LESSON 81

# Scientific Inquiry

How do scientists learn about the natural world?

**Scientific inquiry** involves observing, studying, and understanding the natural world. A **scientific investigation** is the search for an answer to a clear, well-defined question about the natural world.

The table below shows the steps used to conduct a scientific investigation.

Keep in mind that each investigation is different. So, scientists do not always follow the steps in the exact order listed below. Still, you can use these steps to guide you when you are doing investigations.

## Steps of a Scientific Investigation

| Step | What You Do in This Step |
|---|---|
| Identify a question. | Ask *How, What, When, Where,* or *Why*. |
| Research the question. | Use books, the Internet, and other sources to learn more about your question. |
| Make an hypothesis, or possible answer. | Suggest a possible answer to the question. |
| Plan an investigation. | Decide how to test your hypothesis. |
| Conduct the investigation. | Carry out your plan. |
| Collect and record data, or information. | Make observations and measurements. Organize data in graphs, drawings, or tables. |
| Analyze the data and draw conclusions. | Decide what the data mean and if they support the hypothesis. |

## Show What You Know

**Think of a clear, well-defined question about the natural world that you could answer through a scientific investigation.**

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# Hypotheses

## What is an hypothesis?

A **hypothesis** is a possible answer to a question. It can be based on things you have learned or **observations** you have made. For example, you may have noticed that grass becomes brown if it does not rain for a long time. Your hypothesis might be: Plants need water to live.

You should always write your hypothesis in the form of a sentence. Also, you must be able to test your hypothesis. The results of your experiment will help you to decide if your hypothesis is correct. Think about the hypotheses in these investigations:

1. Jose placed two pieces of cloth under a bright lamp. One piece of cloth was dark-colored. The other piece was light-colored. After 30 minutes, he recorded the temperature of the cloths. The dark-colored cloth had a higher temperature than the light-colored cloth.

2. Jared used a scale to weigh an empty balloon. He recorded the measurement in a data table. Then he filled the balloon with air and weighed it again. Jared recorded the measurement and then analyzed his data. He noted that the balloon with air weighed more than the empty balloon.

3. Maria divided a piece of steel wool into two equal halves. She put one piece in a bowl of water for five minutes, and then placed it on a paper towel. She put the other piece of steel wool next to the wet piece. She let both pieces of steel wool sit overnight. The next day, she observed that the dry steel wool was unchanged. But the wet steel wool had turned a rusty color.

## Show What You Know

**Write the hypothesis in each investigation above.**

1. Hypothesis: ____________________

2. Hypothesis: ____________________

3. Hypothesis: ____________________

# Designing an Experiment

How do you plan an experiment?

After forming a hypothesis, you must do an experiment to test it. In an experiment, it is important to follow a procedure. A **procedure** is a step-by-step plan of the experiment. It shows how you will test your hypothesis. Each step in a procedure is listed in logical order.

In your procedure, you should also list the materials you will use and how you will use them to carry out the experiment. Let's say you want to see if running water erodes soil. You would need a pan, water, soil, paper, and a pencil. To save time, gather the materials before beginning the experiment.

A procedure also describes what safety precautions you will use. If you use a lamp, for example, you would want to be sure to keep it away from water. For most experiments, you should wear safety goggles to protect your eyes and a lab apron to protect your clothes. Safety precautions help make sure that no one is harmed during an experiment.

**Hypothesis**
Running water erodes soil.

**Materials**
soil, water hose, shallow pan, paper, pencil

**Procedure**

1. Place soil in the pan. Tilt the pan.
2. Attach a hose to a water faucet. Hold the other end of the hose at the top of the pan.
3. Slowly, turn on the faucet. Record observations.

## Show What You Know

**Give a reason for doing each of the following things.**

1. Planning a procedure

______________________________________________

2. Listing materials

______________________________________________

3. Following safety precautions

______________________________________________

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# Variables

## What is an independent variable?

During your experiment, you must always control variables. A **variable** is anything that can change in an experiment. For example, there are several variables in an experiment to test the effect of sunlight on plants. They include sunlight, water, soil, and type of plants. All variables, except the one you are testing, must be the same. The variable that changes—in this case, sunlight—is the **independent variable**. Controlling variables lets you know for certain that your results are caused by the variable you tested. Think about the independent variables in these investigations.

1. Jose placed two pieces of cloth under a bright lamp. One piece of cloth was dark-colored. The other piece was light-colored. After 30 minutes, he recorded the temperature of the cloths. The dark-colored cloth had a higher temperature than the light-colored cloth.

2. Jared used a scale to weigh an empty balloon. He recorded the measurement in a data table. Then he filled the balloon with air and weighed it again. Jared recorded the measurement and then analyzed his data. He noted that the balloon with air weighed more than the empty balloon.

3. Maria divided a piece of steel wool into two equal halves. She put one piece in a bowl of water for five minutes, and then placed it on a paper towel. She put the other piece of steel wool next to the wet piece. She let both pieces of steel wool sit overnight. The next day, she observed that the dry steel wool was unchanged. But the wet steel wool had turned a rusty color.

## Show What You Know

**Identify the independent variable in each investigation above.**

1. Independent variable: ______________________________

2. Independent variable: ______________________________

3. Independent variable: ______________________________

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# Collecting Data

As you carry out your experiment, you will collect **data,** or information. The data may include observations and measurements. You use your senses to make observations. They may be in the form of numbers or words. You use tools to make measurements.

Scientific Tools

| | |
|---|---|
| Meterstick | Length |
| Stopwatch | Time |
| Thermometer | Temperature |
| Balance | Mass |

Sometimes, your experiment deals with things that are too big or too small to measure directly. If so, you can estimate. To **estimate** means to make an educated guess about the size or number of things that you cannot measure directly.

As you work, you should record, or write down, your data. Include the proper units for your measurements. And remember that the data must be accurate. Otherwise, your results may be wrong. Many experiments are repeated several times. Each repeated experiment is called a **trial.** Doing multiple trials is one way of making sure that your data are correct. The procedure stays exactly the same for each trial.

**Use the following words to complete each sentence.**

**measurements** **observations** **estimate** **trials**

You use your senses to make ____________________.

You can ____________________ to make an educated guess about something that is too big to measure directly.

You use tools such as thermometers and metersticks to

make ____________________.

To be certain that data are accurate, you do several ____________________ of your experiment.

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# Recording Data

## How can you organize data?

The data that you gather can be organized in different ways. For example, you can keep a science journal. In the journal, you can draw or write sentences to describe your observations. Or you may record data in a table. A **data table** organizes the information gathered in an experiment. It has a title that describes what it is about. It also has rows and columns, which are labeled to describe what they show.

Tables often work better for data that involve numbers. In all cases, the data should include a date and time to let you keep track of your observations. The data should also be recorded immediately so that you do not forget or lose information.

**Height of Plants**

| Day | Cup A (5 seeds) | Cup B (20 seeds) |
|---|---|---|
| **Day 1** | 0 cm | 0 cm |
| **Day 3** | 0.02 cm | 0.02 cm |
| **Day 6** | 0.5 cm | 0.4 cm |
| **Day 9** | 1.5 cm | 0.6 cm |
| **Day 12** | 3.4 cm | 0.8 cm |

## Show What You Know

**Use the following information to create a data table.**

Carla wanted to know how much paper was recycled in her town each day. She learned that on Monday, 3 kg of paper were recycled. The same amount of paper was recycled on Tuesday and Wednesday. On Thursday, only 2 kg of paper were recycled. But on Friday, the amount of recycled paper rose to 4.5 kg.

# Reading Data Tables

## How do you read a data table?

A data table compares the characteristics of different things or events. Look at the example to the right. The cars that are being compared are listed in the first column. The characteristics of the cars (in this case, mass and stopping distance) are listed across the top row. As you can see, sometimes more than one characteristic is compared.

### Finding Patterns

You can use the data in a table to find **patterns.** For example, notice in the data table that, the greater the mass of a car, the greater its stopping distance. The data clearly show a relationship, or pattern, between mass and stopping distance.

### Making Predictions

You can also use the data in a table to make **predictions.** Again, look at the data table. Based on the numbers, you can see that for each increase of 250 kg of mass, the car's stopping distance increases by 20 m. So a car with a mass of 2,250 kg would have a stopping distance of 180 m.

**Relationship Between Mass and Stopping Distance**

| Car | Mass (kg) | Stopping Distance (m) |
|---|---|---|
| Car A | 1,000 | 80 |
| Car B | 1,250 | 100 |
| Car C | 1,500 | 120 |
| Car D | 2,000 | 160 |

## Show What You Know

**Based on the data in the table, what would be the stopping distance for a car with a mass of 1,750 kg? Explain your answer.**

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# Drawing Conclusions

## What can data tell you?

After you collect your data, you need to **analyze** it. You look at the data and ask yourself, "What relationships do I see?" After analyzing your data, you then draw a conclusion. A **conclusion** is an explanation based on the data. Depending upon your results, your conclusion may or may not support your hypothesis.

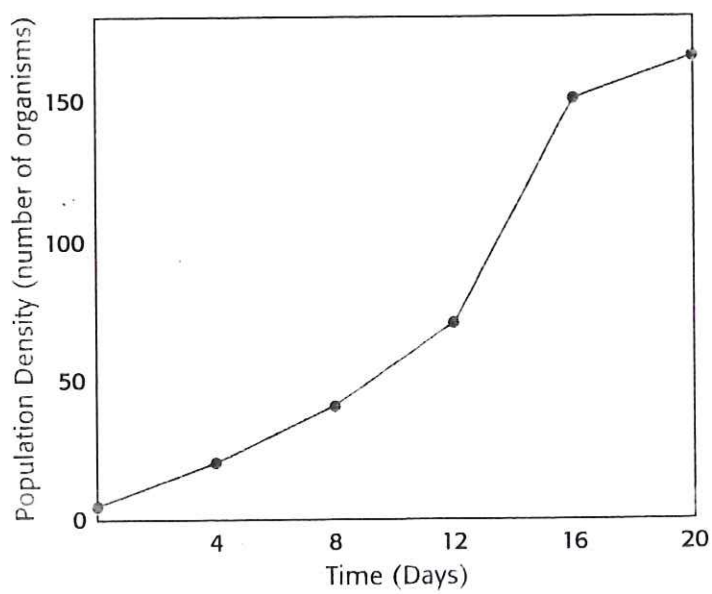
An **inference** is also an explanation. But it is based on prior knowledge, rather than direct observation. For example, you may see smoke in the distance and infer that a fire is burning. This explanation makes sense. However, it is not a conclusion because you do not see an actual fire.

**A scientist collected the following data. Then she put the data in a line graph.**

### Field Mouse Population Data

| Day | Population Density |
|---|---|
| 0 | 5 |
| 4 | 20 |
| 8 | 40 |
| 12 | 70 |
| 16 | 150 |
| 20 | 165 |

Population Density vs. Time




### Show What You Know

1. Based on the graph, how did the population density of field mice change over time?

_______________________________________________

2. What pattern do the data show?

_______________________________________________