

## CHAPTER

## 4

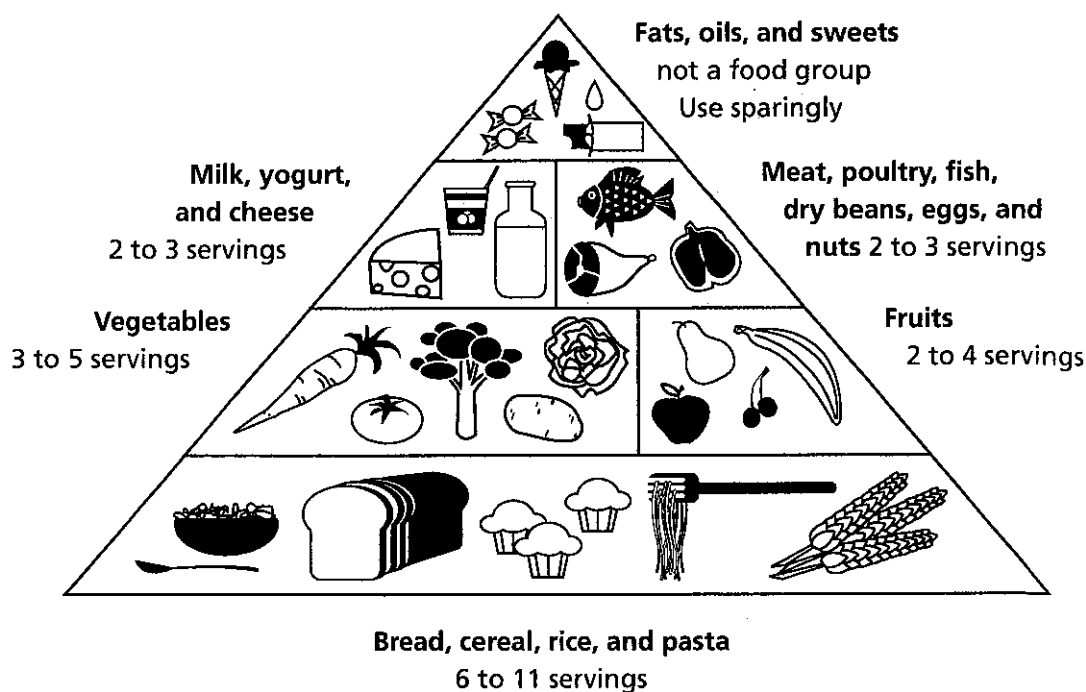
## CLASSIFYING AND CATEGORIZING

## 4-1 Why Do We Classify?

**Classification** is one of the most important ways we have to organize our world. It is the way we make sense of the hundreds and thousands of things around us. Stop and think for a moment. What are some everyday ways we classify things? Some people you know are friends; others are not friends. Some of your subjects are hard; others are easy. Some things you do are work; others are play. Without being aware of it, you put most things in your life into categories.

Classification takes a very complicated world and tries to simplify it by putting things into categories. Think about how difficult it would be to eat a healthy diet if foods were not put into nutritional categories. If the categories shown in **Figure 4-1**: fats, dairy, vegetables, fruits, meats, and grains did not exist, how would you know what foods to eat in which amounts? Things could get very confusing. For this reason classifying is important.

Classifying is also one of the most important tools of scientific thinking. The world of science encompasses everything, from the smallest particle inside an atom to a distant galaxy. If scientists did not divide the universe into smaller categories, they would never be able to understand much of it. One way they have divided the universe into smaller categories is by separating things into different subject areas, such as biology (life science), Earth science, and physical science.



**FIGURE 4-1** The food pyramid classifies different types of food.

**Section 4-1 Why Do We Classify?, continued**

In Chapter 3, you studied how an accurate definition leads to the understanding of a term or idea. Classifying is closely related to defining. Often a term is defined by the category to which it belongs. Take the following example that helps you understand the vast field of physics by defining its two main branches: *classical* and *modern* physics. Classical physics includes everything that physicists knew before 1900. Modern physics deals with the things that physicists have discovered since 1900.

There are often many different ways to classify the same thing. Two people can look at the same objects and classify them very differently. If you do not think so, think of all the different ways to classify the letters of the alphabet.

A B C D E F G H I J K L M  
N O P Q R S T U V W X Y Z

One way to classify the letters of the alphabet is to group them by letters that have curves in them—B, C, D, G, J, O, P, Q, R, S, and U; and letters without curves—A, E, H, I, K, L, M, N, T, V, W, X, Y, Z. Exercise 1 challenges you to think about the many different ways you can classify the letters of the alphabet.

**Exercise 1 Classification**

How many other ways can you think of to classify the capital letters of the alphabet? Write your categories in the spaces below.

- a. \_\_\_\_\_  
\_\_\_\_\_
- b. \_\_\_\_\_  
\_\_\_\_\_
- c. \_\_\_\_\_  
\_\_\_\_\_
- d. \_\_\_\_\_  
\_\_\_\_\_
- e. \_\_\_\_\_  
\_\_\_\_\_

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## CLASSIFYING AND CATEGORIZING

## 4-2 The Direction of Classifying

Classifying involves finding things that have something in common and *grouping* them into a **class** or **category**. That *something in common* is the **basis for classification**. For example, you could group *coal*, *oil*, and *gas* as energy sources. Coal, oil, and gas are members of the class *energy sources*. This method of classifying takes specific items (coal, oil, and gas) and finds a more general word, or a class word, that describes all of them. This method of classifying is called a **bottom-up process** (↑). It goes from the specific to the general.

## ENERGY SOURCES



coal oil gas wind water

You can also classify items in the other direction. Instead of starting with specific items and thinking of a general category, you can start with a general category and then think of specific items in that category. Take, for example, the word *alloy*. An alloy is a mixture that contains two or more metals. If *alloy* is the general class word, then specific items in the class might include bronze, brass, and steel. This method of classifying is called a **top-down process** (↓). It goes from the general to the specific.

## ALLOY



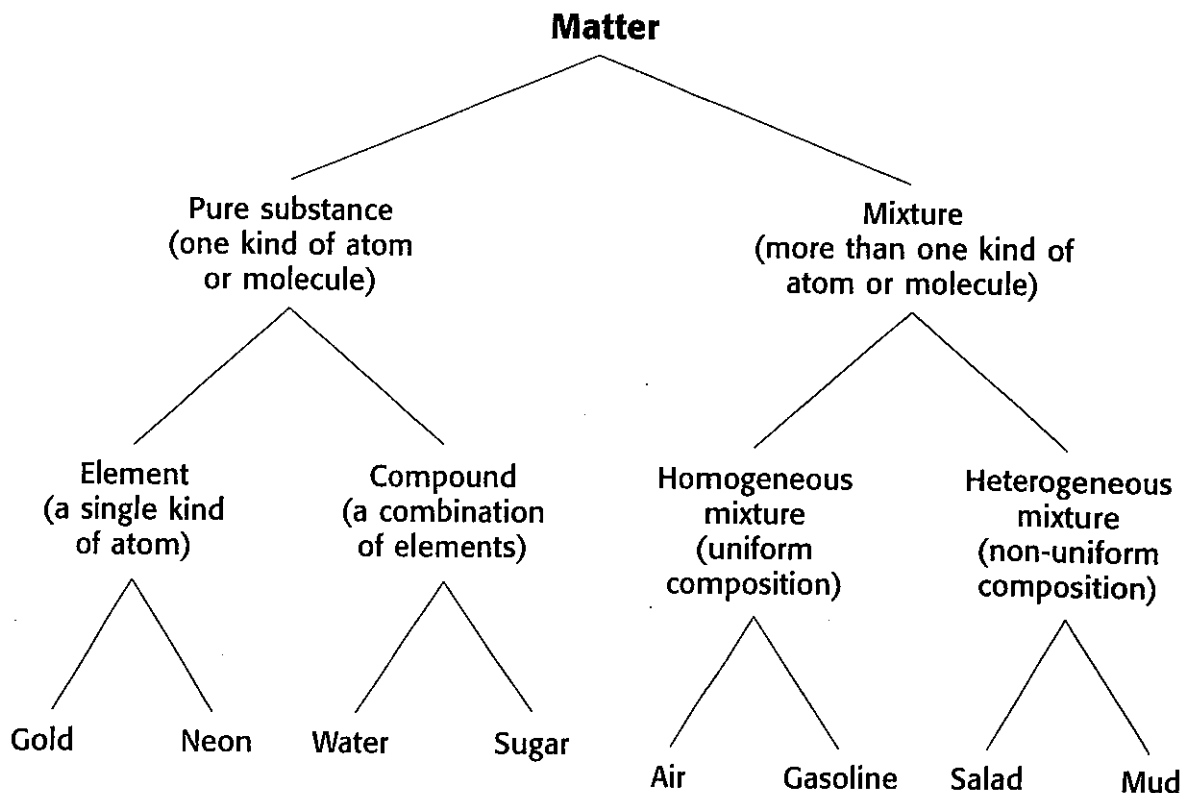
bronze brass steel

At different levels, the same term can be specific (a member of a class) *and* general (a class word). In the previous example, *alloy* was used as a class word. *Alloy* can also be a member of the class *metals*. At the same time, *alloy* is both specific and general, depending on the basis for classification, a concept you will examine shortly.

Take the concept of *elements* in chemistry as another example. The word *element* can be a class word. There are 112 known elements, including carbon, oxygen, and nitrogen. But the word *elements* can also be a member of a higher class, *pure substances*. In turn, *pure substances* can serve as both a class word and a specific member. **Figure 4-2** shows how a **classification tree** can be used to analyze many levels of classes and their members. The classification tree makes up a **taxonomy**, or a top-down diagram that gets more specific at each lower level.

## Section 4-2 The Direction of Classifying, continued

FIGURE 4-2 DIFFERENT CLASSES OF MATTER



Reasoning from the general to the specific is called **deductive reasoning**. Figure 4-2 shows an example of deductive reasoning. A top-down classification is based on deductive reasoning. Reasoning from the specific to the general is called **inductive reasoning**. A bottom-up classification is based on inductive reasoning. Stop for a moment and compare the different terms by studying **Table 4-1**. Exercises 2 and 3 will give you practice using the two directions of classifying.

TABLE 4-1 THE DIRECTION OF CLASSIFYING

Direction of classifying	Description of process	Type of reasoning	How to classify
Top-down ↓	general-to-specific	deductive	start with a class word, then determine specific members
Bottom-up ↑	specific-to-general	inductive	start with a specific member, then determine a general class word

**Section 4-2 The Direction of Classifying, continued**

**Exercise 2 Top-Down Classifying: Deductive Reasoning**

List three members for each class below.

- a. things that are awake at night

\_\_\_\_\_

- b. things that change color

\_\_\_\_\_

- c. things that live in trees

\_\_\_\_\_

**Exercise 3 Bottom-Up Classifying (Inductive Reasoning)**

Put the letters of the 10 characteristics below into two categories, and determine what two objects the characteristics describe.

- a. Some have pictures in them, and others just contain words.
- b. It has various numbers on its face.
- c. Early kinds of it took years to produce.
- d. It may use electrical, battery, or mechanical power.
- e. Some are worn as jewelry.
- f. Its main parts are usually held together by glue.
- g. Early kinds of this object used sand or sun.
- h. It has hands.
- i. It has a spine and a cover.
- j. It is made of paper.

Members of Category 1 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Object 1 \_\_\_\_\_

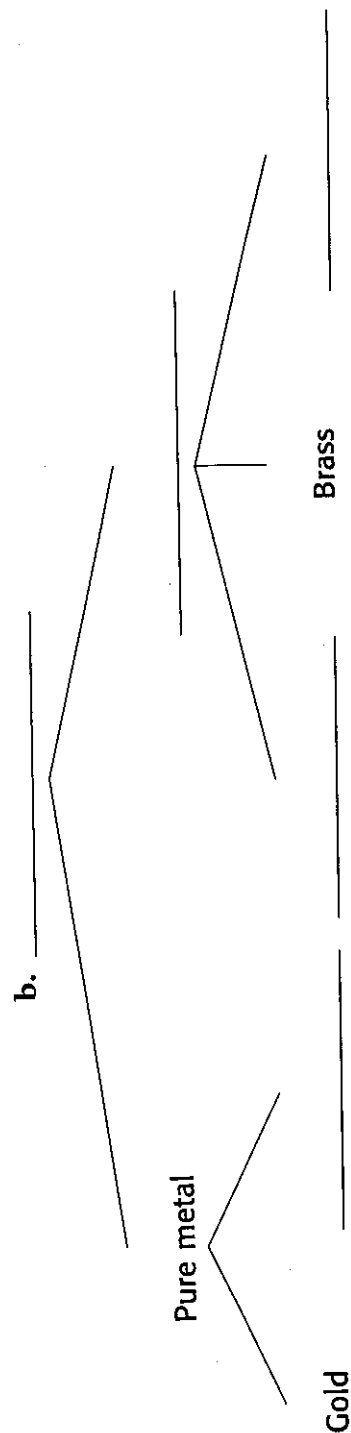
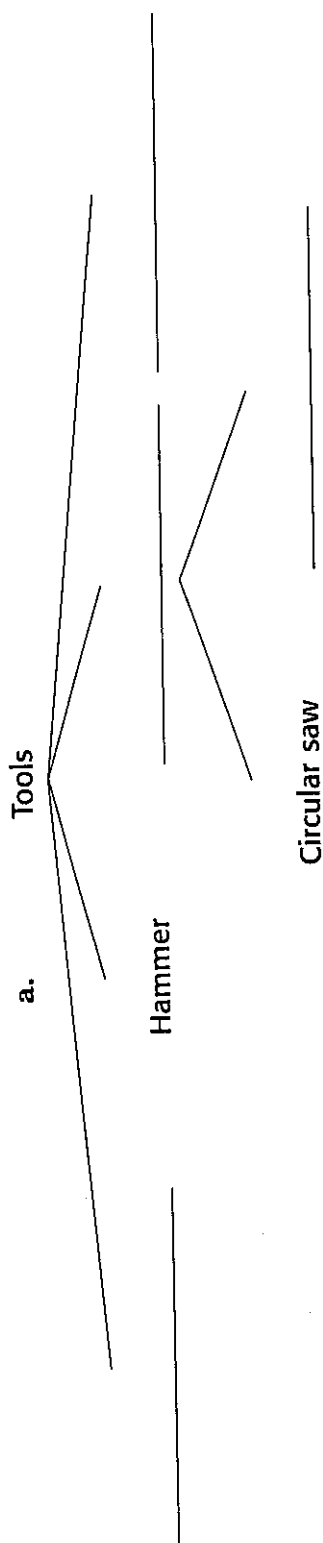
Members of Category 2 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Object 2 \_\_\_\_\_

Section 4-2 The Direction of Classifying, continued

**Exercise 4** Completing Taxonomies

Fill in the empty spaces in these taxonomies (classification trees).



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## CLASSIFYING AND CATEGORIZING

## 4-3 Levels of Generality

Look back at what you have learned about bottom-up and top-down classifying. The taxonomy shown in Figure 4-2 has four levels of classification. These levels are called **levels of generality**. In other words, they go from the general (at the top of the taxonomy) to more and more specific (at the bottom of the taxonomy).

Figure 4-2 illustrates the concept of levels of generality. But these levels can exist in any classification whether or not a formal classification tree is drawn. The word *tool*, for example, is a general word. But the words *hammer*, *saw*, and *drill* are much more specific. If you were classifying tools, the word *tool* would be the first level of generality. The words *hammer*, *saw*, and *drill* would be the second level. If you wanted to classify tools even further, you could add the terms *coping saw*, *circular saw*, and *saber saw* under the term *saw*. These specific types of saws would make up the third level of generality.

### Exercise 5 Identifying Levels of Generality

Read the following passage, and list the levels of generality that are described in the text, using the spaces that follow on the next page.

### Some Scoop on Plants

Plants are an essential part of our lives. The word *plants* includes everything from grass and flowers to trees and bushes. This passage will examine some of the uses of plants. After reading the passage, stop and think about where we would be without plants.

Plants produce oxygen. They also provide us with food; almost everything we eat comes from a plant or an animal that ate a plant. And plants provide us with many other useful products, such as wood, medicines, fibers for making cloth and paper, and rubber.

Did you know that most of the food people eat actually comes from fruits? Fruits are the parts of a flowering plant that contain the plant's seeds. When you think of fruits, you probably think of apples, oranges, and peaches. However, the fruits that provide the most food to humans come from the cereal grasses. The fruits of cereal grasses, which are called grains, include wheat, rice, corn, and oats.

The fruits of the pea or bean family have more protein than the seeds of most plants. These high-protein seeds include lentils and soybeans. Soybeans can be cooked and pressed into cakes called tofu or bean curd.

(from Holt Biology Visualizing Life)

**Section 4-3 Levels of Generality, continued**

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_
6. \_\_\_\_\_

**Analyzing the Levels of Generality**

You have already seen that a classification can have several levels of generality. The taxonomy on classes of matter shown in Figure 4-2 had four levels of generality. The classification of useful plants in Exercise 5 had six levels. To really understand the process of classifying, you should NOT mix the levels of generality or include items in a class to which they do not belong. Consider the following simple example:

radio   television   newspaper   magazine   airplane

The first four items belong to the category *media*. The word *airplane* does not.

Often, you will be asked to create a classification from the bottom up using inductive reasoning. To do so, think of how the items to be classified are related. For example, how are the following words related?

bicycle   car   bus   truck   motorcycle

They all belong to the class *kinds of transportation*. So, there are two levels of generality.

**Level 1:** kinds of transportation

**Level 2:** bicycle, car, bus, truck, motorcycle

But you can classify the items further by adding more levels of generality. For instance, you could divide them into the categories *motorized* and *nonmotorized*.

**Level 1:** kinds of transportation

**Level 2:** motorized                      nonmotorized

**Level 3:** car, bus, truck, motorcycle                      bicycle



**Section 4-3 Levels of Generality, continued**

Or you could divide them into two-wheeled and four-wheeled kinds of transportation.

**Level 1:** \_\_\_\_\_ kinds of transportation

**Level 2:** two-wheeled \_\_\_\_\_ four-wheeled \_\_\_\_\_

**Level 3:** bicycle, motorcycle \_\_\_\_\_ bus, truck, car \_\_\_\_\_

Using either system provides three levels of classification. The way an author classifies—including the number of levels of classification—depends on the writer's purpose, the audience, and, of course, the subject matter.

**Exercise 6 Determining Levels of Generality**

Arrange the following list of words by levels of generality. There may be more answer blanks for levels than you need.

animals	crocodiles	mammals	tigers
apes	humans	monkeys	turtles
big cats	leopards	primates	owl
birds	lions	reptiles	

**Level 1:** \_\_\_\_\_

**Level 2:** \_\_\_\_\_

**Level 3:** \_\_\_\_\_

**Level 4:** \_\_\_\_\_

**Level 5:** \_\_\_\_\_

**Exercise 7 Analyzing the Levels of Generality**

Draw a classification tree for the items below using the space provided on the next page. How many levels of generality does your tree have?

food	meat
name-brand orange juice	dairy products
vegetables	generic orange juice
grapefruit juice	juices
orange juice	

**Number of Levels:** \_\_\_\_\_

Name \_\_\_\_\_ Date \_\_\_\_\_ Class \_\_\_\_\_

### Section 4-3 Levels of Generality, continued

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**Section 4-3 Levels of Generality, continued****Overlap**

Sometimes an item in a classification can belong to more than one class. In this case, there is *overlap*. Do you remember Exercise 1 that asked you to classify the letters of the alphabet? One classification system might divide the letters into *open* and *closed* letters. The letter C would obviously be an open letter. The letter D would obviously be a closed letter. However, the letters A and R seem to fall into both categories. Do they belong to the open-letter class, the closed-letter class, or a class of their own? Most often, when an overlap occurs, it is best to put the items into their own class. The letters A and R could form a new class, *letters that are both open and closed*.

Another example of overlap can be found in biology. Fungi (the plural of *fungus*) contain features of both plants *and* animals, so how are they to be classified? This dilemma is solved by classifying fungi as a separate group, or *kingdom*. Mushrooms are members of the fungi kingdom.

**Exercise 8 Overlap**

The following is a list of the equipment you might need to play baseball, football, and soccer.

cleats	shoulder pads	goal post
helmet	diamond	net
ball	mitt	shin guards
bat	base	

- a. Group the objects into the following categories. Skip any items that belong to more than one category.

<b>Football equipment</b>	<b>Soccer equipment</b>	<b>Baseball equipment</b>
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

- b. List the items that overlap the categories in part (a), and tell which categories they overlap. If all three categories apply to an item, write *all three* in the first category column.

<b>List of items</b>	<b>Category</b>	<b>Category</b>
_____	_____	_____
_____	_____	_____
_____	_____	_____

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## CLASSIFYING AND CATEGORIZING

## 4-4 Analyzing Text for Classification Patterns

There are six main parts to any classification. You were introduced to the first and sixth parts in Section 4-2 of this chapter: the *name of the class or category* and the *basis for classification*. Once an author gives the names of the categories, he or she usually uses a verb such as *divide* or *classify* to separate items into the given classes or categories. This is the second part of a classification.

Often, an author will list the *number of members* in a category. This step is the third part of a classification. The fourth part of a classification includes *classifying words*. These words help categorize the items being classified. **Classifying words** include *kinds*, *types*, *groups*, and *varieties*. The fifth part of a classification simply lists the specific members of the class.

Read the following passage, which describes the classification of rocks. The superscripted letters point out the many different parts of the classification. A list of these parts can be found below the passage. The words in parentheses on the list indicate the example of that part found in the reading passage.

## On the Rocks

Geologists study the forces and processes that act upon the rocks<sup>a</sup> of Earth's crust. Based on these studies, geologists have classified<sup>b</sup> rocks into three<sup>c</sup> major types<sup>d</sup>: igneous<sup>e</sup>, sedimentary<sup>e</sup>, and metamorphic<sup>e</sup>. The classification is based on the way the rocks are formed<sup>f</sup>. Igneous rock forms when magma cools and hardens. Magma is called *lava* if it cools at Earth's surface. Sedimentary rock is formed when fragments of rock, minerals, and organic matter harden after being compressed and cemented together. The word *metamorphic* means "changed form." Metamorphic rocks come from other rocks that are changed by certain forces and processes, including tremendous pressure, extreme heat, and chemical processes. Any of the three major types of rock can be changed into another type.

(from *Modern Earth Science*)

- a. the topic or *name* of the class (rocks)
- b. a *verb* such as classify, divide, separate, categorize, group, arrange (have classified)
- c. the *number of members* in the class (three)
- d. a plural *classifying word*: kinds, types, categories, classes, divisions, groups, species, sorts, varieties (types)
- e. *members of the class* (igneous, sedimentary, metamorphic)
- f. the *basis for classification*. The basis tells how the members are different or alike and describes the features or qualities that distinguish one member of a class from another. (The classification is based on the way the rocks are formed.)

**Section 4-4 Analyzing Text for Classification Patterns, continued**

Some text descriptions contain all six parts of a classification. Others may be incomplete. The previous passage contains all of the possible parts of a classification. The different parts of a classification do not always appear in the same sequence, or order, in the reading passage. Sometimes you will need to look very closely at a passage to find the parts of a classification.

**Exercise 9 Text Analysis**

Read the following passage. Using the list of parts in a classification, give an example from the passage for each part on the lines provided. You are asked for two bases of classification.

**What's Inside an Atom**

As tiny as an atom is, it consists of three even smaller types of particles—protons, neutrons, and electrons. The particles can be distinguished by their location inside the atom. Protons and neutrons make up the nucleus, which is in the center of the atom. Electrons are found outside the nucleus.

The particles inside an atom can also be separated by charge. Protons are the positively charged particles of the nucleus. Neutrons are the particles of the nucleus that have no charge. Neutrons are slightly more massive than protons, but the difference in mass is very small. Electrons are the negatively charged particles in atoms. The current atomic theory states that electrons are found moving around the nucleus within electron clouds. The charges of protons and electrons are opposite but equal in size.

*(from Holt Science and Technology: Physical Science)*

- a. name of class \_\_\_\_\_
- b. verb \_\_\_\_\_
- c. number of members \_\_\_\_\_
- d. classifying word \_\_\_\_\_
- e. members of the class \_\_\_\_\_
- f. basis \_\_\_\_\_
- g. basis \_\_\_\_\_

**Section 4-4 Analyzing Text for Classification Patterns, continued****Exercise 10 Finding Bases**

Read the following passage, and determine the four bases for classification listed in the reading.

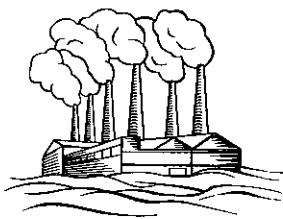
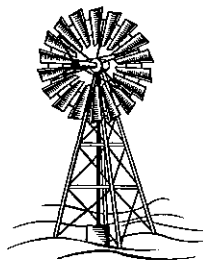
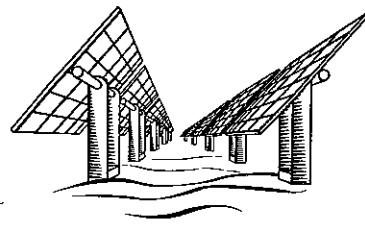
**More Power to You**

The world runs on energy. Cars, airplanes, factories, and your home all require energy. What are the different sources of energy, and what are some of the problems with them? For modern energy needs, we usually think of these five energy sources: fossil fuels, nuclear reactors, wind, the sun (solar energy), and water (hydroelectricity).

These various sources can be viewed, or classified, in different ways. Some are renewable. Others are nonrenewable. Nonrenewable sources cannot be replaced once they're used. Renewable sources can. Fossil fuels—coal, oil, and gas—are nonrenewable. Solar energy, wind, and hydroelectricity are all renewable. We can also think of energy sources as polluting and nonpolluting. Of all the energy sources, only fossil fuels are polluting.

Are energy resources dangerous? Fossil fuels are dangerous because they affect the air we breathe. Nuclear energy is potentially dangerous while the other energy sources are not. We can also view energy sources in terms of cost. Fossil fuels and nuclear energy are currently the least expensive. Solar, wind, and hydroelectricity are the most expensive.

*(from Holt Environmental Science)*

**Fossil fuels****Hydroelectricity****Wind****Solar energy**

- a. \_\_\_\_\_
- b. \_\_\_\_\_
- c. \_\_\_\_\_
- d. \_\_\_\_\_

**Section 4-4 Analyzing Text for Classification Patterns, continued****Exercise 11 Taxonomies from Text Analysis**

Draw a classification tree based on the following passage.

**Ecosystems**

Ecosystems are regions of the world that have similar plants, animals, and climates. Deserts, grasslands, forests, and tundras are some of the world's major ecosystems. There are also marine and savanna ecosystems.

Life, in its endless forms, dwells in the forests of the world. Like life itself, these forests have many faces. One type of forest we've been hearing a lot about lately is the tropical rain forest, with its towering trees and vines. Two other major forms are deciduous forests and taiga, also known as coniferous forests.

**Section 4-4 Analyzing Text for Classification Patterns, continued****Exercise 12 Reading for Classification**

You have already learned to use classification trees to get a picture of a classification. Tables can also be helpful in visualizing categories of items. Determine the bases for classifying forests, and fill in the table that follows. One block of the table is filled in for you as an example.

**Forests**

How do forest ecosystems differ? One way is in their location. Tropical rain forests are located in a belt around Earth near the equator. In contrast, deciduous forests generally occur between 30° and 50° north latitude, while coniferous forests, or taiga, stretch in a broad band across the Northern Hemisphere just below the Arctic Circle. As a result, tropical rain forests are always humid and wet, while deciduous regions can have extreme seasonal variations. In deciduous regions, summer temperatures can soar to 35°C (95°F), and winter temperatures often plummet well below freezing. Coniferous forests have short, cool summers and long, cold winters. Average subfreezing temperatures often plummet to -20°C (-4°F).

Coniferous forests also get very little precipitation (20–60 cm or 9–27 in.), most of which falls as snow. Deciduous forests are moist and receive 75–250 cm (34–114 in.) of precipitation annually. The tropical rain forests get about 250 cm (114 in.) of rain each year.

The rain and snow in a deciduous forest aid in the decomposition of fallen leaves and make the soil rich and deep. Conifer needles contain acidic substances, and when they die and fall, they acidify the soil. As a result, the soil of coniferous forests is less fertile. Rapid decay in tropical rain forests returns nutrients to the soil, but these nutrients are washed away by rainfall, so the soil is usually thin and poor. Still, the rain forest has the greatest variety of plants and animals of any region of the world. Deciduous forests have a wide variety of plants and animals, but not nearly as many as tropical rain forests have. Most plants cannot grow in acidic soil, which is one reason that coniferous forests have a limited variety of plants.

*(from Holt Biology Visualizing Life, and Holt Environment Science)*



### Section 4-4 Analyzing Text for Classification Patterns, continued

Bases For Classification					
Type of forest					
Tropical rain forest	in a belt around the equator				
Temperate deciduous forest					
Coniferous forest (taiga)					

## Section 4-4 Analyzing Text for Classification Patterns, continued

### Sentence Patterns Used in Classifying

There are several patterns that writers use when they are classifying or categorizing information. These patterns fall into the same two groupings that you saw in Section 4-2: specific-to-general and general-to-specific. These patterns are summarized in **Table 4-2**. The passages you have already seen in this chapter contain sentences using some of these patterns. Notice that the pattern in item 5 is not complete. It leaves you wondering what types of rocks make up the three classes. Item 5 requires another sentence to give the reader a full understanding of the classification:

There are three categories of rocks. They include igneous, sedimentary, and metamorphic rocks.

**TABLE 4-2 SENTENCE PATTERNS USED IN CLASSIFICATION**

Specific-to-general				
1. Steel	is/are			an alloy. a metal.
2. Steel	is/are	a kind of a type of an example of a variety of		an alloy. a metal.
3. Steel	is can be may be	classified categorized classed	as	an alloy. a metal.
General-to-specific				
4. Rocks	is/are may be can be	divided separated arranged	into three	classes. groups. categories.
5. There are three		kinds types sorts classes categories	of	rocks.

### Exercise 13 Sentence Patterns

Use each set of words to write two sentences. The first sentence should relate the words using a specific-to-general pattern. The second sentence should use a general-to-specific pattern.

a. soybeans, lentils, beans

specific-to-general: \_\_\_\_\_

\_\_\_\_\_

**Section 4-4 Analyzing Text for Classification Patterns, continued**

general-to-specific: \_\_\_\_\_

b. inductive reasoning, deductive reasoning, reasoning

specific-to-general: \_\_\_\_\_

general-to-specific: \_\_\_\_\_

c. gold, metal

specific-to-general: \_\_\_\_\_

general-to-specific: \_\_\_\_\_

d. igneous, sedimentary, rock, metamorphic

specific-to-general: \_\_\_\_\_

general-to-specific: \_\_\_\_\_

**Exercise 14 Developing Your Own Scheme**

Try to invent an original classification and explain it in detail. Write out your answer using the lines on this and the following page. Use the example below as a model.

There are two kinds of people: *hoarders* and *chuckers*. Hoarders are people who never throw anything out. You can imagine what their rooms look like. Chuckers are people who are *always* throwing things out. What kinds of people are in your family? What kind of person are *you*?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

### Section 4-4 Analyzing Text for Classification Patterns, continued

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#### GLOSSARY

**basis for classification** the system used to group members of a class, or the ways in which the members of a class are different or alike (54)

**bottom-up process** method of going from specific to general (54)

**category** a group of things that are alike in some way (54)

**class** a group of things that are alike in some way (54)

**classification** a grouping of things that are alike in some way (52)

**classification tree** a diagram that analyzes members of a class at more and more specific levels; a taxonomy (54)

**classifying word** a marker that indicates the presence of a classification (63)

**deductive reasoning** reasoning from the general to the specific, or top-down classifying (55)

**inductive reasoning** reasoning from the specific to the general, or bottom-up classifying (55)

**levels of generality** the different levels in a classification (58)

**taxonomy** a top-down diagram that is used for classifying, and that is more specific at each level (54)

**top-down process** method of going from general to specific (54)