SC.5.N.1.1 Define a problem, use appropriate reference materials to support scientific understanding, plan and carry out scientific investigations of various types such as: systematic observations, experiments requiring the identification of variables, collecting and organizing data, interpreting data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.

The Practice of Science

All scientists try to explain how and why things in the natural world happen. Scientists answer questions that arise from observations of the natural world. A good scientific question is one that can be answered by investigation. An **investigation** is a procedure carried out to carefully observe, study, or test something in order to find out more about it. A scientific investigation always begins with a question.

Once a scientist has a testable question, it is time to plan an investigation. **Scientific methods** are ways that scientists perform investigations. The type of investigation can vary, depending on the question. All scientific methods use logic and reasoning.

Some investigations are experiments. An **experiment** is an investigation in which all of the conditions are controlled. Scientists study what happens to a group of samples that are all the same except for one difference. Not all questions can be investigated by experimentation. Scientists also use repeated observations to study processes in nature that they can observe but cannot control. Scientists use models when they cannot experiment on the real thing. Models can be used to represent real objects or processes. Scientists use models to study things that are too big, too expensive, or too uncontrollable to study in any other way.

Scientists use the results from their investigation to draw conclusions. The conclusion may answer the question or indicate that further investigation is needed.

Models

Some scientific questions involve objects that are too far away, too expensive, too big, or too complex to study by experimentation. Scientists can use models to address these questions. Scientists use models to draw conclusions and make predictions. **Predictions** are statements about future events based on information.

A variety of models can be used for different purposes. The best model is the one that most closely represents the real thing. The simplest model is a diagram or flow chart that shows relationships between objects or ideas. A physical model is a three-dimensional representation of the object or process. A computer simulation model is very useful for complex processes because it can change factors that cannot be controlled in the real world.

Experiments

Many scientific questions can be answered using experiments. An experiment is a procedure used to test a hypothesis. A hypothesis is a statement that can be tested and will explain what can happen in an investigation. An experiment should be designed with two or more situations that are compared. A variable is any condition in an experiment that can be changed. The idea is to keep all variables the same except one. This variable is the one you test. Among the setups should be one called the control. The **control** is the setup to which all the others are compared.

A **procedure** is the steps followed in an experiment. It is common for the procedure to be repeated multiple times. Repeated experiments increase the amount of data that can be considered. When the results are similar, you will have more evidence to support your conclusions.

All conclusions should be supported by evidence. The more evidence there is supporting it, the stronger the conclusion. Results are also used to evaluate the hypothesis. If the evidence does not support the hypothesis, the hypothesis may need to be revised. Further experiments can be designed to test the revised hypothesis.

Data Displays

Data displays summarize the results of an investigation. The type of display used depends on the type of data. The results of experiments are usually organized in a table. This makes it easier to compare setups. Sometimes additional calculations are required to make the results more useful.

Results are often displayed and communicated in graphs or diagrams. These types of displays summarize key points in the results. Data that show a change in time, or in another continuous variable, are often displayed as a line graph. Bar graphs are used to compare data from different categories. Circle graphs are useful when comparing parts to a whole. Non-numerical data can be represented in diagrams.

Science Tools

Some scientists investigate the natural world on location. Their investigations are often in the form of repeated observations. They use tools to increase the power of their senses. The tools they use depend on the question.

A field scientist might use a collecting net to catch small animals without harming them. The scientist can then take various types of measurements of various kinds. A hand lens can be used to magnify small objects to make observation easier. Cameras allow scientists to record events for later analysis. Photographs also help track and identify organisms. Scientists use computers to record and analyze data, construct models, and communicate with other scientists.

Some tools are too big or too delicate to be taken into most field locations. These tools are used in the laboratory. A light microscope magnifies things, or makes them look bigger. The object to be viewed is placed on a clear slide. The scanning electron microscope (SEM) can magnify an object up to one million times. The SEM shoots a beam of electrons at the object. An image of the surface of the object appears on a computer screen.

Measurements

Taking measurements is making observations involving numbers and units. Scientists around the world use the International System (SI), or metric system. The metric system is based on multiples of 10. In the metric system, base units are divided into smaller units using prefixes such as *milli-* and *centi-*. Base units are changed to bigger units using prefixes such as *kilo-*.

Length is the distance between two points. The base metric unit of length is the meter. Rulers, metersticks, and tape measures are tools used to measure length.

Time describes how long events take. The base unit of time is the second. Time is measured with clocks, stopwatches, timers, and calendars.

Temperature describes how hot or cold something is. Thermometers are used to measure temperature. Scientists measure temperature in degrees Celsius.

Mass is the amount of matter in an object. The base unit of mass is the gram. A balance is a tool used to measure mass. There are different types of balances; pan balance, triple-beam balance, and digital balance.

A spring scale is a tool used to measure force. Force is a push or pull. The base unit is called a newton.

Volume is the amount of space a solid, liquid, or gas takes up. There are two base metric units for measuring volume the cubic meter and the liter. A cubic meter is one meter long, one meter high, and one meter wide. A liter is the base unit often used for measuring liquids.

When a measurement is close to the true size, it is **accurate**. Accurate measurements are important when doing science investigations. Make sure a tool is not broken and that you know how to use it properly. Use the tool the same way every time. Measure to the smallest place value the tool allows. Be sure to use the correct units.

Student-Response Activity

❶ Which type of investigation–repeated observations, using models, or controlled experiments– would work best to answer each question?

- What type of shark visits a reef at different times of the year? _____

  _____

- Does hot water or cold water dissolve sugar faster? _____

  _____

- How does a rocket work? _____

  _____

- How does the color of light affect plant growth? _____

  _____

❷   Karen hypothesizes that plants will grow better in water that has more minerals. She uses distilled water on tomato plants, tap water on bean plants, and mineral water on squash plants. What is wrong with her procedure?

_____

_____

_____

_____

_____

❸   Identify which tools you would use to investigate each question.

meterstick   pan balance   magnifying lens   computer   net   camera

• How are two types of fish scales similar and different? _____

_____

• What do scientists already know about the surface of Mars? _____

_____

• Does the mass of a ball affect how high it bounces?_____

_____

• Which fish live in a pond?_____

_____

❹   What conclusion can you draw from the graph?

Estimated Number of Orangutans in Sumatra

_____

_____

_____

_____

_____
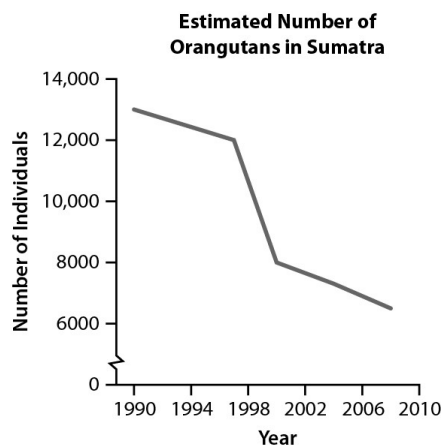
Benchmark Assessment SC.5.N.1.1

Fill in the letter of the best choice.

❶ Scientists want to determine if how loud music is played affects a person's blood pressure. Which variable should change in the experiment?

Ⓐ the type of music played

Ⓑ the amount of time the person hears the music

Ⓒ the volume of music played

Ⓓ the tools used to test the blood pressure

❷ Shayla observes the change from caterpillar to butterfly. She draws and labels each phase and shares her drawings with the class. Which statement **best** describes Shayla's investigation?

Ⓕ It involves modeling.

Ⓖ It involves experimentation.

Ⓗ It involves repeated observations.

Ⓘ It involves both experimentation and repeated observation.

❸ Jermaine uses cell phone Internet service from provider A. Ricardo uses Internet service from provider B. How can Jermaine and Ricardo determine in a scientific way which Internet company has faster download speeds?

Ⓐ Read information from each Internet service provider.

Ⓑ Use a timer to find out how long it takes to download the same game.

Ⓒ Have each student download a different game and compare the time it took.

Ⓓ Ask ten friends who use each Internet service which one is faster.

❹ Chen counts the number of people who visit the community pool each day for 1 week. He displays his data using a bar graph.

Number of Pool Visitors
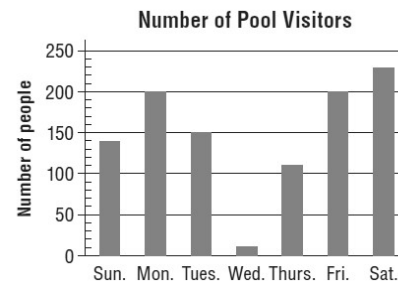
How many more people did Chen observe at the pool on Friday than on Thursday?

Ⓕ 19

Ⓖ 200

Ⓗ 100

Ⓘ 90

❺ Teresa has been growing plants without fertilizer. Now, she wants to see what happens to the plants when the amount of fertilizer is increased, as shown in the chart.

Plant	Amount of Fertilizer
1	No fertilizer
2	1 teaspoon every week
3	1 teaspoon twice per week
4	1 teaspoon once every two weeks

Which plant is the control?

Ⓐ 1

Ⓑ 2

Ⓒ 3

Ⓓ 4