAME ______________________

Circle the letter of the best answer to each question below.

1. What caused the balloon to inflate when Annie and Kimiko did their experiment?
   a. vinegar
   b. baking soda
   c. a chemical reaction
   d. Not enough information is given.

2. Which of the following could be a variable?
   a. the size of the balloon
   b. the liquid in the bottle
   c. the powder placed in the balloon
   d. All of the above

Write your answers on the lines below.

3. Why do you think Kimiko put the baking soda into the balloon? What probably would have happened if she had put it into the bottle and then put the balloon on the bottle afterward?

   ____

   ____

4. Explain why only one variable at a time should be changed.

   ____

   ____

5. The next time Kimiko and Annie do the experiment, they are going to use baker's yeast. Write the hypothesis you think they plan to test.

   ____

   ____

6. Name two other substances, besides orange juice and baker's yeast, that Kimiko and Annie could test.

   ____________________   ____________________