Section 2
Organizing Your Data

Key Concept Scientists organize data to make quantitative statements about the relationships between the variables in an investigation.

What You Will Learn
- Scientists use data tables and graphs to organize information.
- The independent variable is the factor or parameter that the investigator can change.
- The dependent variable is the factor or parameter that the investigator measures.
- Graphs help show patterns in data. Linear and nonlinear graphs show different relationships between the variables.

Why It Matters
Graphs and data tables can help you see trends in data, analyze results, and draw conclusions.

It's Tuesday night, and you are studying for a test. You have a notebook, the textbook, and flashcards. You have so much information that you feel overwhelmed! In the same way, you—like the student in **Figure 1**—could be easily overwhelmed by all of the data gathered from scientific investigations. To be useful, data must be organized. But how? In this section, you will learn some of the same methods that scientists use to make information easier to interpret and understand.

Figure 1 When conducting research, you can collect so much information that you become overwhelmed, as this student has.

Creating a Data Table

For several years, a teacher has been investigating the amount of exercise his students get weekly. The students gather information about the total hours of exercise they get each week. The first step that the teacher and the students take in organizing the data is to fill in a data table.

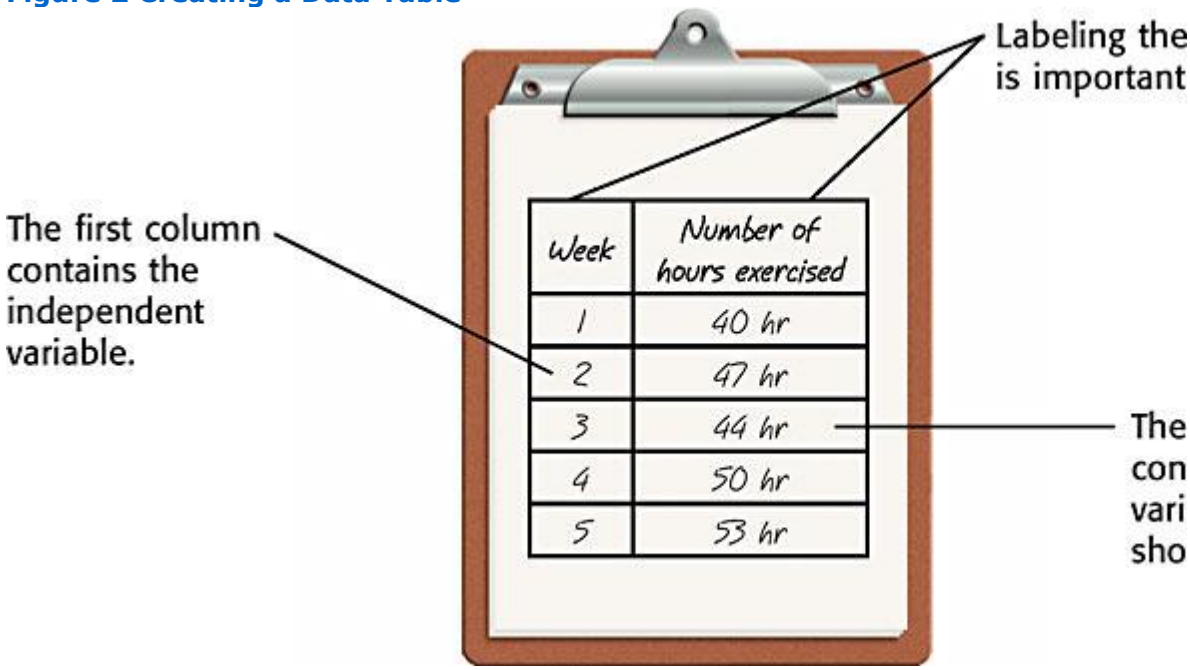
Organizing: The First Step

It's important to determine what information you are going to gather and to create a data table before the experiment starts. Then, you can be as organized as possible and can be sure not to miss any information that might be important.

Independent and Dependent Variables

A data table has two columns, as shown in **Figure 2.** The first column lists the **independent variable,** the factor or parameter that the investigator can change. In this case, the class chose to study the total number of hours exercised each week for five weeks. So, the independent variable is the week. If the class chose to study the total number of hours exercised each month, the independent variable would be a month.

Figure 2 Creating a Data Table



The second column in the data table lists the dependent variable. The **dependent variable** is the factor that changes in response to the independent variable. It is the variable that the scientist measures. In **Figure 2,** the dependent variable is the total number of hours exercised. It changes with the independent variable. So, the hours exercised change every week.

Variable and Controlled Parameters

When you design an experiment, you have controlled parameters and variable parameters. *Controlled parameters* are factors that stay constant throughout the experiment. *Variable parameters* are factors that change, or vary, throughout the experiment. If you want to explore the relationship between two factors, such as mass and volume, then those factors are your variable parameters. All other factors, such as temperature and the material you study, should be kept constant and are your controlled parameters.

Standards Check Explain the difference between variable and

controlled parameters.

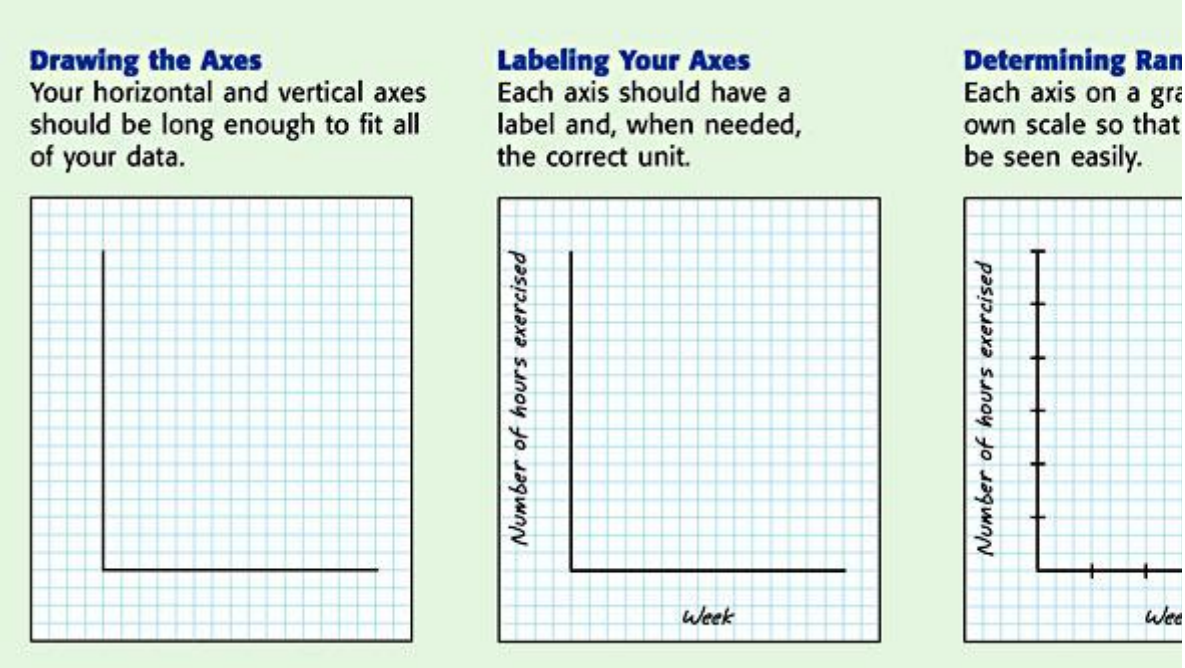
Creating a Graph

Data tables help you organize data. Graphs help you understand and use that data. Graphs make it easy to identify trends and make predictions. Students studying the amount of exercise they get each week used their data table to graph the total number of hours exercised over a five-week period.

Axes

Figure 3 shows how to make a graph. First, use a data table to determine the graph's axes (singular, *axis*). An **axis** is a reference line that forms one side of a graph. A graph has a horizontal *x*-axis and a vertical *y*-axis. The *x*-axis usually represents the independent variable in the data table. The *y*-axis usually represents the dependent variable. In a graph of the number of hours exercised in a five-week period, the *x*-axis represents the week, and the *y*-axis represents the number of hours exercised. Each axis is labeled with the name of the variable that is represented.

Figure 3 Creating a Data Graph



Range

Each axis has its own range. To find the range, subtract the smallest value of a single variable from the largest value of the same variable. For the exercise data, the range of the independent variable, the week, is 5 weeks. Therefore, the *x*-axis must cover at least 5 weeks. The range of the dependent variable, the number of hours, is 53 − 40 = 13. Thus, the *y*-axis must have room for at least 13 hours.

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Scale

The next step is to decide the scale of the graph. Each axis has its own scale. The scale is the size that is used for each box or grid mark on the graph. For the exercise data, we can choose a scale of 1 week for each grid mark on the *x*-axis. For the *y*-axis, the grid marks can be placed at intervals of 10. The scale should be chosen such that the graph spreads out to fill most of the available space.

Data Points

Now, the data points need to be plotted. You plot the data points by putting a dot on the graph for each pair of data in the data table. Sometimes, a "line of best fit" is needed. Most graphs of data or observations are not drawn dot to dot through the data points. A line of best fit, such as the one in **Figure 4,** is a smooth line that is drawn to "fit," or to include, some but not all of the data points. The smooth line without sharp turns or sudden bends shows the pattern described by the data. The line of best fit also shows how the data differ from the pattern.

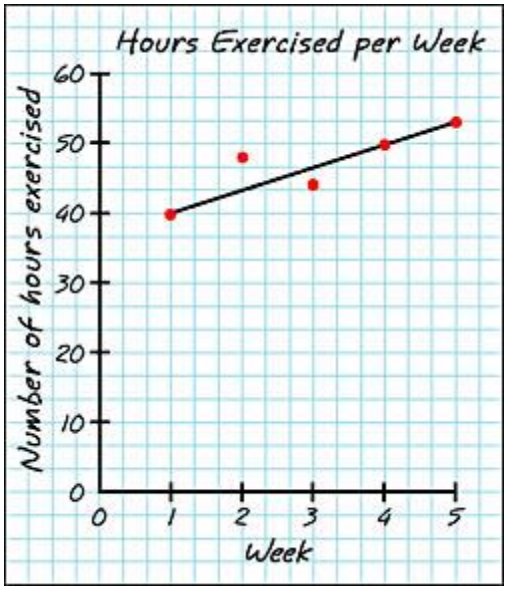


Figure 4 The line of best fit shows the general relationship between the two variables in the graph. It also shows how data vary from the overall relationship.

Labels

The last step is to give the graph a title. The title helps people recognize what the graph describes. Scientists often include the independent and dependent variables in the title.

Standards Check Why is an appropriate title for a graph important?

Patterns Shown by Graphs

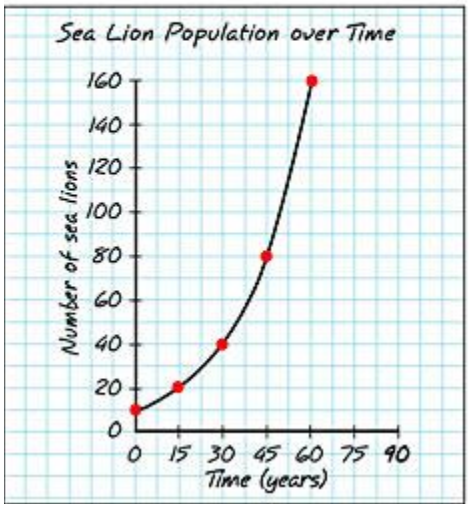
When you graph data, you can identify what the pattern, or *trend,* of the data is. A trend shows the relationship between the two variables studied in the experiment. Graphs make it easy to tell if something is increasing, decreasing, or staying the same.

A straight line can sometimes be used to show the trend of data on a graph. A graph in which the relationship between the independent variable and dependent variable can be shown with a straight line is called a *linear graph*. Sometimes, the relationship between the variables studied is not a straight line but a smooth curve. Any graph in which the relationship between the variables cannot be shown with a straight line is called a *nonlinear graph*.

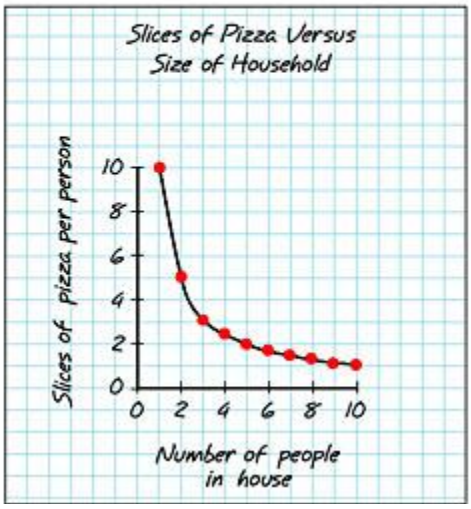
Graphs allow scientists to determine if the relationship between the variables is direct or inverse. If a graph shows that the dependent variable increases as the independent variable increases, the relationship between the variables is direct. If one variable increases while the other variable decreases, the relationship between the variables is inverse. **Figure 5** shows two nonlinear graphs, one of which has a direct relationship and one of which has an inverse relationship.

Figure 5 Trends in Nonlinear Graphs

Direct Nonlinear Relationship
The dependent variable increases as the independent variable increases.



Inverse Nonlinear Relationship
The dependent variable decreases as the independent variable increases.



Standards Check Describe the difference between linear and nonlinear relationships on a graph.

Using Computers to Create Graphs

Computer technology can be used to make organizing data easier. Computers help scientists collect, organize, process, and display large amounts of data. In **Figure 6,** a doctor is recording data on her hand-held computer. With this tool, she is able to gather data rapidly and as needed. Specially designed software makes appropriate graphs from lists of data. These graphs can be quickly examined to find patterns and relationships between the variables. The instant feedback provided by computer technology allows scientists to make mathematical representations of large amounts of data as they are collected.

Figure 6 This doctor uses a hand-held computer to help her keep track of patient information and her demanding schedule.

Standards Check How can technology help scientists create and interpret graphs from data?

Section Summary

- Scientists use data tables to organize information.
- Labels and units are important parts of data tables and graphs.
- The independent variable is the factor that the investigator changes.
- The dependent variable is the factor that the investigator measures.
- The line of best fit shows the trend of a linear graph.
- Graphs help show patterns, or trends, in data.
- Linear and nonlinear graphs show different relationships between variables.