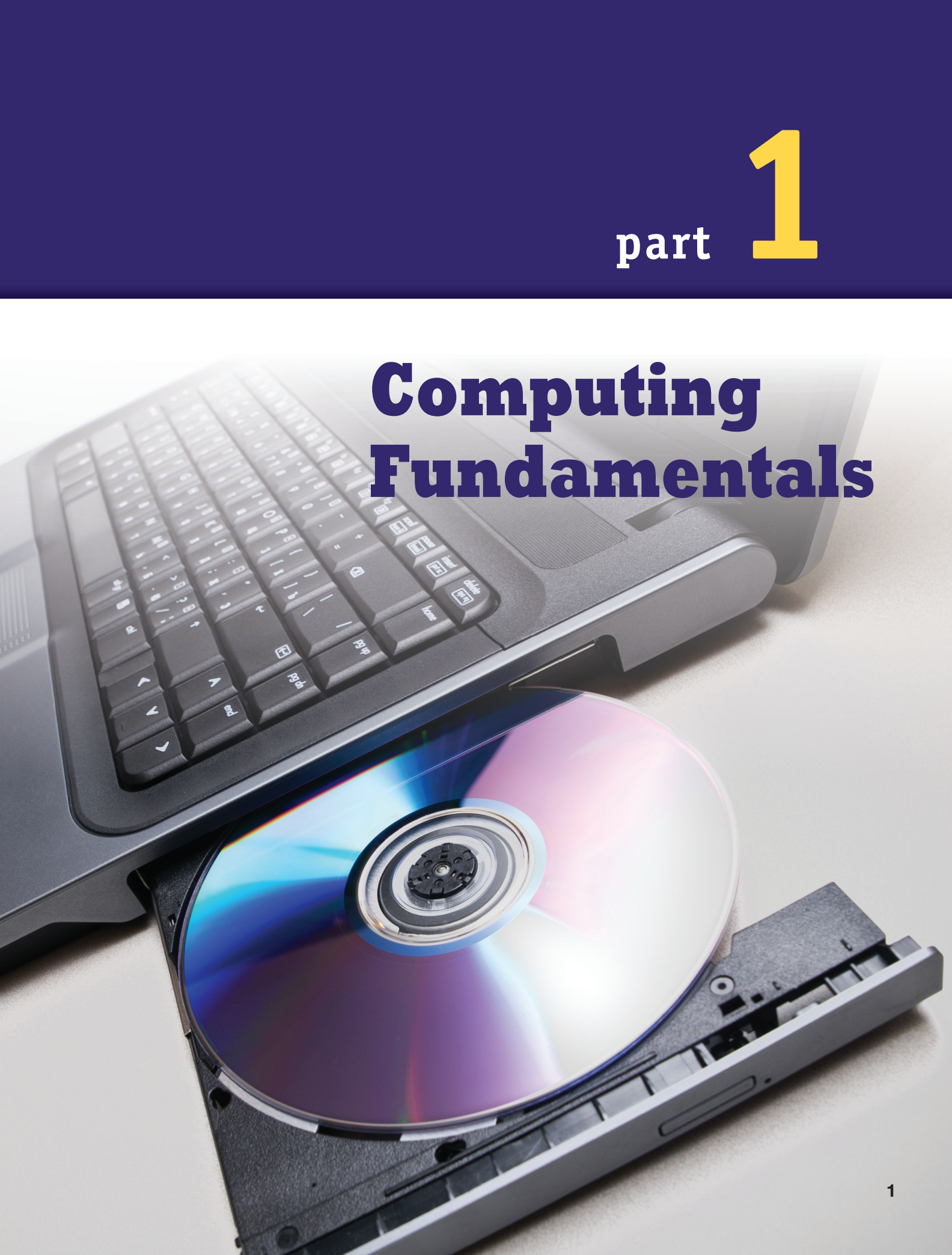
part 1

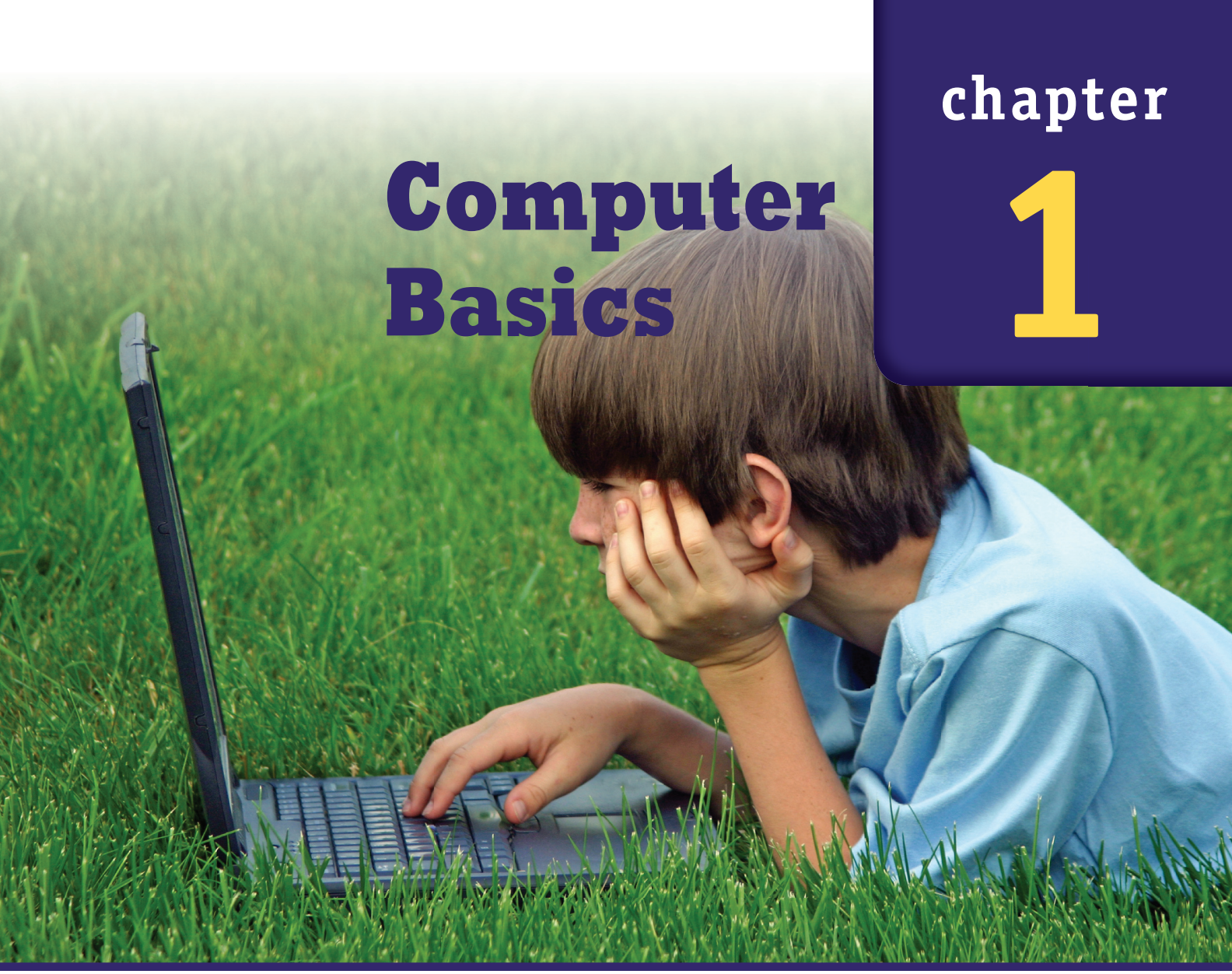
Computing Fundamentals



chapter

1

Computer Basics



How Do Computers Work? The answer to this question can be very long and complicated, even though computers work in a fairly simple way. At its core, a computer contains a set of on/off switches; by turning these switches on and off very rapidly, the computer can represent information. Imagine a wall covered with a thousand light bulbs, each with its own on/off switch. By turning switches on and off in a certain way, you could use the lights to spell words or create pictures. Computers work in a similar way.

But a computer cannot use its switches without instructions. That's where software and you, the user, come into play. By giving the computer instructions and data to work with, you and your software programs tell it how to work its switches—turning them on and off millions of times each second.

Chapter Outline

Lesson 1–1

What Is a Computer?

Objectives

- Describe the four operations of computers.
- Contrast analog and digital computers.
- Explain why data and instructions for computers are coded as 0s and 1s.
- Identify three benefits of computers.

As You Read

Sequence Information Use a sequence chart to help you organize the four operations of computers as you read the lesson.

Key Terms

- bit
- byte
- computer
- input
- output
- processing
- storage

Computer Basics

A **computer** is a machine that changes information from one form into another by performing four basic actions. Those actions are input, processing, output, and storage. Together, these actions make up the information processing cycle. By following a set of instructions, called a program, the computer turns raw data into organized information that people can use. Creation of usable information is the primary benefit of computer technology. There are two kinds of computers:

- Analog computers measure data on a scale with many values. Think of the scales on a mercury thermometer or on the gas gauge of a car.
- Digital computers work with data that has a fixed value. They use data in digital, or number, form. The computers that run programs for playing games or searching the Internet are digital computers.

Input

Input is the raw information, or data, that is entered into a computer. This data can be as simple as letters and numbers or as complex as color photographs, videos, or songs. You input data by using a device such as a keyboard or digital camera.

Bits of Data Data is entered into a computer in a coded language. The building blocks of that language are units called **bits**. *Bit* is short for *b*inary dig*it*. Each bit is a number, or a digit. A bit can have only two possible values—0 or 1.

Bits into Bytes Every letter, number, or picture is entered into the computer as a combination of bits, or 0s and 1s. The bits are combined into groups of eight or more. Each group is called a **byte**. Each letter or number has a unique combination of bits. For instance, on most personal computers, the letter *A* is coded as 01000001. The number *1* is 00110001.

Even images are formed by combinations of bytes. Those combinations tell the computer what colors to display and where to put them.

Processing

The second step of the information processing cycle is called **processing**. In this step, the computer does something to the data.

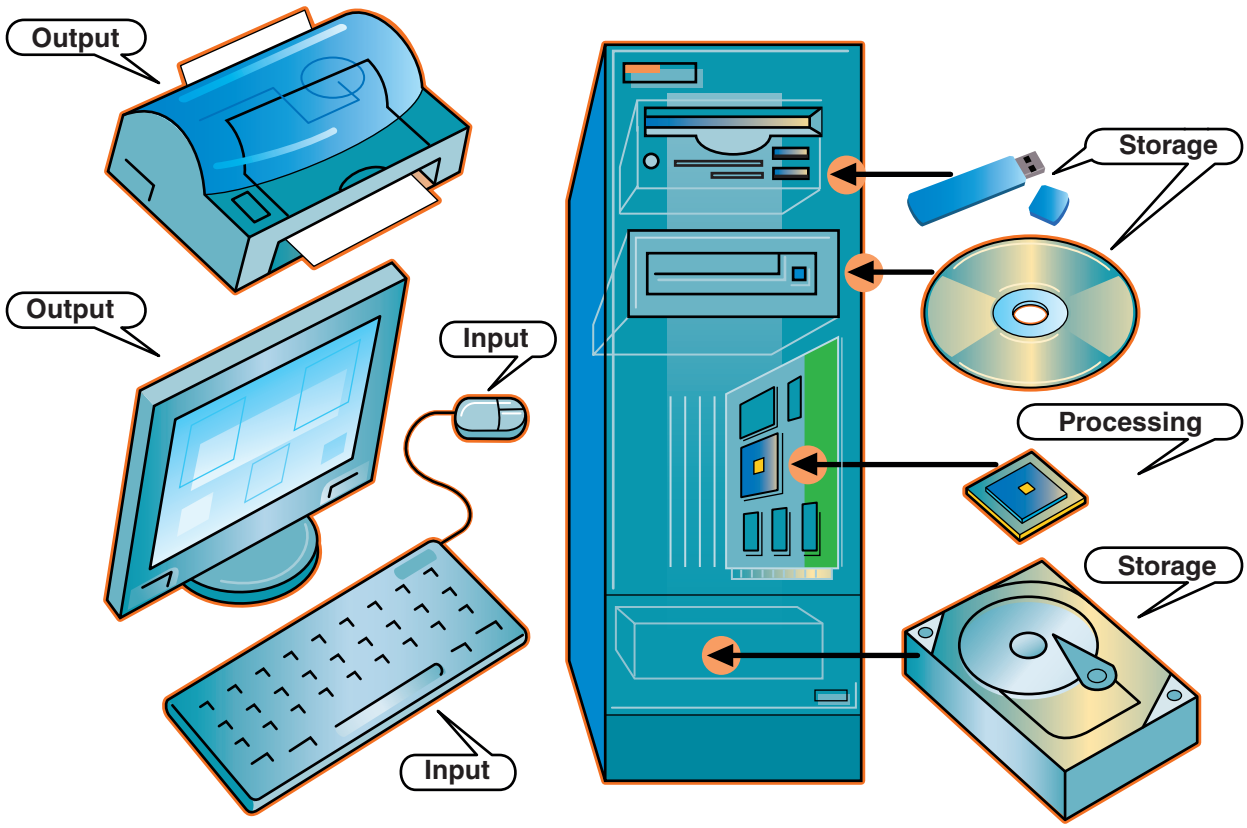
Coded Instructions What the computer does depends on the instructions, or program, given to the computer. The instructions are also written in binary code, using combinations of 0s and 1s. They might tell the computer to add two numbers, or they might have the computer compare two numbers to see which is larger.

Speed of Processing Computers can process data very rapidly, performing millions of operations every second. The ability to process data with lightning speed is another reason computers are so valuable.

Connections

Math You ordinarily count using the decimal, or base 10, system. That system has 10 values, 0 through 9. But you can express many numbers using those values. You simply add additional places—the 10s, the 100s, and so on. Each place is 10 times larger than the previous place. In a binary system, the quantity represented by each place is 2 times the previous quantity. In an 8-digit binary number, the places are the 1s, 2s, 4s, 8s, 16s, 32s, 64s, and 128s.

Figure 1.1.1 Each computer component plays a role in one of the system's four primary functions.



Technology @ School

In some schools, students' work is collected over the year in electronic portfolios. These portfolios reflect a range of the students' work on many projects during the school year. The computer's ability to store this information is perfect for portfolio work.

Think About It!

Think about how an electronic portfolio might be used. Circle each item that you think could be in an electronic portfolio.

- multimedia presentations
- maps
- paper-and-pencil homework
- poetry
- lab report

Output

The third step shows what happens after the computer processes the data. This is the **output** step. If the program tells the computer to add two numbers, the output stage displays the result. To create output, the computer takes the bytes and turns them back into a form you can understand, such as an image on the screen or a printed document.

Output can take many forms. A program might convert the 0s and 1s into a report. It might become an image you are drawing on the computer. If you are playing a game, the output might be a car zooming along a road and the sound of its engine. A computer provides output through a device such as a monitor, speaker, or printer.

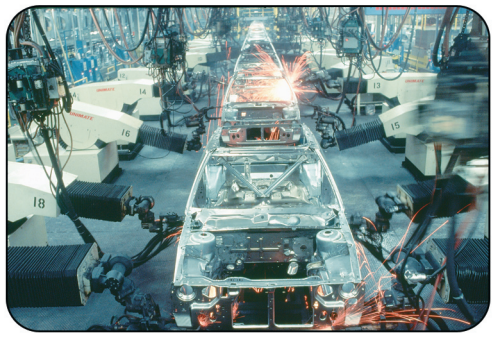
Storage

The fourth operation is **storage**, in which the computer saves the information. Without storage, all the work you do on the computer would be lost. Computers have a temporary memory that is used during the processing stage. When the computer is turned off, however, any data in that temporary memory is lost.

By storing the data in a permanent form, you can access the information over and over. This is another great advantage of computers—what you do one day can be saved and reused on another day.

Real-World Tech

Robots at Work Some output is very unusual. Computer-controlled robots work in some auto factories. Their output is cars. The robots are perfect for the tasks that take place on an assembly line. These tasks are done over and over again without change. For instance, robots weld parts together and paint car bodies.



What is a disadvantage to workers of bringing in robots to do tasks such as factory work? What can businesses and workers do to make that less of a problem?

What Is Computer Hardware?

Lesson 1–2

Objectives

- Summarize how a CPU and RAM work together.
- Contrast primary and secondary storage.
- Compare the features of three secondary storage devices.
- Identify three types of connectors and the peripherals that use each.

As You Read

Compare and Contrast Use a chart to help you compare and contrast computer hardware as you read.

What Is Hardware?

When you think about a computer, you probably picture its **hardware**, the computer's physical parts. You use hardware devices such as a keyboard or mouse to input data. The processor is a hardware device that turns the raw data into usable information. Hardware devices such as a monitor or a disk drive show output and store data for later access.

Key Terms

- central processing unit (CPU)
- cloud storage
- hardware
- peripheral
- random access memory (RAM)
- universal serial bus (USB)

Inside the Case

Much of a computer's hardware is found inside the computer case, hidden from view. Most of this hardware is used for processing and storing data.

Processing Devices Perhaps the most important piece of hardware in a computer is the **central processing unit**, or **CPU**. This is the device that processes data. The CPU is a small, thin piece of silicon attached to a circuit board. The CPU is covered with tiny electrical circuits. By moving data along these circuits in specific ways, the CPU can do arithmetic and compare data very quickly.

Primary Storage Some hardware used to store data is inside the computer case near the CPU. The computer uses **random access memory**, or **RAM**, to store data and instructions while the computer is working. In this way, the CPU can quickly find the data it works with. This type of storage is called primary storage. Data in RAM is lost when the computer is turned off.

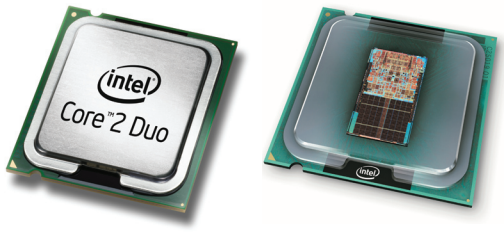


Figure 1.2.1 Intel's Core 2 Duo is one type of processor.

Secondary Storage Devices Other pieces of storage hardware are secondary storage. The following devices let you store data permanently—even when the computer is turned off.

Service Technician Computer hardware sometimes fails. When that happens, people call service technicians. These people work for computer companies. They might work in the offices of the company that employs them, or they might travel to business sites to fix machines. Technicians need to know about software and hardware because problems are sometimes caused by a computer's programs and not by its equipment.

- Hard drives use a stack of disk platters to store large amounts of information permanently on the computer. External hard drives, which are plugged into the computer, are used to store back-ups of your data. They can be desktop or portable devices. They usually connect to the computer via a universal serial bus, or USB, port.
- Flash, jump, thumb, or pen drives—all names for the same kind of storage device—connect to the computer through a USB port. They hold anywhere from 4 gigabytes to as many as 32 gigabytes or more.
- Compact Discs (CDs) and Digital Video Discs (DVDs) are optical storage devices. You insert the CD or DVD into your computer through the disc drive. A CD can store 650 to 700 megabytes of data. DVDs can store anywhere from 4.7 gigabytes to double that amount if the DVD is double-sided. We'll learn more about different types of CDs and DVDs in Chapter 5.
- "Cloud" storage is online storage offered on various Web sites. Most of them will give you a few gigabytes for free, but then require you to pay for more space.

Secondary Storage Capacity Hard disk drives hold the most data. Many computers now have hard drives that can store several hundred gigabytes. A gigabyte is just over a billion bytes. Thumb or flash drives hold the next largest amount of data, sometimes going over 32 gigabytes. CDs and DVDs hold the least amount of data—from around 700 megabytes to almost 10 gigabytes. A megabyte is just over a million bytes, but still several hundred of them on a CD can store entire encyclopedias, including images, maps, and sound.

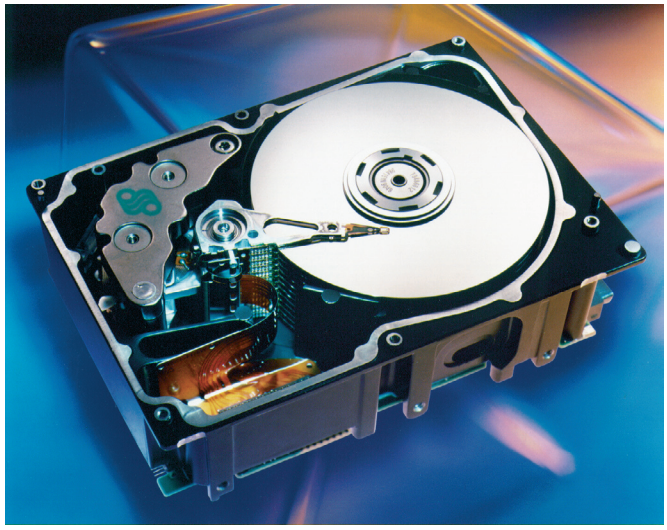


Figure 1.2.2 Today, nearly all computers feature a built-in hard drive, with capacities of 400 gigabytes or more.

Peripherals

For most desktop systems, input devices, such as the keyboard and mouse, are separate from the case. So are output devices, such as monitors and printers. Hardware that is separate but can be connected to the case is called a **peripheral**.

Not all computers have all this equipment as peripherals. Apple's iMac® computers include the monitor as a physical part of the main system. Other computers may have built-in storage devices. Portable computers have the keyboard, a type of mouse, and a monitor all attached to the main unit.

Cables Peripherals need to be connected to the computer so that data can be moved back and forth. Each peripheral is linked to the computer by a cable with a plug. The plug joins the computer at a connector on the computer case.

Connectors There are several main types of connectors, or ports:

- Serial ports move data one bit at a time. For example, they connect computers to modems for Internet access.
- Parallel ports move data in groups. They are typically used to connect printers to computers.
- Multiple device ports, such as Small Computer Systems Interface (SCSI) and Universal Serial Bus (USB) ports, connect several peripherals to a computer at one time. They all move data faster than serial ports can.

Did You Know?

One problem with computer hardware is the tangle of cables that can result from lots of peripherals. Bluetooth™ is a wireless way of communicating that uses radio waves to communicate between electronic devices.

Many cell phones and other portable devices use Bluetooth to send signals to each other. For example, many people use Bluetooth to send photos from their cell phones to their computers. These users may also use Bluetooth to send commands from their telephones and computers to DVD players, data video recorders, refridgerators, and other computer-controlled appliances.

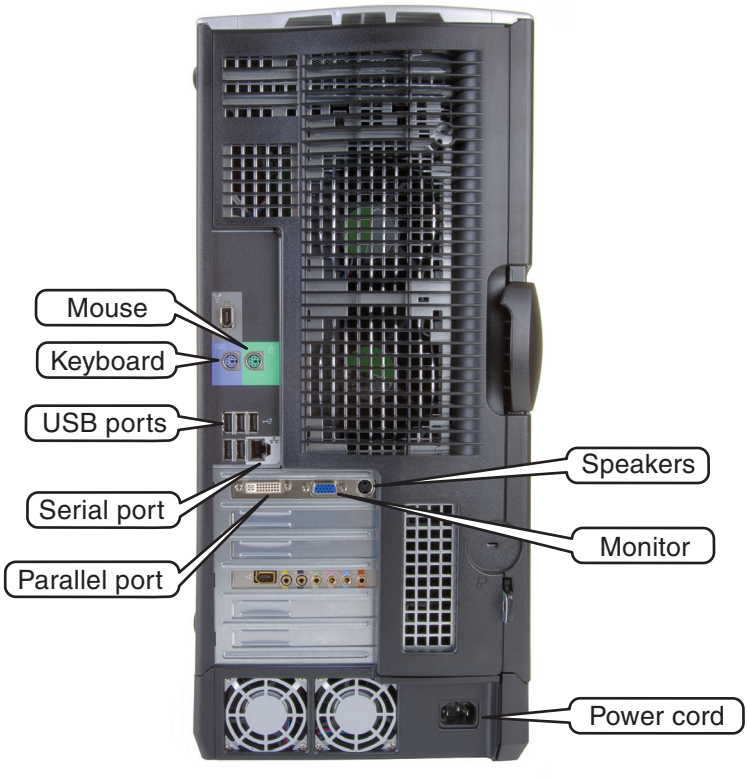


Figure 1.2.3 Personal computers have a variety of special ports, so you can connect many different devices to them.

Lesson 1–3

What Is Computer Software?

Objectives

- Describe what an operating system does.
- Summarize why compatibility is an issue for computer users.
- Explain what utility software does.
- Identify four types of application software and ways to obtain them.

As You Read

Classify Information Use a concept web to help you classify different types of computer software as you read.

Key Terms

- application software
- compatibility
- operating system (OS)
- software
- system software
- utility software

What Is Software?

Hardware includes all the physical pieces that make up a computer. Hardware is useless without software, however. **Software** includes all of the programs that tell a computer what to do and how to do it. Think of a computer as a sports team. Hardware is the players, and software is the coach. No matter how talented the players are, the team will only perform properly if the coach gives it the right instructions.

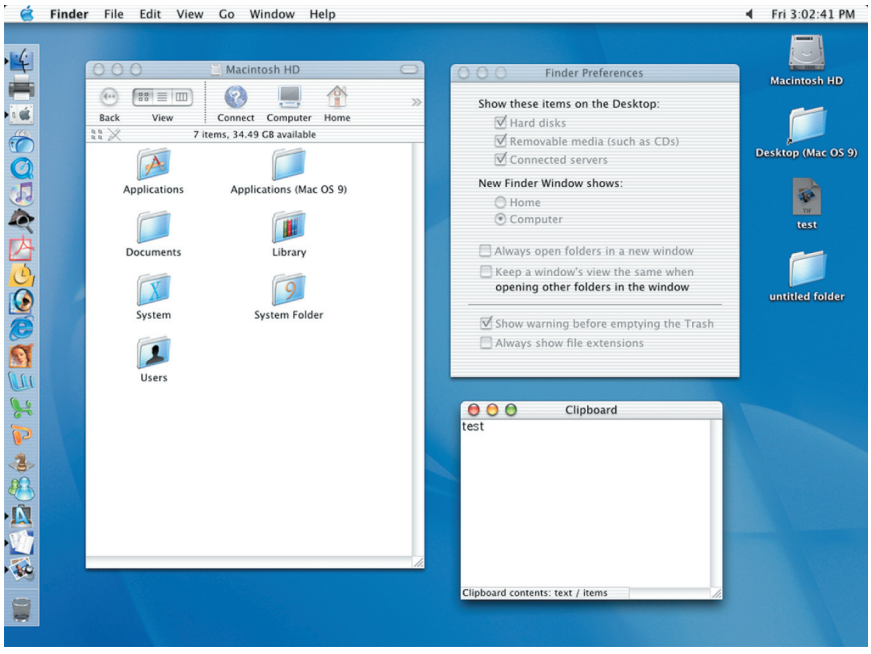


Figure 1.3.1 MacOS™, which runs Apple computers, is an example of system software.

Types of Software

Software is divided into two main types: system software and application software. **System software** includes programs that help the computer work properly. You are probably more familiar with **application software**, which are programs designed to help you do tasks such as writing a paper or making a graph. This type of software also includes programs that allow you to use the computer to listen to music or play games.

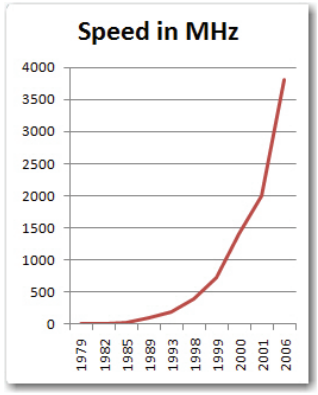
System Software

There are two types of system software: operating systems and system utilities. Both help computers run smoothly.

Operating Systems The **operating system (OS)** lets the hardware devices communicate with one another and keeps them running efficiently. It also supports the hardware when applications programs are running. The two most widely used operating systems are the Macintosh® OS and Microsoft® Windows®.

Did You Know?

One key to processor speed is its clock speed, the rhythm at which the processor works. Clock speed is measured in Gigahertz (GHz) and Megahertz (MHz). 1 GHz equals one billion cycles per second; 1 MHz equals one million cycles per second. The graph below shows the sharp rise in clock speed from 1982– 2006.



Clock speed is not the only thing to consider when you select a processor, however. Speed is also influenced by factors such as the amount of RAM, clock speed of the RAM, and the size of the cache.

Spotlight on...

BILL GATES

"Bill Gates has the obsessive drive of a [computer] hacker working on a tough technical dilemma, yet [he also] has an uncanny grasp of the marketplace, as well as a firm conviction of what the future will be like and what he should do about it."

Steven Levy
Writer

Bill Gates has a simple idea about the future of computing. "The goal," he says, "is information at your fingertips." It will not surprise anyone if Gates and his company, Microsoft, play a major role in making that goal become a reality. Gates started writing software in high school. He and a childhood friend, Paul Allen, wrote a programming language to run on a machine called the Altair, the first personal computer. Allen and Gates then formed Microsoft, which is now one of the leading software companies in the world.

Technology @ Work

A software program's version is usually indicated by a number, such as "Version 4" or "Version 8.5." Software is upgraded to remove programming errors and to add new features. Some revisions are major, and the version number jumps from, for example, 9.0 to 10. Minor fixes typically change the number after the decimal point, such as 10 to 10.2.

Think About It!

For which items below would it be worthwhile for you to buy the new version of the program?

- a program you use all the time that is moving from 4.3 to 5.0
- a program you rarely use that is moving from 2.2 to 2.3
- a program you often use that is moving from 5.1 to 5.2
- a program you often use that is moving from 1.0 to 3.0

System Utilities Programs that help the computer work properly are called **utility software**. They usually do maintenance and repair jobs that the operating system cannot do itself. Some utility programs repair damaged data files or save files in certain ways so they take up less space. Others translate files created in one OS so they can be read and worked on in another.

Application Software

There are many different applications. They can be grouped into four main categories:

- Productivity software helps people be more productive at work. People use these programs to write reports, prepare financial plans, and organize data.
- Graphics software makes it possible to draw, paint, and touch up photos.
- Communication software allows computers to connect to the Internet and to send e-mail.
- Home, education, and entertainment software helps people manage their money or figure their taxes. Other products can be used to learn new skills or simply to have some fun.

Custom Software There are two ways to obtain application software. Some organizations need software programs to do very specific jobs. They hire people to write custom software designed to do those jobs. Because these programs are custom written, they are usually quite expensive.

Off-the-Shelf Software Most people use software to do standard jobs. They might want to write letters or keep track of their CD collection. They can choose from many ready-made programs to handle these common tasks. These are called "off-the-shelf" programs because stores and companies that sell software from the Internet stock them. Because software publishers can sell many copies of this software, it is less expensive than custom software.

Figure 1.3.2 You can buy off-the-shelf software in many places, from computer stores to department stores.

Use the Vocabulary

Directions: *Match each vocabulary term in the left column with the correct definition in the right column.*

_____ **1.** input
_____ **2.** bit
_____ **3.** byte
_____ **4.** output
_____ **5.** hardware
_____ **6.** central processing unit
_____ **7.** random access memory
_____ **8.** peripheral
_____ **9.** software
____ **10.** utility software

a. program that tells the computer what to do
b. group of 8 bits
c. area where data and instructions are stored while the computer is working
d. physical parts of a computer
e. raw data entered into a computer
f. program that does maintenance or repair tasks
g. part of a computer that processes data
h. basic unit of data a digital computer can understand
i. hardware separate but connected to the computer
j. the results of the computer's processing

Check Your Comprehension

Directions: *Complete each sentence with information from the chapter.*

1. A _____ is a machine that changes information from one form into another.
2. _____ is a basic operation of computers.
3. Data and instructions in computers are coded with a _____ because computers only understand two values.
4. The CPU uses _____ to hold data it is working on.
5. Data in RAM is _____ when the computer is turned off.
6. A _____ is an example of a connector that works with only one kind of peripheral.
7. SCSI and USB connectors connect _____ peripherals at the same time.
8. Programs and files created on either Macintosh or Windows operating systems _____ files differently.
9. _____ software is used to connect to the Internet and send e-mail.
10. Off-the-shelf software is _____ expensive than custom software because publishers sell more units.

Think Critically

Directions: *Answer the following questions.*

1. How do analog and digital computers differ?

2. Which benefit of computers—the ability to use any kind of data, the ability to work rapidly, or the ability to access stored data again and again—do you think is the most important? Why?

3. What are the differences between primary and secondary storage?

4. Why might the operating system be called a computer's most important software?

5. What type of application software do you use most? Explain.

Extend Your Knowledge

Directions: *Choose one of the following projects. Complete the exercise on a separate sheet of paper.*

A. Look at a computer. Create a five-column chart. In the first column, list all the hardware that you can identify. In the remaining columns, state whether each item is used for inputting, processing, outputting, or storage. Examine how the different pieces are connected to the computer. What other hardware do you think the computer has that you cannot see? What kinds of hardware were usually peripherals? Which were usually in the computer's case? What exceptions did you identify? Share your findings with the class.

B. Using the Internet or library resources, research at least three types of processing devices used in laptop computers. Create a chart that compares and contrasts the price, top speed, and number of operations per second each one can perform. Determine which device would be most appropriate for working with text, graphics, and math. Using a computer and an appropriate processing device available in class, do an example of each of these types of work. Then, visit a computer store and repeat this work using at least two of the appropriate processing devices you researched. Share your findings in a report to your class.