Computers and Digital Basics

Chapter Contents

SECTION A: ALL THINGS DIGITAL
- The Digital Revolution
- Data Processing
- Personal Computing
- Network Computing
- Cloud Computing
- Digital Society

SECTION B: DIGITAL DEVICES
- Computer Basics
- Computer Types and Uses
- Microcontrollers

SECTION C: DIGITAL DATA REPRESENTATION
- Data Representation Basics
- Representing Numbers, Text, Images, and Sound
- Quantifying Bits and Bytes
- Circuits and Chips

SECTION D: DIGITAL PROCESSING
- Programs and Instruction Sets
- Processor Logic

SECTION E: PASSWORD SECURITY
- Authentication Protocols
- Password Hacks
- Secure Passwords

ISSUE: WHAT IS THE VALUE OF INFORMATION?

INFORMATION TOOLS: FINDING THE RIGHT STUFF

TECHNOLOGY IN CONTEXT: MARKETING

NEW PERSPECTIVES LABS

REVIEW ACTIVITIES

INFOWEBLINKS
You’ll find updates for chapter material by connecting to the NP2014 Chapter 1 InfoWebLink.

CLICK TO CONNECT
www.infoweblinks.com/np2014/ch01

Learning Objectives
After reading this chapter, you will be able to answer the following questions by completing the outcomes-based Learning Objectives Checkpoints on page 53.

1. What are the four phases of the digital revolution?
2. What is convergence and how does it apply to the digital revolution?
3. How does digital technology affect society?
4. How do computers work with input, output, processing, storage, and stored programs?
5. What’s the difference between an operating system and application software?
6. How do personal computers differ from servers, mainframes, and supercomputers?
7. Are portable media players and mobile phones classified as computers?
8. Why are microcontrollers the computers no one sees?
9. Aren’t data and information the same thing?
10. What’s the difference between analog and digital?
11. How do digital devices use 1s and 0s to work with numbers, text, images, and sound?
12. Why is there so much jargon pertaining to bits and bytes?
13. What hardware components manipulate the bits that represent data?
14. Why do computers need programs?
15. How do a microprocessor’s ALU and control unit work?
16. How do hackers steal passwords?
17. How can I create secure passwords?

Apply Your Knowledge
The information in this chapter will give you the background to:

- Inventory the digital devices you own
- Select secure passwords for protecting your computer and Internet logins
- Put digital technology in the context of history, pop culture, and the global economy
- Use a password manager to keep track of all your passwords
- Read computer ads with an understanding of technical terminology
- Use digital devices with an awareness of how they might infringe on your privacy
TRY IT!

WHAT’S MY DIGITAL PROFILE?

The average American consumer owns more than 24 digital devices. Before you begin Chapter 1, take an inventory of your digital equipment to find the brands, models, and serial numbers. Tuck this information in a safe place. It can come in handy when you need to call technical support, arrange for repair services, or report missing equipment.

1. Fill in the following table for any digital equipment you own, rent, lease, or use.

<table>
<thead>
<tr>
<th>BRAND</th>
<th>MODEL</th>
<th>SERIAL NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMPUTER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KEYBOARD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MOUSE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MONITOR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PRINTER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIGITAL CAMERA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIGITAL MUSIC PLAYER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTERNET OR NETWORK DEVICE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MOBILE PHONE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GAME CONSOLE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OTHER (LIST)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
WE LIVE IN THE INFORMATION AGE: a period in history when information is easy to access and affects many aspects of everyday life, from the economy to politics and social relationships. The importance of information is not new. It has always been a powerful tool. Scrolls treasured by monks during the Middle Ages, scientific knowledge collected during the Renaissance, and intelligence data collected during the Cold War were all critical in shaping world events. The Information Age is unique because of its underlying technology based on digital electronics. Section A offers an overview of the digital revolution that ushered in the Information Age.

THE DIGITAL REVOLUTION

What is the digital revolution? The digital revolution is an ongoing process of social, political, and economic change brought about by digital technology, such as computers and the Internet.

Like the agricultural and industrial revolutions, the digital revolution offers advantages, but requires adaptations. Digital innovations challenge the status quo and require societies to make adjustments to traditions, lifestyles, and legislation.

The technology driving the digital revolution is based on digital electronics and the idea that electrical signals can represent data, such as numbers, words, pictures, and music. Without digital electronics, computers would be huge machines, priced far beyond the reach of individuals; your favorite form of entertainment would probably be foosball, and you’d be listening to bulky vacuum tube radios instead of carrying sleek iPods (Figure 1-1).

FIGURE 1-1
From Victrolas to stereos, and from boomboxes to iPods, music is only one aspect of life that’s been affected by technology.

TERMINOLOGY NOTE
The word digital comes from the root digit. In Latin, the word digitus means finger or toe. The modern use of the term digital is probably derived from the idea of counting on your fingers.
What is the significance of digitization? Digitization is the process of converting text, numbers, sound, photos, and video into data that can be processed by digital devices. The significant advantage of digitization is that things as diverse as books, movies, songs, conversations, documents, and photos can all be distilled down to a common set of signals that do not require separate devices.

Before digitization, a phone conversation required a telephone handset and dedicated phone lines. Viewing photos required a slide projector and screen. Reading required a paper book. Viewing movies required a film projector. Once digitized, however, conversations, photos, books, and movies can all be managed by a single device or transmitted over a single set of communication lines.

You can pull a photo down from a Web site, store it on your computer’s hard disk, make a copy of it on a flash drive, send it to a friend as an e-mail attachment, add it to a report, print it, combine it with other photos to make a slide show, burn the slide show to a CD, and watch the slide show on your home theater system.

You can use a digitized photo in so many ways. In contrast, if you just have a photo print, you can make a copy of it with a photo copier, send it by snail mail, or frame it, but not much else. Digitization creates versatility.

The digital revolution has evolved through four phases, beginning with big, expensive, standalone computers, and progressing to today’s digital world in which small, inexpensive digital devices are everywhere (Figure 1-2).

### TRY IT!

According to Figure 1-2, AOL and CompuServe were popular when:
- data processing was the main digital technology
- most people had dial-up Internet access and used desktop computers
- smartphones and tablets were introduced
- people stopped using cloud computing

**FIGURE 1-2**

As the digital revolution progressed, technology changed, as did the way we use it.

<table>
<thead>
<tr>
<th>Expired</th>
<th>Tired</th>
<th>Uninspired</th>
<th>Desired</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data processing</td>
<td>Personal computing</td>
<td>Network computing</td>
<td>Cloud computing</td>
</tr>
<tr>
<td>Big corporate and government computers</td>
<td>Desktop computers</td>
<td>Laptop computers</td>
<td>Smartphones and tablets</td>
</tr>
<tr>
<td>Custom applications</td>
<td>Standalone applications</td>
<td>Monolithic software suites</td>
<td>Handheld apps and cloud-based apps</td>
</tr>
<tr>
<td>CB radios</td>
<td>Dial-up Internet access</td>
<td>Cable and satellite Internet access</td>
<td>4G and Wi-Fi Internet access</td>
</tr>
<tr>
<td>ARPANET</td>
<td>AOL and CompuServe</td>
<td>The Web and virtual worlds</td>
<td>Social media</td>
</tr>
<tr>
<td>Arcade games</td>
<td>2-D action games</td>
<td>3-D multiplayer games</td>
<td>Touchscreen micro-games</td>
</tr>
</tbody>
</table>
DATA PROCESSING

When did the digital revolution begin? Some historians mark the 1980s as the beginning of the digital revolution, but engineers built the first digital computers during World War II for breaking codes and calculating missile trajectories. In the 1950s, computers were marketed for business applications, such as payroll and inventory management.

What was computing like back then? In this first phase of the digital revolution, computers were huge, complex, and expensive devices. They existed in limited numbers, primarily housed in big corporations and government agencies. Computers were operated by trained technicians. Each computer installation required specialized software. The idea that computers might be used by ordinary people in their homes was only a glimmer of an idea in the minds of science fiction writers.

Back then, processing components for computers were housed in closet-sized cabinets that did not usually include a keyboard or display device. Computers were accessed using the keyboard and display screen of a terminal. Terminals had little processing capability of their own, so they were simply used to enter data and view results produced by software that ran on the main computer.

During the antiestablishment era of the 1960s, the digital revolution was beginning to transform organizations, but ordinary people had little direct contact with computers. As with many new technologies, computers were initially viewed with suspicion by consumers, who were uncomfortable with the idea of giant machine “brains.” Computers seemed remote. They were housed out of sight in special facilities and were inaccessible to ordinary people. Computers also seemed impersonal. Instead of names, computers used Social Security numbers to uniquely identify people (Figure 1-3).

Throughout the first phase of the digital revolution, businesses adopted computers with increasing enthusiasm as benefits for cutting costs and managing mountains of data became apparent. Computers and data processing became crucial tools for effective business operations.

What is data processing? Data processing is based on an input-processing-output cycle. Data goes into a computer, it is processed, and then it is output. For example, a batch of employee time cards are entered into a payroll computer system; the payroll data is processed to calculate take-home pay, deductions, and taxes; paychecks are output (Figure 1-4).

FIGURE 1-3

In the 1950s and 1960s, data used by government and business computers was coded onto punched cards that contained the warning “Do not fold, tear, or mutilate this card.” Similar slogans were used by protesters who were concerned that computers would have a dehumanizing effect on society.

FIGURE 1-4

Data processing is the computing model for the first phase of the digital revolution. The concept of large computers performing tasks based on the input-processing-output cycle represents the primary way computers were used from the 1940s through the 1970s. Data processing installations still exist today, but other technologies emerged, making computing available to a more diverse group of users. See an example of data processing.
PERSONAL COMPUTING

When did digital devices become available to consumers? Digital devices were first available to consumers in the 1970s when handheld calculators and digital watches hit store shelves. The first personal computers made their debut in 1976, but sales got off to a slow start. Without compelling software applications, personal computers, such as the Apple II, seemed to offer little for their $2,400 price.

As the variety of software increased, however, consumer interest grew. In 1982, TIME magazine’s Man of the Year award went to the computer, an indication that these digital machines had finally gained a measure of popular acceptance.

What is personal computing? The model for the second phase of the digital revolution, personal computing is characterized by small, standalone computers powered by local software. Local software refers to any software that is installed on a computer’s hard drive.

During this phase of the digital revolution, computers were not connected to networks, so they were essentially self-contained units that allowed users to interact only with installed software. On the business front, large computers continued to run payroll, inventory, and financial software. Some managers used personal computers and spreadsheet software to crunch numbers for business planning.

If you owned a computer back in the second phase of the digital revolution, it was probably a small standalone machine with a display device that looked like an old-fashioned television (Figure 1-5).

How long was the second phase of the digital revolution? In 1982, computers had gained recognition in TIME magazine, but fewer than 10% of U.S. households had a computer. Working on a standalone computer wasn’t for everyone.

People without an interest in typing up corporate reports or school papers, crunching numbers for accounting, or playing computer games weren’t tempted to become active soldiers in the digital revolution. Social scientists even worried that people would become increasingly isolated as they focused on computer activities rather than social ones. Computer ownership increased at a gradual pace until the mid-1990s, and then it suddenly accelerated into the third phase of the digital revolution.

FIGURE 1-5
The most popular uses for personal computers were word processing and gaming; sound systems and graphics capabilities were primitive. The Internet wasn’t open to public use, so computing was not a social experience.

TRY IT!
During the second phase of the digital revolution, which one of the following was making news headlines?

- A new band called The Beatles
- The first space flights
- President Bill Clinton
- Apple II computers
NETWORK COMPUTING

♦ What caused the sudden upswing in computer ownership during the 1990s? The third phase of the digital revolution materialized as computers became networked and when the Internet was opened to public use. A computer network is a group of computers linked together to share data and resources.

Network technology existed before the Internet became popular, but those networks were mainly deployed to connect computers within a school or business. Networks were complicated to set up and unreliable. As the third phase of the digital revolution unfolded, network technology became consumer-friendly, allowing homeowners to connect multiple computers, exchange files, and, most importantly, share an Internet connection.

The Internet is a global computer network originally developed as a military project, and was then handed over to the National Science Foundation for research and academic use. When restrictions on commercial use of the Internet were lifted in 1995, companies such as AOL and CompuServe became popular services for access to e-mail and the World Wide Web. Internet access was a major factor contributing to the upswing in computer ownership during the 1990s.

♦ What about the Web? When historians look back on the digital revolution, they are certain to identify the Web as a major transformative influence. The Web (short for World Wide Web) is a collection of linked documents, graphics, and sounds that can be accessed over the Internet.

A key aspect of the Web is that it adds content and substance to the Internet. Without the Web, the Internet would be like a library without any books or a railroad without any trains. Online storefronts, auction sites, news, sports, travel reservations, and music downloads made the Web a compelling digital technology for just about everyone.

♦ So what was computing like? During the period from 1995–2010, computing was characterized by the Web, e-mail, multiplayer games, music downloads, and enormous software applications, such as Microsoft Office, Norton's Internet Security Suite, and Corel Digital Studio (Figure 1-6).

TRY IT!
The Web and the Internet are not the same. Why?
- The Internet is a communications network; but the Web consists of content that is distributed by the Internet
- The Internet consists of sites like Twitter and Facebook, whereas the Web links devices like iPods and computers

FIGURE 1-6
Computers were the primary devices for accessing the Internet prior to 2010, but applications, media, and data remained on the local hard disk.
CLOUD COMPUTING

Is the Web dead? A 2010 *Wired* magazine cover announced “The Web is Dead.” That pronouncement was premature, but Facebook, Twitter, and Google Apps have sent computing in new directions. Local applications are being eclipsed by cloud computing, which characterizes the fourth phase of the digital revolution.

What is cloud computing? Cloud computing provides access to information, applications, communications, and storage over the Internet. Before cloud computing, most computers ran software based locally. For example, to use a word processor, you might fire up the latest edition of Microsoft Word, which you’d installed on your computer’s hard disk. Prior to the cloud, you stored data locally, too. E-mail, documents, photos, and music all resided on your computer’s hard disk or flash drive.

With cloud computing, all that changes. You can use your browser to access word processing applications that run from the Internet, instead of software that you have installed on your local hard disk. You can use online applications to manage your e-mail, create floor plans, produce presentations, and carry out a host of other activities. You can store your data in the cloud, too, making it available no matter what computer you’re using as long as it has an Internet connection.

The cloud gets its name from diagrams like the one in Figure 1-7, which shows Internet-based applications, storage, and other services outlined by a cloud-like shape designed to help you visualize the idea that cloud services are “out there” somewhere on the Internet.

What is convergence? The expansion of cloud computing is due in part to convergence, a process by which several technologies with distinct functionalities evolve to form a single product. Your computer plays movies. Your cell phone has a camera. Your clock has a radio. Your watch functions as a compass. You can store data on your iPod touch. All these are examples of technological convergence.

Convergence worked its magic on cell phones, computers, portable media players, digital cameras, GPSs, watches, and ebook readers. Now you get features from all of them by purchasing a single digital device. Whether you purchase a full-size computer, a sophisticated mobile phone, or even a game console, you generally have access to software, music, photos, ebooks, movies, communications, and the Web (Figure 1-8).

Convergence is important to the digital revolution because it created sophisticated mobile devices whose owners demand access to the same services available from full-size computers on their desks.

Your smartphone isn’t usually in range of the cable modem in your house, so it needs a different way to access the Internet. Your iPad is too small for a huge hard disk, so it needs an alternative place to store data and applications. Touchscreen devices are not great for typing tasks, so cloud-based apps can be specially designed to suit the use of gestures, rather than the use of a mouse and keyboard. You can see how these mobile devices require a solution such as cloud computing to provide a full spectrum of digital services.
What role do social media play? The fourth phase of the digital revolution turned the worry of social isolation on its head; instead of computers decreasing human interaction, social media encourage interpersonal communications and relationships. Social media are cloud-based applications designed for social interaction and consumer-generated content. They include social networking services, wikis, blogging services, photo sharing services, and microblogging sites (Figure 1-9).

Myspace, Facebook, and Twitter became some of the first popular social networking services. Myspace lost steam in 2008, but Facebook and Twitter marched ahead by attracting millions of users. Many factors influenced the popularity of these sites, but one important factor is their ease of use. As cloud-based services, there is no software to install and there are no updates to worry about. Getting started is as simple as registering your name and creating a password.

How is today’s computing different from the past? Using computers during the fourth phase of the digital revolution, you’re likely to have a mobile device that accesses the Internet using a cell phone service provider.

The touchscreen on your mobile device gives you access to apps that play music, show movies, report news and sports scores, help you find the nearest Starbucks, and all kinds of other fun stuff. You occasionally use Google or Wikipedia to access information; and when you need to produce a document, you head over to Google to access its cloud-based word processor. You spend lots of time maintaining your profiles on social networking services and interacting with friends through cloud-based social media.

DIGITAL SOCIETY

How does digital technology affect freedom and democracy? Freedom of speech is the cornerstone of democracy. It can be defined as being able to speak freely without censorship or fear of reprisal. The concept is not limited to speaking, but includes all forms of expression, such as writing, art, and symbolic actions. The more inclusive term freedom of expression is sometimes used instead of freedom of speech.

Freedom of speech is not an absolute. Most societies prohibit or repress some types of expression, such as hate speech, libel, pornography, and flag burning. Although freedom of expression is guaranteed under the U.S. Constitution, the European Convention on Human Rights, and the Universal Declaration of Human Rights, these documents recognize the necessity for some restrictions, which might vary from one society to the next.

Incidents ranging from the controversy over teaching evolution in schools to the Arab world’s fury over cartoons of Mohammed illustrate that societies...
draw the freedom of speech line in different places. The types of expression that are allowed or prohibited in a particular country are, in many respects, a reflection of its culture.

Digital technologies and communications networks make it easy to cross cultural and geographic boundaries. News, television shows, music, and art from all over the globe are accessible on the Internet. The Internet has the potential to expand freedom of speech by offering every person on the planet a forum for personal expression using personal Web sites, blogs, chat groups, social media, and collaborative wikis. Anonymous Internet sites such as Freenet and anonymizer tools that cloak a person’s identity even make it possible to exercise freedom of speech in situations where reprisals might repress it.

Internet information that seems innocuous in some cultures is not acceptable in others. Governments, parents, and organizations sometimes find it necessary to censor the Internet by limiting access and filtering content. Despite attempts to censor and filter speech on the Internet, it seems clear that digital technology opens the door to freedom of expression in unprecedented ways. Limitations on Internet speech are likely to change, too, as technology evolves and as societies come to grips with the balance between freedom and responsibility.

**TRY IT!**
Which country has the most Draconian Internet censorship?
Search the Web to find out.
- United States
- Russia
- Iran
- Greece

**FIGURE 1-10**
Is your location private information? Many applications and social media sites want to know your location. Do you want to reveal it? If not, turn location off.

Some individuals dismiss the erosion of privacy saying, “I have nothing to hide, so I don’t care.” Many other people don’t want stores, hackers, and curious onlookers to have access to data about what they buy, read, and watch; who they call; where they travel; and what they say.

Social media, however, encourage participants to reveal personal details online, and that information is being captured, aggregated, reposted, and distributed publicly. Privacy advocates fear that these digital technologies are fundamentally changing our expectation of what is private and what is not.
How does digital technology affect intellectual property? Intellectual property refers to the ownership of certain types of information, ideas, or representations. It includes patented, trademarked, and copyrighted material, such as music, photos, software, books, and films. In the past, such works were difficult and expensive to copy.

Digital technology has made it easy to produce copies with no loss in quality from the original. Pirating—illegal copying and distribution of copyrighted material—is simple and inexpensive. It has caused significant revenue loss for software publishers, recording studios, and film producers. The fight against piracy takes many forms, from passing strict anti-piracy laws; to scrambling, encryption, and digital rights management schemes that physically prevent copying; to anti-piracy videos (Figure 1-11).

Digital technology adds complexity to intellectual property issues. For example, artists used to think nothing of cutting out various photos from magazines and pasting them together to form a collage. It is even easier to download digital images from the Web and paste them into reports, add them to Web pages, and incorporate them into works of art. Without permission, however, such digital cut and paste is not allowed.

Some films contain scenes that parents would rather their children not see. Even some scenes from family-oriented Harry Potter films might be too intense for young viewers. So, why not simply edit them out digitally to make a new DVD that even preschoolers can watch? Such modifications are not allowed under current U.S. law, even for private viewing.

In the U.S., it is legal to make a backup copy of software CDs or DVDs that you own. However, if a software CD is copy protected to prevent you from making a copy, it is against the law to break the copy protection. So, legally you have a right to a backup, but you don’t have the right to circumvent the copy protection to legally create one!

Bucking protectionist trends are open source projects that promote copying, free distribution, peer review, and user modification. Linux is an open-source computer operating system that can be modified and freely distributed. Open source application software includes the popular LibreOffice suite, Firefox Web browser, and Thunderbird e-mail.

Digital technology makes it possible to copy and modify films, music, software, and other data, but a tricky balancing act is required to allow consumers flexibility to use data while protecting the income stream to artists, performers, and publishers.

What effect does digital technology have on the economy? Digital technology is an important factor in global and national economies, in addition to affecting the economic status of individuals. Globalization can be defined as the worldwide economic interdependence of countries that occurs as cross-border commerce increases and as money flows more freely among countries.
In a global economy, consumers gain access to a wide variety of products, including technology products manufactured in locations scattered all over the globe.

Global communications technology offers opportunities for teleworkers in distant countries. Customer service lines for U.S.-based companies, such as IBM, Dell, and Hewlett-Packard, are often staffed by offshore technicians who earn far more than they could if working for a company that is based in their home country.

Globalization, fueled by digital technology, has controversial aspects, however. Worker advocates object to the use of cheap offshore labor that displaces onshore employees.

Some individuals are affected by the digital divide, a term that refers to the gap between people who have access to technology and those who do not. Digital have-nots may face economic barriers. They cannot afford computers, cell phones, and Internet access, or they are located in an economically depressed region where electricity is not available to run digital devices, where Internet access is slow, or where cell phone service is unavailable (Figure 1-12).

Globalization is an ongoing process that will have far-reaching effects on people in countries with developed technologies and those with emerging economies. Digital technology will be called upon to open additional economic opportunities without disrupting the lifestyles of currently prosperous nations.

**So what’s the point?** Learning about digital technology is not just about circuits and electronics, nor is it only about digital gadgets, such as computers and portable music players. Digital technology permeates the very core of modern life. Understanding how this technology works and thinking about its potential can help you comprehend many issues related to privacy, security, freedom of speech, and intellectual property. It will help you become a better consumer and give you insights into local and world events.

As you continue to read this textbook, don’t lose sight of the big picture. On one level, in this course you might be simply learning about how to use a computer and software. On a more profound level, however, you are accumulating knowledge about how digital technology applies to broader cultural and legal issues that are certain to affect your life far into the future.

### QuickCheck

1. Data _________ was the computing technology behind the first phase of the digital revolution.
2. _________ software refers to any software that is installed on a computer’s hard drive.
3. A computer _________ is a group of computers linked together to share data and resources.
4. The process of converting text, numbers, sound, photos, or video into data that can be processed by a computer is called _________.
5. _________ computing provides access to information, applications, communications, and storage over the Internet.

**SECTION A**
**WHETHER YOU REALIZE IT** or not, you already know a lot about the devices produced by the digital revolution. You’ve picked up information from commercials and news articles, from books and movies, from friends and coworkers—even from using a variety of digital devices and trying to figure out why they don’t always work! Section B provides an overview that’s designed to help you start organizing what you know about digital devices, beginning with computers.

**COMPUTER BASICS**

- **What is a computer?** The word *computer* has been part of the English language since 1646; but if you look in a dictionary printed before 1940, you might be surprised to find a computer defined as a person who performs calculations! Prior to 1940, machines designed to perform calculations were usually referred to as calculators and tabulators, not computers. The modern definition and use of the term *computer* emerged in the 1940s, when the first electronic computing devices were developed.

Most people can formulate a mental picture of a computer, but computers do so many things and come in such a variety of shapes and sizes that it might seem difficult to distill their common characteristics into an all-purpose definition. At its core, a *computer* is a multipurpose device that accepts input, processes data, stores data, and produces output, all according to a series of stored instructions (Figure 1-13).

![A computer accepts input from an input device, such as a keyboard, mouse, scanner, or digital camera.](Image)

![Data is processed in the CPU according to instructions that have been loaded into the computer’s memory.](Image)

![A computer uses disks, CDs, DVDs, and flash drives to permanently store data.](Image)

![Computers produce output on devices such as screens and printers.](Image)

**FIGURE 1-13**

A computer can be defined by its ability to accept input, process data, store data, and produce output, all according to a set of instructions from a computer program.
What is input? Computer input is whatever is typed, submitted, or transmitted to a computer system. Input can be supplied by a person, by the environment, or by another computer. Examples of the kinds of input that computers can accept include words and symbols in a document, numbers for a calculation, pictures, temperatures from a thermostat, audio signals from a microphone, and instructions from a computer program. An input device, such as a keyboard or mouse, gathers data and transforms it into a series of electronic signals for the computer to store and manipulate.

What is output? Output is the result produced by a computer. Some examples of computer output include reports, documents, music, graphs, and pictures. Output devices display, print, or transmit the results of processing.

What does process data mean? Technically speaking, data refers to the symbols that represent facts, objects, and ideas. Computers manipulate data in many ways, and this manipulation is called processing. Some of the ways that a computer can process data include performing calculations, modifying documents and pictures, keeping track of your score in a fast-action game, drawing graphs, and sorting lists of words or numbers (Figure 1-14).

In a computer, most processing takes place in a component called the central processing unit or CPU. The CPU of most modern computers is a microprocessor, which is an electronic component that can be programmed to perform tasks based on data it receives. You’ll learn more about microprocessors later in the chapter. For now, visualize a microprocessor as the little black box that’s the brain of a digital device.

How do computers store data? A computer stores data so that it will be available for processing. Most computers have more than one place to put data, depending on how the data is being used. Memory is an area of a computer that temporarily holds data waiting to be processed, stored, or output. Storage is the area where data can be left on a permanent basis when it is not immediately needed for processing.

Data is typically stored in files. A computer file, usually referred to simply as a file, is a named collection of data that exists on a storage medium, such as a hard disk, CD, DVD, or flash drive. A file can contain data for a term paper, Web page, e-mail message, or music video. Some files also contain instructions that tell the computer how to perform various tasks.

What’s so significant about a computer’s ability to store instructions? The series of instructions that tells a computer how to carry out processing tasks is referred to as a computer program, or simply a program. These programs form the software that sets up a computer to do a specific task. When a computer “runs” software, it performs the instructions to carry out a task.

Take a moment to think about the way you use a simple handheld calculator to balance your checkbook each month. You’re forced to do the calculations in stages. Although you can store data from one stage and use it in the next stage, you cannot store the sequence of formulas—the program—required to balance your checkbook. Every month, therefore, you have to...
perform a similar set of calculations. The process would be much simpler if your calculator remembered the sequence of calculations and just asked you for this month’s checkbook entries.

The idea of a **stored program** means that a series of instructions for a computing task can be loaded into a computer’s memory. These instructions can easily be replaced by a different set of instructions when it is time for the computer to perform another task. This ability to switch programs makes computers multipurpose machines.

The stored program concept allows you to use your computer for one task, such as word processing, and then easily switch to a different type of computing task, such as editing a photo or sending an e-mail message. It is the single most important characteristic that distinguishes a computer from other simpler and less versatile digital devices, such as watches, calculators, and pocket-sized electronic dictionaries.

**What kinds of software do computers run?** Computers run two main types of software: application software and system software. A computer can be applied to many tasks, such as writing, number crunching, video editing, and online shopping. **Application software** is a set of computer programs that helps a person carry out a task. Word processing software, for example, helps people create, edit, and print documents. Personal finance software helps people keep track of their money and investments. Video editing software helps people create home movies and professional films. Software applications are sometimes referred to as **apps**, especially in the context of handheld devices.

Whereas application software is designed to help a person carry out a task, the primary purpose of **system software** is to help the computer system monitor itself in order to function efficiently. An example of system software is a computer **operating system** (OS), which is essentially the master controller for all the activities that take place within a computer. Although an operating system does not directly help people perform application-specific tasks, such as word processing, people do interact with the operating system for certain operational and storage tasks, such as starting programs and locating data files.

**COMPUTER TYPES AND USES**

**Are computers categorized in any way?** At one time it was possible to define three distinct categories of computers. Mainframes were housed in large, closet-sized metal frames. Minicomputers were smaller, less expensive, and less powerful computers that were able, nevertheless, to support multiple users and run business software. Microcomputers were clearly differentiated from computers in other categories because they were dedicated to a single user and their CPUs consisted of a single microprocessor chip.

Today, microprocessors are no longer a distinction between computer categories because just about every computer uses one or more microprocessors as its CPU. The term **minicomputer** has fallen into disuse, and the terms **microcomputer** and **mainframe** are used with less and less frequency.

Computers are versatile machines, but some computers are better suited than others for certain tasks. Categorizing computers is a way of grouping them according to criteria such as usage, cost, size, and capability. Experts don’t necessarily agree on the categories or the devices placed in each category, but commonly used computer categories include personal computers, servers, mainframes, and supercomputers.
What is a personal computer? A personal computer is a microprocessor-based computing device designed to meet the computing needs of an individual. It commonly includes a keyboard and screen, and provides access to a wide variety of local and cloud-based applications.

Personal computers are available as desktop or portable models, and in a variety of shapes, sizes, and colors. You’ll learn more about the wide variety of personal computers in the Hardware chapter. For now, simply remember that computers like those pictured in Figure 1-15 are classified as personal computers.

Are handheld devices computers? Handheld digital devices include familiar gadgets such as iPhones, iPads, iPods, Garmin GPSs, Droids, and Kindles. These devices incorporate many computer characteristics. They accept input, produce output, process data, and include storage capabilities. Handheld devices vary in their programmability and their versatility.

Handheld devices can be divided into two broad categories: those that allow users to install software applications (apps) and those that do not. Handheld devices that allow you to install applications can be classified as personal computers; devices that are not programmable cannot.

iPads and Droid phones, for example, offer access to a wide range of apps that include games, ebook readers, maps, comics, recipes, and news, which are tasks also performed by personal computers that sit on a desk or table (Figure 1-16).

Is an Xbox a computer? A videogame console, such as Nintendo’s Wii, Sony’s PlayStation, or Microsoft’s Xbox, is a computer, but would not generally be referred to as a personal computer because of its history as a dedicated game device. Videogame consoles originated as simple digital devices that connected to a television and provided only a pair of joysticks for input.

Today’s videogame consoles contain microprocessors that are equivalent to any found in a fast personal computer, and they are equipped to produce graphics that rival those on dedicated technical and scientific computers. Add-ons such as keyboards, DVD players, and Internet access make it possible to use a videogame console for activities similar to those for which you’d use a personal computer. Despite these features, videogame consoles like the one in Figure 1-17 fill a specialized niche and are not considered a replacement for a personal computer.
What is a workstation? The term **workstation** has two meanings. It can simply refer to an ordinary personal computer that is connected to a network. A second meaning refers to powerful desktop computers used for high-performance tasks, such as medical imaging and computer-aided design, that require a lot of processing speed. Workstations, such as the one pictured in Figure 1-18, typically cost a bit more than an average personal computer.

What makes a computer a server? In the computer industry, the term **server** has several meanings. It can refer to computer hardware, to a specific type of software, or to a combination of hardware and software. In any case, the purpose of a **server** is to serve computers on a network (such as the Internet or a home network) by supplying them with data.

Any software or digital device, such as a computer, that requests data from a server is referred to as a **client**. For example, on the Internet, a server might respond to a client’s request for a Web page. Servers also handle the steady stream of e-mail that travels among clients from all over the Internet. A server might also allow clients within a home, school, or business network to share files or access a centralized printer.

Client computers can download and upload files from servers. The term **download** refers to the process of copying a file from a server to your own client computer. For example, you can say “I had to download the file before I could install it.” The term can also refer to the file that you download, as in “I had to delete the download because it was infected with a virus.”

**Upload** refers to the process of copying files from your client computer to a server. As with the term **download**, **upload** can also refer to the file you have uploaded.

Remarkably, just about any personal computer, workstation, mainframe, or supercomputer can be configured to perform the work of a server. That fact should emphasize the concept that a server does not require a specific type of hardware. Nonetheless, computer manufacturers such as IBM, SGI, HP, and Dell offer devices called servers (Figure 1-19) that are especially suited for storing and distributing data on a network.

Server prices vary, depending on configuration, but tend to be more similar to workstation prices than personal computer prices. Despite impressive performance on server-related tasks, these machines do not offer features such as sound cards, DVD players, and other fun accessories, so they are not a suitable alternative to a personal computer.
What's so special about a mainframe computer? A mainframe computer (or simply a mainframe) is a large and expensive computer capable of simultaneously processing data for hundreds or thousands of users. Mainframes are generally used by businesses or governments to provide centralized storage, processing, and management for large amounts of data. Mainframes remain the computer of choice in situations where reliability, data security, and centralized control are necessary.

The price of a mainframe computer typically starts at $100,000 and can easily exceed $1 million. Its main processing circuitry is housed in a closet-sized cabinet (Figure 1-20); but after large components are added for storage and output, a mainframe computer system can fill a good-sized room.

How powerful is a supercomputer? A computer falls into the supercomputer category if it is, at the time of construction, one of the fastest computers in the world (Figure 1-21).

Because of their speed, supercomputers can tackle complex tasks and compute-intensive problems that just would not be practical for other computers. A compute-intensive problem is one that requires massive amounts of data to be processed using complex mathematical calculations. Molecular calculations, atmospheric models, and climate research are all examples of projects that require massive numbers of data points to be manipulated, processed, and analyzed.

Common uses for supercomputers include breaking codes, modeling worldwide weather systems, and simulating nuclear explosions. One impressive simulation, which was designed to run on a supercomputer, tracked the movement of thousands of dust particles as they were tossed about by a tornado.

At one time, supercomputer designers focused on building specialized, very fast, and very large CPUs. Today, most supercomputer CPUs are constructed from thousands of microprocessors. Of the 500 fastest supercomputers in the world, the majority use microprocessor technology.
MICROCONTROLLERS

What is a microcontroller? Have you ever wondered how a guided missile reaches its target or how your refrigerator knows when to initiate a defrost cycle? What controls your microwave oven, digital video recorder, washing machine, and watch? Many common appliances and machines are controlled by embedded microcontrollers. A microcontroller is a special-purpose microprocessor that is built into the machine it controls. A microcontroller, such as the one in Figure 1-22, is sometimes called a computer-on-a-chip or an embedded computer because it includes many of the elements common to computers.

How does a microcontroller work? Consider the microcontroller in a Sub-Zero refrigerator. It accepts user input for desired temperatures in the refrigerator and freezer compartments. It stores these desired temperatures in memory. Temperature sensors collect additional input of the actual temperatures. The microcontroller processes the input data by comparing the actual temperature to the desired temperature. As output, the microcontroller sends signals to activate the cooling motor as necessary. It also generates a digital readout of the refrigerator and freezer temperatures.

Is a microcontroller really a computer? Recall that a computer is defined as a multipurpose device that accepts input, produces output, stores data, and processes it according to a stored program. A microcontroller seems to fit the input, processing, output, and storage criteria that define computers. Some microcontrollers can even be reprogrammed to perform different tasks.

Technically, a microcontroller could be classified as a computer. Despite this technicality, however, microcontrollers tend to be referred to as processors rather than as computers because in practice they are used for dedicated applications, not as multipurpose devices.

TRY IT!
Which one of the following would you most likely use to add and use apps such as games and weather tracking?

- A microcontroller
- Any handheld digital device
- A handheld computer

FIGURE 1-22
A microcontroller is a self-contained chip that can be embedded in an appliance, vehicle, or other device.
Why are microcontrollers significant? Microcontrollers can be embedded in all sorts of everyday devices, enabling machines to perform sophisticated tasks that require awareness and feedback from the environment (Figure 1-23).

When combined with wireless networks, devices with embedded processors can relay information to Web sites, cell phones, and a variety of data collection devices. Machines and appliances with embedded processors tend to be smarter about their use of resources—such as electricity and water—which makes them environmentally friendly.

Perhaps the most significant effect of microcontrollers is that they are an almost invisible technology, one that doesn’t require much adaptation or learning on the part of the people who interact with microcontrolled devices. However, because microcontrollers remain mostly out of sight and out of mind, it is easy for their use to creep into areas that could be detrimental to quality of life, privacy, and freedom.

The GPS chip in your cell phone, for example, can be useful if you’re lost and need 911 assistance, but it could potentially be used by marketers, law enforcement, and others who want to track your location without your consent.

QuickCheck

1. A computer is a digital device that processes data according to a series of __________ instructions called a program or software.

2. Computer data is temporarily stored in __________, but is usually transferred to __________ where it can be left on a more permanent basis.

3. __________ computers are available in desktop and portable models.

4. A digital device, such as a computer, is called a(n) __________ when it requests data from a server.

5. A(n) __________ is a special-purpose microprocessor that is built into the machine it controls.
**Digital Data Representation**

**COMPUTERS AND OTHER DIGITAL DEVICES** work with all sorts of “stuff,” including text, numbers, music, images, speech, and video. The amazing aspect of digital technology is that it distills all these different elements down to simple pulses of electricity and stores them as 0s and 1s. Understanding the data representation concepts presented in Section C will help you grasp the essence of the digital world and get a handle on all the jargon pertaining to bits, bytes, megahertz, and gigabytes.

**DATA REPRESENTATION BASICS**

- **What is data?** As you learned earlier in the chapter, *data* refers to the symbols that represent people, events, things, and ideas. Data can be a name, a number, the colors in a photograph, or the notes in a musical composition.

- **Is there a difference between data and information?** In everyday conversation, people use the terms *data* and *information* interchangeably. Nevertheless, some technology professionals make a distinction between the two terms. They define data as the symbols that represent people, events, things, and ideas. Data becomes information when it is presented in a format that people can understand and use. As a general rule, remember that (technically speaking) data is used by machines, such as computers; information is used by humans.

- **What is data representation?** Data representation refers to the form in which data is stored, processed, and transmitted. For example, devices such as smartphones, iPods, and computers store numbers, text, music, photos, and videos in formats that can be handled by electronic circuitry. Those formats are data representations. Data can be represented using digital or analog methods.

- **What’s the difference between analog and digital?** For a simple illustration of the difference between analog and digital, consider the way you can control the lights in a room using a traditional light switch or a dimmer switch (Figure 1-24).

  A traditional light switch has two discrete states: on and off. There are no in-between states, so this type of light switch is digital. A dimmer switch, on the other hand, has a rotating dial that controls a continuous range of brightness. It is, therefore, analog.

  **Digital data** is text, numbers, graphics, sound, and video that have been converted into discrete digits such as 0s and 1s. In contrast, **analog data** is represented using an infinite scale of values.

**TERMINOLOGY NOTE**

The word *data* can be correctly treated either as a plural noun or as an abstract mass noun, so phrases such as “The data are being processed” and “The data is being processed” are both correct usage. In this textbook, the word *data* is paired with singular verbs and modifiers.

---

**FIGURE 1-24**

A computer is a digital device, more like a standard light switch than a dimmer switch.
How does digital data work? Imagine that you want to send a message by flashing a light. Your light switch offers two states: on and off. You can use sequences of ons and offs to represent various letters of the alphabet. To write down the representation for each letter, you can use 0s and 1s. The 0s represent the off state of your light switch; the 1s indicate the on state. For example, the sequence on on off off would be written as 1100, and you might decide that sequence represents the letter A.

Digital devices are electronic and so you can envision data flowing within these devices as pulses of light. In reality, digital signals are represented by two different voltages, such as +5 volts and +.2 volts. They can also be represented by two different tones as they flow over a phone line. Digital data can also take the form of light and dark spots etched onto the surface of a CD or the positive and negative orientation of magnetic particles on the surface of a hard disk.

The 0s and 1s used to represent digital data are referred to as binary digits. It is from this term that we get the word bit—binary digit. A bit is a 0 or 1 used in the digital representation of data.

**REPRESENTING NUMBERS, TEXT, IMAGES, AND SOUND**

How do digital devices represent numbers? Numeric data consists of numbers that can be used in arithmetic operations. For example, your annual income is numeric data, as is your age. Digital devices represent numeric data using the binary number system, also called base 2.

The binary number system has only two digits: 0 and 1. No numeral like 2 exists in this system, so the number two is represented in binary as 10 (pronounced “one zero”). You’ll understand why if you think about what happens when you’re counting from 1 to 10 in the familiar decimal system. After you reach 9, you run out of digits. For ten, you have to use the digits 10—zero is a placeholder and the 1 indicates one group of tens.

In binary, you just run out of digits sooner—right after you count to 1. To get to the next number, you have to use the 0 as a placeholder and the 1 indicates one group of twos. In binary, then, you count 0 (zero), 1 (one), 10 (one zero), instead of counting 0, 1, 2 in decimal. If you need to brush up on binary numbers, refer to Figure 1-25 and to the lab at the end of the chapter.

<table>
<thead>
<tr>
<th>Decimal (Base 10)</th>
<th>Binary (Base 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>5</td>
<td>101</td>
</tr>
<tr>
<td>6</td>
<td>110</td>
</tr>
<tr>
<td>7</td>
<td>111</td>
</tr>
<tr>
<td>8</td>
<td>1000</td>
</tr>
<tr>
<td>9</td>
<td>1001</td>
</tr>
<tr>
<td>10</td>
<td>1010</td>
</tr>
<tr>
<td>11</td>
<td>1011</td>
</tr>
<tr>
<td>1000</td>
<td>111101000</td>
</tr>
</tbody>
</table>

**FIGURE 1-25**

The decimal system uses ten symbols to represent numbers: 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9. The binary number system uses only two symbols: 0 and 1.

**TRY IT!**

The table shows the binary equivalent of numbers 1 through 11. What is the binary for the number 12?

- 10111
- 1100
- 10000
- 1111
The important point to understand is that the binary number system allows digital devices to represent virtually any number simply by using 0s and 1s. Digital devices can then perform calculations using these numbers.

**How do digital devices represent words and letters?**

Character data is composed of letters, symbols, and numerals that are not used in arithmetic operations. Examples of character data include your name, address, and hair color. Just as Morse code uses dashes and dots to represent the letters of the alphabet, a digital computer uses a series of bits to represent letters, characters, and numerals.

Digital devices employ several types of codes to represent character data, including ASCII, EBCDIC, and Unicode. ASCII (American Standard Code for Information Interchange, pronounced “ASK ee”) requires only seven bits for each character. For example, the ASCII code for an uppercase letter is 1000001. ASCII provides codes for 128 characters, including uppercase letters, lowercase letters, punctuation symbols, and numerals.

EBCDIC (Extended Binary-Coded Decimal Interchange Code, pronounced “EB seh dick”) is an 8-bit code used only by older, mainframe computers.

Extended ASCII is a superset of ASCII that uses eight bits to represent each character. For example, Extended ASCII represents the uppercase letter A as 01000001. Using eight bits instead of seven bits allows Extended ASCII to provide codes for 256 characters. The additional Extended ASCII characters include other graphical symbols. Figure 1-26 lists the Extended ASCII character set.

### Figure 1-26

The Extended ASCII code uses eight 1s and 0s to represent letters, symbols, and numerals. The first 32 ASCII characters are not shown in the table because they represent special control sequences that cannot be printed. The two blank entries are space characters.

**TRY IT!**

Write out H!i in Extended ASCII code. (Hint: Use an uppercase H, but a lowercase i.)
Unicode (pronounced “YOU ni code”) uses sixteen bits and provides codes for 65,000 characters—a real bonus for representing the alphabets of multiple languages. For example, Unicode represents an uppercase A in the Russian Cyrillic alphabet as 0000010000010000.

Why do ASCII and Extended ASCII provide codes for 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9? While glancing at the table of ASCII codes in Figure 1-26, you might have wondered why the table contains codes for 0, 1, 2, 3, and so on. Aren’t these numbers represented by the binary number system? A computer uses Extended ASCII character codes for 0, 1, 2, 3, etc. to represent numerals that are not used for calculations.

How can bits be used to store images? Images, such as photos, pictures, line art, and graphs, are not small, discrete objects like numbers or the letters of the alphabet. Images have to be digitized in order for digital devices to work with them.

Images can be digitized by treating them as a series of colored dots. Each dot is assigned a binary number according to its color. For example, a green dot might be represented by 0010 and a red dot by 1100, as shown in Figure 1-27. A digital image is simply a list of color numbers for all the dots it contains.

How can bits be used to store sound? Sound, such as music and speech, is characterized by the properties of a sound wave. You can create a comparable wave by etching it onto a vinyl platter—essentially how records were made in the days of jukeboxes and record players. You can also represent that sound wave digitally by sampling it at various points, and then converting those points into digital numbers. The more samples you take, the closer your points come to approximating the full wave pattern. This process of sampling, illustrated in Figure 1-28, is how digital recordings are made.

An analog sound wave is a smooth curve of continuous values.

To digitize a wave, it is sliced into vertical segments, called samples. For purposes of illustration, this one-second sound wave was sliced into 30 samples. The height of this sample is about 160, which can be converted into a binary number and stored.

Social Security numbers and the numerals in a street address are considered character data. If your address is 10 B St, how would you complete the Extended ASCII code?
QUANTIFYING BITS AND BYTES

How can I tell the difference between bits and bytes?
The ads for digital devices often include lots of abbreviations relating to bits and bytes. A few key concepts can help you understand what these abbreviations mean. Even though the word bit is an abbreviation for binary digit, it can be further abbreviated, usually as a lowercase b.

On older digital devices, bits were handled in groups, and terminology from that era is still used. A group of eight bits is called a byte and is usually abbreviated as an uppercase B.

Transmission speeds are usually expressed in bits, whereas storage space is typically expressed in bytes. For example, a cable Internet connection might transfer data from the Internet to your computer at 8 megabits per second. In an iPod ad, you might notice that it can store up to 60 gigabytes of music and video.

What do the prefixes kilo-, mega-, giga-, and tera-mean? When reading about digital devices, you’ll frequently encounter references such as 50 kilobits per second, 1.44 megabytes, 2.8 gigahertz, and 2 terabytes. Kilo, mega, giga, tera, and similar terms are used to quantify digital data as shown in Figure 1-29.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Abbreviation</th>
<th>Bytes</th>
<th>Bits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit</td>
<td></td>
<td>One binary digit</td>
<td>$2^{30}$</td>
</tr>
<tr>
<td>Byte</td>
<td></td>
<td>8 bits</td>
<td>$2^{30}$ bytes</td>
</tr>
<tr>
<td>Kilobit</td>
<td></td>
<td>1,024 or $2^{10}$</td>
<td>$2^{30}$</td>
</tr>
<tr>
<td>Kilobyte</td>
<td></td>
<td>1,024 or $2^{10}$</td>
<td>$2^{40}$ bytes</td>
</tr>
<tr>
<td>Megabit</td>
<td></td>
<td>1,048,576 or $2^{20}$</td>
<td>$2^{30}$ bytes</td>
</tr>
<tr>
<td>Megabyte</td>
<td></td>
<td>1,048,576 or $2^{20}$</td>
<td>$2^{60}$ bytes</td>
</tr>
</tbody>
</table>

In common usage, kilo, abbreviated as K, means a thousand. For example, $50K$ means $50,000. In the context of computers, however, $50K$ means 51,200. Why the difference? In the decimal number system we use on a daily basis, the number 1,000 is 10 to the third power, or $10^3$. For digital devices where base 2 is the norm, a kilo is precisely 1,024, or $2^{10}$. A kilobit (abbreviated Kb or Kbit) is 1,024 bits. A kilobyte (abbreviated KB or Kbyte) is 1,024 bytes. Kilobytes are often used when referring to the size of small computer files.

The prefix mega means a million, or in the context of bits and bytes, precisely 1,048,576 (the equivalent of $2^{20}$). A megabit (Mb or Mbit) is 1,048,576 bits. A megabyte (MB or MByte) is 1,048,576 bytes. Megabytes are often used when referring to the size of medium to large computer files.

In technology lingo, the prefix giga refers to a billion, or precisely 1,073,741,824. As you might expect, a gigabit (Gb or Gbit) is approximately 1 billion bits. A gigabyte (GB or GByte) is 1 billion bytes. Gigabytes are commonly used to refer to storage capacity.

Computers—especially mainframes and supercomputers—sometimes work with huge amounts of data, and so terms such as tera (trillion), peta (thousand trillion), and exa (quintillion) are also handy.

TERMiology NOTE

What’s a kibibyte? Some computer scientists have proposed alternative terminology to dispel the ambiguity in terms such as mega that can mean 1,000 or 1,024. They suggest the following prefixes:

- Kibi = 1,024
- Mebi = 1,048,576
- Gibi = 1,073,741,824

TRY IT!

Fill in the correct abbreviation (B, MB, KB, or GB):

- My iPhone has 8____ storage space.
- I uploaded a high-resolution 8-________ graphic.
- You can download my resume; the file is only 8____.
CIRCUITS AND CHIPS

> How do digital devices store and transport all those bits? Because most digital devices are electronic, bits take the form of electrical pulses that can travel over circuits in much the same way that electricity flows over a wire when you turn on a light switch. All the circuits, chips, and mechanical components that form a digital device are designed to work with bits.

At the simplest level, you can envision bits as two states of an electric circuit; the state used for a 1 bit would be on and the state for a 0 bit would be off. In practice, the 1 bit might be represented by an elevated voltage, such as +5 volts, whereas a 0 bit is represented by a low voltage, such as 0.2.

> What’s inside? If it weren’t for the miniaturization made possible by digital electronic technology, computers, cell phones, and portable media players would be huge and contain a complex jumble of wires and other electronic gizmos. Instead, today’s digital devices contain relatively few parts—just a few wires, some microchips, and one or more circuit boards.

> What’s a computer chip? The terms computer chip, microchip, and chip originated as technical jargon for integrated circuit. An integrated circuit (IC), such as the one pictured in Figure 1-30, is a super-thin slice of semiconducting material packed with microscopic circuit elements, such as wires, transistors, capacitors, logic gates, and resistors.

Semiconducting materials (or semiconductors), such as silicon and germanium, are substances with properties between those of a conductor (like copper) and an insulator (like wood). To fabricate a chip, the conductive properties of selective parts of the semiconducting material can be enhanced to essentially create miniature electronic pathways and components, such as transistors.

Integrated circuits are packaged in protective carriers that vary in shape and size. Figure 1-31 illustrates some chip carriers, including small rectangular DIPs (dual in-line packages) with caterpillar-like legs protruding from a black, rectangular body; and pin-cushion-like PGAs (pin-grid arrays).

> TRY IT!
Suppose for a moment that you are a microprocessor and you get the set of signals shown at left. What letter are you processing?

- Q
- a
- j
- S

FIGURE 1-30
The first computer chips contained fewer than 100 miniaturized components, such as diodes and transistors. The chips used as the CPUs for today’s computers and cutting-edge graphics cards contain billions of transistors.

FIGURE 1-31
Integrated circuits can be used for microprocessors, memory, and support circuitry. They are housed within a ceramic carrier. These carriers exist in several configurations, or chip packages, such as DIPs and PGAs.
1. Data refers to the format in which data is stored, processed, and transferred.

2. Digital devices often use the number system to represent numeric data.

3. Most computers use Unicode or Extended code to represent character data. (Hint: Use the acronym.)

4. KB is the abbreviation for .

5. Integrated circuits are fabricated from materials that have properties of a conductor and an insulator.
Digital Processing

Computers and other digital devices process data, but how do they know what to do with it? The instructions you issue aren’t 0s and 1s that a digital device can work with. So what goes on inside the box? Section D explains the programs that make digital devices tick. You’ll discover that although digital devices appear to perform very complex tasks, under the hood they are really performing some very simple operations, but doing them at lightning speed.

Programs and Instruction Sets

- **How do digital devices process data?** Computers and dedicated handheld devices all work with digital data under the control of a computer program. Let’s take a closer look at programs to see how they are created and how digital devices work with them.

- **Who creates programs?** Computer programmers create programs that control digital devices. These programs are usually written in a high-level programming language, such as C, BASIC, COBOL, or Java.

Programming languages use a limited set of command words such as Print, If, Write, Display, and Get to form sentence-like statements designed as step-by-step directives for the processor chip. An important characteristic of most programming languages is that they can be written with simple tools, such as a word processor, and they can be understood by programmers. A simple program to select a song on your iPod might contain the statements shown in Figure 1-33.

![Program: Display Playlist, Get Song, Play Song](image)

The human-readable version of a program, like the one above, created in a high-level language by a programmer is called **source code**. However, just as a digital device can’t work directly with text, sounds, or images until they have been digitized, source code has to be converted into a digital format before the processor can use it.

- **TRY IT!**

Was the first computer programmer a man or a woman? There is controversy surrounding the answer to this question. Check online to find the name of the person who is often cited as the first computer programmer.

- Bill Gates
- Ada Lovelace
- Grace Hopper
- Charles Fortran

**Figure 1-33**

The program for an iPod displays a list of songs that the user can choose to play. A program works behind the scenes to display the list, get your selection, process it, and play the song.
How does source code get converted? The procedure for translating source code into 0s and 1s can be accomplished by a compiler or an interpreter. A compiler converts all the statements in a program in a single batch, and the resulting collection of instructions, called object code, is placed in a new file (Figure 1-34). Most of the program files distributed as software contain object code that is ready for the processor to execute.

As an alternative to a compiler, an interpreter converts and executes one statement at a time while the program is running. After a statement is executed, the interpreter converts and executes the next statement, and so on (Figure 1-35).

Compilers and interpreters don’t simply convert the characters from source code into 0s and 1s. For example, in the first line of the iPod program, Display Playlist, a compiler would not simply convert the D into its ASCII equivalent. No, computers are a little trickier than that.

What does the conversion process produce? A microprocessor is hard-wired to perform a limited set of activities, such as addition, subtraction, counting, and comparisons. This collection of preprogrammed activities is called an instruction set. Instruction sets are not designed to carry out any specific task, such as word processing or playing music. Instead, an instruction set is designed to be general purpose so that programmers can use it in creative ways for the wide variety of tasks performed by all kinds of digital devices.

Each instruction has a corresponding sequence of 0s and 1s. For example, 00000100 might correspond to Add. The list of codes for a microprocessor’s instruction set, called machine language, can be directly executed by the processor’s circuitry. A set of machine language instructions for a program is called machine code.
A machine language instruction has two parts: the op code and the operands. An op code, which is short for operation code, is a command word for an operation such as add, compare, or jump. The operand for an instruction specifies the data, or the address of the data, for the operation. In the following instruction, the op code means add and the operand is 1, so the instruction means add 1.

![Instruction Diagram]

A single high-level instruction very often converts into multiple machine language instructions. Figure 1-36 illustrates the number of machine language instructions that correspond to a simple high-level program.

```c
#include <stdio.h>
int main ()
{
    int i;
    for (i=1; i<=100; i=i+1)
        printf("%d	",i);
    return(0);
}
```

To summarize what you should now know about programs and instruction sets, a programmer creates human-readable source code using a programming language. A compiler or an interpreter converts source code into machine code. Machine code instructions are a series of 0s and 1s that correspond to a processor’s instruction set.

**PROCESSOR LOGIC**

> What happens inside a computer chip? A microprocessor contains miles of microscopic circuitry and millions of miniature components divided into different kinds of operational units, such as the ALU and the control unit.

The ALU (arithmetic logic unit) is the part of the microprocessor that performs arithmetic operations, such as addition and subtraction. It also performs logical operations, such as comparing two numbers to see if they are the same. The ALU uses registers to hold data that is being processed, just as you use a mixing bowl to hold the ingredients for a batch of cookies.

The microprocessor’s control unit fetches each instruction, just as you get each ingredient out of a cupboard or the refrigerator. Data is loaded into the ALU’s registers, just as you add all the ingredients to the mixing bowl. Finally, the control unit gives the ALU the green light to begin processing, just as you flip the switch on your electric mixer to begin blending the cookie ingredients. Figure 1-37 illustrates a microprocessor control unit and an ALU preparing to add 2 + 3.
What happens when a computer executes an instruction?
The term instruction cycle refers to the process in which a computer executes a single instruction. Some parts of the instruction cycle are performed by the microprocessor's control unit; other parts of the cycle are performed by the ALU. The steps in this cycle are summarized in Figure 1-38.

What role does the control unit play?
The instructions that a computer is supposed to process for a particular program are held in memory. When the program begins, the memory address of the first instruction is placed in a part of the microprocessor's control unit called an instruction pointer.

The control unit can then fetch the instruction by copying data from that address into its instruction register. From there, the control unit can interpret the instruction, gather the specified data, or tell the ALU to begin processing. Figure 1-39 helps you visualize the control unit's role in processing an instruction.

When does the ALU swing into action?
The ALU is responsible for performing arithmetic and logical operations. It uses registers to hold data ready to be processed. When it gets the go-ahead signal from the control unit, the ALU processes the data and places the result in an accumulator. From the accumulator, the data can be sent to memory or used for further processing. The TRY IT! on the next page helps you visualize what happens in the ALU as the computer processes data.
What happens after an instruction is executed? When the computer completes an instruction, the control unit increments the instruction pointer to the memory address of the next instruction, and the instruction cycle begins again.

Do I need to know all this detailed stuff? What you should take away from the discussion about programming and instruction sets is the idea that computers and other digital devices accomplish a wide array of complex tasks by performing a very limited set of machine language instructions very fast.

These concepts about how processors work will help you understand the significance of microprocessor performance, such as speed and word size, which you’ll learn about in the next chapter.

QuickCheck

1. A(n) ________ converts all of the source code instructions into a new file containing ________ code.

2. A microprocessor is hard-wired to perform a set of activities called a(n) ________ set.

3. A machine language instruction has two parts: a(n) ________ code and an operand.

4. The ALU in your computer’s microprocessor holds data in ________.

5. The microprocessor’s control unit contains a(n) ________ pointer that holds the address of the instruction being executed.
**Password Security**

**SECTION E**

**USER IDS**, passwords, and personal identification numbers (PINs) are a fact of everyday life in the information age. They are required for activities such as using ATMs and debit cards, logging in to Windows, accessing wireless networks, making an iTunes purchase, instant messaging, reading e-mail, and file sharing. Many Web sites encourage you to sign up for membership by choosing a user ID and password. Section E provides information about selecting secure passwords and managing the mountain of passwords you collect and tend to forget.

**AUTHENTICATION PROTOCOLS**

- **What is an authentication protocol?** Security experts use the term **authentication protocol** to refer to any method that confirms a person’s identity using something the person knows, something the person possesses, or something the person is. For example, a person might know a password or PIN. A person might possess an ATM card or a credit card. A person can also be identified by **biometrics**, such as a fingerprint, facial features (photo), or a retinal pattern (Figure 1-40).

Authentication protocols that use more than one means of identification are more secure than others. Two-factor authentication, which verifies identity using two independent elements of confirmation such as an ATM card and a PIN, is more secure than single-factor authentication, such as a password. Computer-related security is primarily based on passwords associated with user IDs. The level of protection offered by single-factor authentication depends on good password selection and management on the part of users.

- **What is a user ID?** A **user ID** is a series of characters—letters and possibly numbers or special symbols—that becomes a person’s unique identifier, similar to a Social Security number. It is also referred to as a user name, login, screen name, online nickname, or handle. User IDs are public. Because they are not secret, they do not offer any level of security.

The rules for creating a user ID are not consistent throughout all applications, so it is important to read instructions carefully before finalizing your user ID. For example, spaces might not be allowed in a user ID. Hence, the underline in brunhilde_jefferson is used instead of a space. There might be a length limitation, so Ms. Jefferson might have to choose a short user ID, such as bjeffe. It is becoming common to use your e-mail address as a user ID; it is unique and easy to remember.

**FIGURE 1-40**

Biometric authentication protocols include retinal scans that identify unique patterns of blood vessels in the eye.

**TRY IT!**

When you use a debit card, you have to enter your PIN. This is an example of:
- single-factor authentication
- single user ID
- two-factor authentication
- password security
Some computers that host password-protected resources don’t differentiate between uppercase and lowercase letters, and would consider the user IDs B_Jefferson and b_jefferson to be the same. Other computers are case sensitive and differentiate between uppercase and lowercase. On such computers, if Ms. Jefferson selected Brun_Jeff as her user ID, she would not be able to gain access by typing brun_jeff.

**What is a password?** A password is a series of characters that verifies a user ID and guarantees that you are the person you claim to be. Although you might be assigned a password, more commonly you are asked to provide your own. In some situations, you might be given a temporary password and then be asked to change it as soon as you successfully log in for the first time. Passwords and user IDs are created on a registration or enrollment screen similar to the one in Figure 1-41.

![User Name & Password form](image)

**FIGURE 1-41**
When you create an account, you are usually required to enter a user ID and password. Then you are required to confirm the password to make sure you typed it correctly.

**What if I forget my password?** Login screens for many applications provide a “forgot my password” link. Clicking this link checks your identity using your answer to a personal question. If your identity checks out, your password is e-mailed to you. A personal question provides an alternative authentication protocol to ensure that you are not a hacker pretending to be a legitimate user who has lost a password.

Personal questions and answers are usually set up at the same time you create an account. After selecting a password, you are required to choose a question that you must answer before your forgotten password is e-mailed to you. This question might be something like: *What is your mother’s maiden name?*, *What is your favorite color?*, or *Where were you born?* You should be careful about the question you choose because public information like your mother’s maiden name or the town of your birth can be researched by any hacker.

**What is the difference between a password and a PIN?**
Both passwords and PINs are classified as *something-the-user-knows* authentication methods. In practice, PINs tend to be a short sequence of numbers that can be entered using a numeric keypad, whereas passwords tend to be longer sequences of letters, numbers, and special characters that require a full qwerty keyboard for entry. PINs are commonly used with two-factor authentication protocols, whereas passwords are used in conjunction with single-factor authentication protocols.
For example, ATMs require a bank card (something you possess) and a PIN (something you know). In contrast, passwords are associated with single-factor authentication used for networks, Web sites, and other situations in which the hardware for dealing with ID cards is not available.

**PASSWORD HACKS**

- **How serious is password theft?** To a hacker, obtaining the password for a specific user ID can be even more rewarding than a burglar figuring out the combination to a house safe. Once hackers get into a user account, a wealth of personal information can be at their fingertips. This information could be anything from juicy e-mail gossip to Social Security numbers, credit card numbers, bank account numbers, health data, and other private details. When someone gains unauthorized access to your personal data and uses it illegally, it is called identity theft. Victims of this increasingly common crime often don’t realize what has happened until it’s too late.

Armed with your password and other personal data, a cybercriminal can rack up bills using your credit card, apply for a mortgage using your financial data, create fake accounts in your name, send embarrassing e-mail messages, or wreak havoc on your bank account. Once a thief breaks into an online account, he or she can also change your password and you will no longer be able to log in. Password theft is serious and pervasive, so it is important to understand how hackers get passwords and how you can protect yours.

- **How can hackers get my password?** Hackers employ a whole range of ways to steal passwords. Some primitive means include shoulder surfing, which is looking over your shoulder as you type in your password, and dumpster diving, which is going through your trash.

Password thieves can easily find your password if you write it down on a yellow sticky note hidden under your keyboard or in plain sight on top of your monitor. If a hacker doesn’t have physical access to your work area but your computer is connected to a network, your password can be discovered by a hacker using a remote computer and software tools that systematically guess your password, intercept it, or trick you into revealing it.

A dictionary attack helps hackers guess your password by stepping through a dictionary containing thousands of the most commonly used passwords. Password dictionaries can be found on black hat sites and packaged with password-cracking software, such as John the Ripper. Unfortunately, dictionary attacks are often enough to break a password because many users choose passwords that are easy to remember and likely to be in the most commonly used list (Figure 1-42).

![Figure 1-42](image-url) Some of the most commonly used passwords are included in the dictionaries packaged with password-cracking software. These passwords (listed in order of popularity) should not be used.

TERMINOLOGY NOTE

**Hacker** can refer to a skilled programmer or to a person who manipulates computers with malicious intent. The terms **black hat** and **cracker** are also used to refer to a malicious or criminal hacker.
The brute force attack also uses password-cracking software, but its range is much more extensive than the dictionary attack. Because it exhausts all possible combinations of letters to decrypt a password, a brute force attack can run for days to crack some passwords.

If hackers can’t guess a password, they can use another technique called sniffing, which intercepts information sent out over computer networks. Sniffing software is used legitimately by network administrators to record network traffic for monitoring and maintenance purposes. The same software can also be used for illicit activities. If your user ID and password travel over a network as unencrypted text, they can easily fall into the hands of a password thief.

An even more sophisticated approach to password theft is phishing, in which a hacker poses as a legitimate representative of an official organization such as your ISP, your bank, or an online payment service in order to persuade you to disclose highly confidential information. Mostly through e-mail or instant messaging, a fake customer representative or administrator asks you to visit a Web page to confirm billing information or verify your account by providing your password, credit card number, or Social Security number.

If you examine phishing messages more closely, you might realize that the Web sites referred to are fake. However, seasoned hackers try to make the URLs look as close as possible to the official Web sites they claim to represent (Figure 1-43).

As users became better at identifying phishing messages, password thieves resorted to the use of keyloggers. Short for keystroke logging, a keylogger is software that secretly records a user’s keystrokes and sends the information to a hacker. A keylogger is a form of malicious code called a Trojan horse, or Trojan. Trojans are computer programs that seem to perform one function while actually doing something else. They can be embedded in e-mail attachments, software downloads, and even files. Trojans are discussed in more detail in the security section of the Software chapter.
SECURE PASSWORDS

How do I create a secure password? With password theft becoming more and more widespread, security experts recommend using a strong, secure password for financial transactions such as those that involve PayPal, iTunes, or bank accounts. A strong, secure password is one that is easy to remember but difficult to crack. Figure 1-44 offers guidelines for selecting secure passwords and avoiding ones that are easily crackable.

- Use passwords that are at least eight characters in length. The longer the password, the tougher it is to crack.
- Use a combination of letters, numbers, and special characters such as $, #, if permitted.
- Use uppercase and lowercase letters if the hosting computer is case sensitive.
- Use a passphrase based on several words or the first letters of a verse from a favorite poem or song. For example, the words from the nursery rhyme “Jack and Jill went up the hill” can be converted to jjwuth. You can then insert special characters and numbers, and add some uppercase letters to create a password that still makes sense to you personally, such as J&J w^thhill. This type of password appears random to anyone else but you.
- Do not use a password based on public information such as your phone number, Social Security number, driver’s license number, or birthday. Hackers can easily find this information, and other personal facts such as names of your spouse, children, or pets.
- Avoid passwords that contain your entire user ID or part of it. A user ID of bjaffe coupled with a password of bjaffe123 is an easy target for password thieves.
- Steer clear of words that can be found in the dictionary, including foreign words. Dictionary attacks can utilize foreign language dictionaries. Even common words spelled backwards, such as drowssap instead of password, are not tricky enough to fool password-cracking software.

How do I protect my password? Once you have selected a strong password, you must take steps to keep it safe. Do not share your password with anyone. Avoid writing down a password. If possible, memorize it. If you must write down a password, do not leave it in an obvious place such as under your keyboard or mouse pad. Recording passwords in an unencrypted file stored on your computer is risky, too, especially if you have more than one password. A hacker who gains access to that file can use the passwords to access all your accounts.

If you think one of your passwords has been compromised, change it immediately. Even if you have no evidence of password tampering, security experts recommend that you change passwords periodically, say every six months. When you change your passwords, do not just make a slight variation to your current one. For example, do not change just4Me1 to just4Me2. You should not reuse your old passwords either, so it’s best to keep a password history list.

TRY IT!
Which password for Dave Meyers is most secure?
- DaveBMeyers
- Dave12345
- Gilgamesh
- Ih2gtg8pw
- HomeGilgamesh
Aside from good password maintenance habits, computer maintenance is also essential. Make sure that your entire computer is protected by security software, which is explained in the Software chapter.

> How do I deal with all my passwords and user IDs? You can accumulate many passwords and user IDs—for logging in to Windows, accessing online banking, using e-mail, shopping online, downloading music, and getting into your Facebook account. The more passwords and user IDs you have, the more difficult they become to remember.

How many times have you had to click the “I forgot my password” link when you logged in to an online account? Your passwords provide the most protection if they are unique, but accessing even 25 different Web sites that require 25 different user IDs and 25 corresponding passwords requires quite a memory. To add to the confusion, you must also regularly change passwords to your critical accounts!

Instead of using 25 different user IDs and passwords, you need some way to reduce the number of things you have to memorize. First, strive to select a unique user ID that you can use for more than one site. Remember that people with your name who selected user IDs before you might have already taken the obvious user IDs. For example, when John Smith selects a user ID, you can bet that other people have already used johnsmith, jsmith, and john_smith. To keep his user ID unique, John might instead select jsl2wm (the first letters in “John Smith loves 2 watch movies”).

Next, you can maintain two or three tiers of passwords—the top level for high security, the second level for medium security, and the third level for low security. If you do not have too many accounts, you can opt for just two tiers—for high and low security. You can then select two passwords. Use the high-security password for accessing critical data, such as online banking, for managing an online stock portfolio, or for your account at an online bookstore that stores a copy of your billing and credit card information.

Use your low-security password in situations where you don’t really care if your security is compromised. Some places on the Internet want you to establish an account with a user ID and password just to add your name to a mailing list. At other sites, your user ID and password provide access to information, but none of your critical personal or financial data is stored there. It is not necessary to change your low-security password very often. Figure 1-45 provides more information about tiered passwords.

**Figure 1-45**
Tiered passwords reduce the number of user IDs and passwords that you have to remember; however, the disadvantage is that a hacker who discovers one of your passwords will be able to use it to access many of your accounts.
Can my computer help me to remember passwords?

Your computer’s operating system, Web browser, or other software might include a password manager to help you keep track of user IDs and passwords. A password manager (sometimes called a keychain) stores user IDs with their corresponding passwords and automatically fills in login forms. For example, when you register at a Web site while using a browser such as Internet Explorer, the browser stores your new ID and password in an encrypted file on your computer’s hard disk. The next time you visit the Web site, your ID and password are automatically filled in on the login screen (Figure 1-46).

The drawback to password managers that are built into browsers, operating systems, or other software is that if you switch to different software or to a different computer, you will not have access to the stored passwords. For example, if you usually work with the Safari browser on your MacBook Air, it stores your passwords; but if you use a public computer in a coffee shop, your passwords are not accessible from that machine.

Standalone password manager software offers a more inclusive approach to creating and retrieving passwords.

What is password manager software? A standalone password manager is a software application that feeds passwords into login forms regardless of the software you’re using. As with built-in password managers, a standalone password manager stores user IDs and passwords in an encrypted file. You can access this file using a master password. This type of password manager can be moved from one computer to another, for example, if you purchase a new computer.

A standalone password manager can also generate secure “nonsense passwords.” You don’t have to worry if the passwords are difficult to remember because the password manager software can keep track of them (Figure 1-47).
In addition to generating and tracking your passwords, most password manager software provides other features, such as password strength meters and form fillers.

A password strength meter indicates whether your passwords are secure enough—a feature that is useful if you’ve created your own passwords, rather than using your password manager to generate them.

Form fillers automatically enter data into online Web forms such as those that request billing data when you order at an online shopping site. Many form fillers also match a Web form’s URL against a set of valid URLs that you have provided in order to avoid sending data to a fake Web site that you have been lured to visit by a phishing message. When entering passwords, form fillers are not collecting your password from the keyboard; therefore, a hacker’s keylogger cannot secretly record keystrokes.

There are several free, shareware, or open source password managers, such as KeePass, RoboForm, DataVault, and Kaspersky Password Manager. Some password manager software is portable, which means that it does not have to be installed on a computer before it is used. Instead, you can carry it around on a USB flash drive so that your passwords are available wherever you use a computer, such as in your school lab, at the library, or at work. When you remove the flash drive, your portable password manager leaves no traces of passwords behind (Figure 1-48).

For extra protection against intruders who might search your computer for passwords, a flash drive that contains a password manager can be unplugged when you are not accessing password-protected sites. You can also remove the flash drive from your computer when you’re out so that your nosy roommate can’t snoop through your computer files.

Should I store passwords in the cloud? New password management techniques are being developed, but some offer their own set of potential security problems. For example, Web-based password managers can be attractive targets for password thieves. By breaking into a single site, a password thief could harvest thousands of passwords. As new password management technologies appear, make sure you evaluate them carefully before trusting them with your valuable data.

QuickCheck

1. An authentication _______ is any method that confirms a person’s identity using something the person knows, something the person possesses, or something the person is.
2. On a(n) _______ -sensitive server, the user ID BJP is different from bjp.
3. A(n) _______ attack can guess your password if you are using common passwords or everyday words.
4. A(n) _______ scam looks like a request from your bank or an online payment service, but is actually a hacker who wants you to disclose your user ID and password.
5. Most browsers include a built-in password _______ that remembers the user IDs and passwords you use when logging in to Web sites or online e-mail.

SECTION E

FIGURE 1-48

Some password managers are portable so that you can carry them with you on a USB flash drive.

TRY IT!

Smartphone access can be controlled by a password. Would you recommend a password manager to your friend with an iPhone?

- No. The phone’s password is all my friend will need
- Yes, especially if my friend wants to access Facebook or other subscription sites from the phone
THE GUERRILLA Open Access Manifesto begins, “Information is power. But like all power, there are those who want to keep it for themselves. The world’s entire scientific and cultural heritage, published over centuries in books and journals, is increasingly being digitized and locked up by a handful of private corporations.”

Written by Aaron Swartz, the manifesto makes a case for free access to information, particularly scientific information that has the potential to benefit society. To publicize his views, Swartz took action, allegedly downloading nearly 5 million articles, editorials, reviews, and other material from the prestigious JSTOR academic database. He was arrested on felony charges.

Shortly after the Swartz story broke, another open access advocate, Gregg Maxwell, uploaded more than 18,000 articles from Philosophical Transactions of the Royal Society to a file sharing site. The articles, all dated prior to 1923 and previously available by subscription, became accessible to the general public for free.

In explaining his actions, Maxwell wrote, “The liberal dissemination of knowledge is essential to scientific inquiry. More than in any other area, the application of restrictive copyright is inappropriate for academic works: there is no sticky question of how to pay authors or reviewers, as the publishers are already not paying them. And unlike ‘mere’ works of entertainment, liberal access to scientific work impacts the well-being of all mankind. Our continued survival may even depend on it.”

Certainly there are expenses associated with operating academic databases such as JSTOR, but the researchers who write academic articles are typically not paid for their contributions. Money to support their research often comes from public funding collected from taxpayers. Yet academic databases often charge access fees to read full-text articles.

Schools and libraries often pay a per-year fee that provides students and faculty with free access to academic publications, but members of the general public trying to access such information from their home or work computers hit a paywall that becomes a barrier to access. Open access advocates want information to be freely available, and technologies of the Information Age seem on the way to making that a reality.

Information purveyors such as JSTOR and The New York Times argue that free data is unsustainable. Gathering, storing, and distributing information entail costs that need to be passed on to consumers. Information has value that consumers should be willing to pay for.

A U.S. Department of the Navy report suggests that information has value whether or not it is free; however, the value of information increases when it is easy to access, organized, current, and reliable.

On the surface, information available from the Web might seem free, but there are hidden costs such as intrusive advertising, surreptitious tracking, and personal data collection that erode privacy.

Public release of massive numbers of documents onto the Internet is becoming more common as open access advocates take action. Sometimes information, such as Sarah Palin’s e-mails and FBI files on the Roswell UFO incident, can be obtained through the Freedom of Information Act (FOIA) and other legitimate channels.

When legitimate routes fail, documents and databases are sometimes released through backdoor channels. Climategate and WikiLeaks are notorious examples of leaked data.

Open access is a complex concept that requires intelligent compromise among the interests of individuals, businesses, and government agencies. Individuals want to retain their privacy, businesses want to retain their income stream, and governments want to maintain security. Yet, all parties would like as much information as possible in order to make informed decisions and take constructive action.
TRY IT! Explore the value of information, paywalls, and data leaks by working on the following activities.

1. Despite the widespread belief that digital information should be free, the popularity of iTunes and ebook readers, such as the Kindle, demonstrate that consumers are willing to pay for some digital content accessed from the Internet. Make a list of digital content that you currently pay for.

2. A paywall blocks access to documents, news articles, and other content until the consumer pays an access or registration fee. Notable publications such as The New York Times and The Wall Street Journal have instituted paywalls with varying degrees of success. Use a search engine to answer two questions about paywalls:
   a. What is the reason that premium newspapers and magazines believe that paywalls are necessary?
   b. How successful are paywalls based on the number of consumers who actually pay for access to content in online newspapers and magazines?

3. Paywalls are not the only barrier that blocks access to information. Individuals, corporations, and governments hold personal, proprietary, and classified information that is not available for public access. That information sometimes goes public. Explore some of the most notorious data leaks by filling in the following table.

<table>
<thead>
<tr>
<th>LEAK</th>
<th>CONTENTS</th>
<th>DATE</th>
<th>NUMBER OF DOCUMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRU CLIMATE DATA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U.S. DIPLOMATIC CABLES</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WAR DIARY: AFGHANISTAN WAR LOGS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WAR DIARY: IRAQ WAR LOGS</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. Many countries have legislation similar to the United States Freedom of Information Act, which provides a legitimate channel for requesting the release of proprietary and classified information. Declassified data is posted on Web sites for public access. The FBI maintains a fascinating site called The Vault, where you can read dossiers about Marilyn Monroe, Malcolm X, and the Roswell UFO incident.

Head over to The Vault (vault.fbi.gov), browse through the documents for a topic that interests you, and record the most surprising piece of information you find.

What Do You Think?

1. From what you have learned, do you think that academic research articles should be available for free?
2. Do you agree with magazine and news companies that quality content requires a paywall?
3. Do you support efforts to make information accessible through back channels such as WikiLeaks?
You’re looking for information. Where you start depends on how you plan to use the information. The sources you need for a class research paper often differ from information sources for personal use.

Information sources can be roughly divided into two categories: those that serve academic audiences and those that serve consumers.

**Scholarly and academic sources**
- Written by experts
- Intended for academic or professional readers
- Peer-reviewed by other experts before publication
- Contain original research, theoretical analysis, or best practices
- Carefully documented by footnotes or endnotes
- Published by academic publishers, professional associations, or university presses
- Include academic books, academic journals, papers, conference proceedings, dissertations, textbooks, and monographs in printed or digital format

**Consumer-level sources**
- Written by reporters, bloggers, or practitioners
- Intended for the general public
- Usually reviewed by an editor before publication
- Sometimes open to public comment after publication
- Printed or displayed in color with included photos
- Often published in for-profit publications that include advertising
- Include trade books, magazines, encyclopedias, press releases, trade journals, blogs, news sites, and online forums

**HELP!**

Can’t access what you need for a research project? Here are some common problems encountered by students, and solutions that help you find the resources you need for a paper that earns you an A.

**PROBLEM:** Web search engines, such as Google, sometimes miss many of the articles most relevant for a college-level research project because articles are often locked behind paywalls or firewalls that don’t allow search engine access. **SOLUTION:** Go directly to a journal’s Web site and search there.

**PROBLEM:** Many scholarly journals display only abstracts to the general public; viewing the full text of articles requires a subscription or download fee. **SOLUTION:** Use your library’s online database to locate articles that are included in the physical collection. You might have to go to the library to read the articles or ask for the full article from inter-library loan.

**PROBLEM:** Access to academic search engines and databases, such as LexisNexis, requires subscriptions. **SOLUTION:** Your school might provide registered students with free access to journal databases if you log in from a computer on the school network or from within the library.
TRY IT! Research about computers and technology relies on information from a broad base of sources. Let’s explore these sources by comparing what they offer. Some searches will produce information suitable for academic projects, such as term papers, while other searches tend to produce information suitable for personal use, such as figuring out if someone is hacking into your home network.

To record the results of this comparison, write down (or screen capture) one example that you get from each source, and then describe an academic project or personal use for which that information would be suitable. As an example, suppose that you search for “cloud computing” using Google Scholar and one of the results is:

*Introduction to parallel algorithms and architectures*

T Leighton - sce. uhcl.edu

... Catalog Description: This course covers parallel computations using popular interconnection networks such as arrays, trees, hypercubes, and permutation networks such as the star and the pancake networks, as well as grid and cloud computing...

Cited by 2996 - Related articles - View as HTML - Library Search - All 5 versions

This information is academic and could be suitable as one of the sources for a term paper about cloud computing for a computer science course. Okay, now see what you can do with the rest.

1. Check Wikipedia for general information about “cloud computing” and then look at the list of references.
2. Search for academic and trade books about cloud computing at Amazon Books.
3. Search for conference proceedings about cloud computing at the ACM Digital Library.
4. Search an open access database such as DOAJ (see sidebar) for a recent paper about cloud computing.
5. Search an academic database (see sidebar) for an abstract about cloud computing.
6. Search Science.gov for a full text article about cloud computing.
7. Search an online computer magazine, such as *Wired*, for a recent article about cloud computing.
8. Use a search engine, such as Google or Bing, to locate a recent press release about cloud computing.
9. Search Amazon Electronics for cloud computing products and customer reviews.
10. Search a technology news site (see sidebar) for the latest industry news about cloud computing.
Walking out the gate of ancient Pompeii, you might have come across an eye-catching sign extolling the virtues of a popular tavern in the next town. The sign was a clever bit of marketing designed to target thirsty travelers and drum up business. Throughout the centuries, handbills, newspaper ads, television commercials, radio spots, and mass mail campaigns were all important tools of the marketing industry. Now, computers have opened new vistas for communicating with consumers.

The American Marketing Association defines marketing as an organizational function and a set of processes for creating, communicating, and delivering value to customers and for managing customer relationships in ways that benefit the organization and its stakeholders. A person-in-the-street definition might simply be that marketing is an attempt to sell products.

Computers first played a role in marketing as a research tool for quickly crunching numbers from consumer surveys and sales figures. Statistics derived from that data helped companies focus development efforts on the most promising products and market them effectively. Marketing research data made one fact very clear: Even the most effective advertising cannot convince everyone to buy a particular product. A costly prime-time television ad, for example, might be seen by millions of viewers, but many of them have no interest in the advertised product. To better target potential buyers, marketers turned to direct marketing.

Direct marketing attempts to establish a one-to-one relationship with prospective customers rather than waiting for them to learn about a product from general, impersonal forms of advertising, such as billboards, radio spots, television commercials, and newspaper ads. The first direct marketing techniques included personalized letters, catalogs, and telemarketing. Customer names, addresses, and phone numbers were mined from computer databases maintained by mailing list brokers. Lists could be tailored in rudimentary ways to fit target markets. Selling snow tires? Get a list of consumers in northern states. Looking for Peace Corps volunteers? Get a list of college students.

“Dear Carmen Smith, you might already have won...” Just about everyone in America has received a personalized sweepstakes mailing. Initially, personalized names were crudely inserted using dot matrix printers, but today high-speed laser printers dash off thousands of personalized letters per hour and use graphics capabilities to affix signatures that appear to have been hand-signed in ink.

Telemarketing is a technique for telephone solicitation. Computerized autodialers make it possible for telemarketers to work efficiently. An autodialer is a device that can dial telephone numbers stored in a list. It can also generate and dial telephone numbers using a random or sequential number generator.

A smart autodialer, called a predictive dialer, increases a telemarketer’s efficiency even more by automatically calling several numbers at the same time and only passing a call to the marketer when a person answers.

If you’ve picked up the telephone only to hear silence or a disconnect, it was likely an autodialer that connected to more than one person at the same time and dropped your call. Predictive dialers eliminate telemarketing time that would be otherwise wasted with busy signals, answering machines, and so on.

The Internet opened up dramatic new horizons in direct marketing by providing an inexpensive conduit for collecting information about potential customers and distributing targeted direct marketing. According to author Jim Sterne, “The Internet and the World
Wide Web have become the most important new communication media since television, and ones that are fundamentally reshaping contemporary understanding of sales and marketing. Today, a vast amount of information flows over the Internet and marketers are trying to harness that information to most efficiently communicate their messages to prospective customers.

E-commerce Web sites offer a global distribution channel for small entrepreneurs as well as multinational corporations. Consumers can locate e-commerce sites using a search engine. Some search engines allow paid advertising to appear on their sites. Clever marketers use search engine optimization techniques to get their Web sites to the top of search engine lists.

Another way to drive traffic to an e-commerce site is banner advertising that clutters up Web pages with inviting tag lines for free products. Clicking the ad connects consumers to the site. The cost of placing a banner ad depends on the click-through rate—the number of consumers who click an ad. Sophisticated banner ad software displays the banner ad across an entire network and monitors click-through rates. Not only does this software keep track of clickthroughs for billing purposes, it can automatically adjust the sites that carry each ad to maximize click-through rates.

Internet marketing is often associated with the tidal wave of spam that’s currently crashing into everyone’s Inbox. These mass spam e-mails, however bothersome, are a very crude form of direct marketing. Typically, spammers use unscrubbed mailing lists containing many expired, blocked, and invalid e-mail addresses. This hit-or-miss strategy is cheap. Ten million e-mail addresses can be rented for as low as $100 and server bandwidth provided by e-mail brokers costs about $300 per million messages sent.

Marketing professionals regard massive e-mail spamming with some degree of scorn because most lists don’t narrow the focus to the most promising customers. Worse yet, consumers react by installing spam filters. Some spammers try to evade spam filters. More than one Web site offers marketers a free service that analyzes mass e-mail solicitations using a spam filter simulator. If the solicitation can’t get through the filter, the service offers suggestions on what to change so the message slips through.

In contrast to gratuitous spammers, marketing professionals have learned that opt-in mailing lists have much higher success rates. Consumers who have asked for information more often appreciate receiving it and act on it. Opt-in consumers are also more willing to divulge information that develops an accurate profile of their lifestyle so marketers can offer them the most appropriate products.

When given a choice, however, consumers tend to opt out, and marketers responded by surreptitiously collecting data from free apps, Web sites, Facebook pages, and the content of Web-based e-mail messages. Privacy advocates attacked this practice, and savvy consumers have found tools and techniques to minimize the amount of personal data that is harvested behind the scenes.

Most consumers would agree that the marketing industry needs professionals who are socially responsible. In describing the qualifications for marketing professionals, the Bureau of Labor Statistics states the obvious when it says, “Computer skills are vital because marketing, product promotion, and advertising on the Internet are increasingly common.”
New Perspectives Labs

To access the New Perspectives Labs for Chapter 1, open the NP2014 interactive eBook and then click the icon next to the lab title.

OPERATING A PERSONAL COMPUTER

IN THIS LAB YOU’LL LEARN:

• How to start a Windows computer
• What to do when a computer is in sleep mode
• How to deactivate a screensaver
• How to select a different screensaver
• How to use the Alt, Ctrl, Esc, Num Lock, Caps Lock, Windows, Fn, Backspace, Delete, and arrow keys
• The difference between forward and backward slashes
• How to start and exit a program
• How to close a program that is not responding
• When to use the reset button
• How to shut down Windows

LAB ASSIGNMENTS

1. Start the interactive part of the lab. Make sure you’ve enabled Tracking if you want to save your QuickCheck results. Perform each lab step as directed, and answer all the lab QuickCheck questions. When you exit the lab, your answers are automatically graded and your results are displayed.

2. Make a note of the brand and location of the computer you’re using to complete these lab assignments.

3. Use the Start button to access your computer’s Control Panel folder. Describe the status of your computer’s power saver settings.

4. Preview the available screensavers on the computer you use most frequently. Select the screensaver you like the best and describe it in a few sentences.

5. What is the purpose of an Fn key? Does your computer keyboard include an Fn key? Explain why or why not.

6. In your own words, describe what happens when you (a) click the Close button; (b) hold down the Ctrl, Alt, and Del keys; (c) press the reset button; and (d) select the Shut Down option.

WORKING WITH BINARY NUMBERS

IN THIS LAB YOU’LL LEARN:

• The difference between the binary number system and the decimal number system
• How to count in binary
• How to convert decimal numbers into binary numbers
• How to convert binary numbers into decimal numbers
• How to use the Windows Calculator to convert numbers
• How to work with powers of two

LAB ASSIGNMENTS

1. Start the interactive part of the lab. Make sure you’ve enabled Tracking if you want to save your QuickCheck results. Perform each lab step as directed, and answer all the lab QuickCheck questions. When you exit the lab, your answers are automatically graded and your results are displayed.

2. Using paper and pencil, manually convert the following decimal numbers into binary numbers. Your instructor might ask you to show the process that you used for each conversion.

   a. 100
   b. 1,000
   c. 256
   d. 27
   e. 48
   f. 112
   g. 96
   h. 1,024

3. Using paper and pencil, manually convert the following binary numbers into decimal numbers. Your instructor might ask you to show the process that you used for each conversion.

   a. 100
   b. 101
   c. 1100
   d. 10101
   e. 1111
   f. 10000
   g. 1111000
   h. 110110

4. Describe what is wrong with the following sequence:

   10 100 110 1000 1001 1100 1110 10000

5. What is the decimal equivalent of $2^0$, $2^1$, $2^2$?
Key Terms

Make sure you understand all the boldfaced key terms presented in this chapter. With the NP2014 interactive eBook, you can use this list of terms as an interactive study activity. First, try to define a term in your own words, and then click the term to compare your definition with the definition presented in the chapter.

<table>
<thead>
<tr>
<th>Term</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALU, 31</td>
<td>116</td>
</tr>
<tr>
<td>Analog data, 22</td>
<td>116</td>
</tr>
<tr>
<td>Anonymizer tools, 11</td>
<td>116</td>
</tr>
<tr>
<td>Application software, 16</td>
<td>116</td>
</tr>
<tr>
<td>Apps, 16</td>
<td>116</td>
</tr>
<tr>
<td>ASCII, 24</td>
<td>116</td>
</tr>
<tr>
<td>Authentication protocol, 34</td>
<td>116</td>
</tr>
<tr>
<td>Binary number system, 23</td>
<td>116</td>
</tr>
<tr>
<td>Biometrics, 34</td>
<td>116</td>
</tr>
<tr>
<td>Bit, 23</td>
<td>116</td>
</tr>
<tr>
<td>Brute force attack, 37</td>
<td>116</td>
</tr>
<tr>
<td>Byte, 26</td>
<td>116</td>
</tr>
<tr>
<td>Case sensitive, 35</td>
<td>116</td>
</tr>
<tr>
<td>Central processing unit, 15</td>
<td>116</td>
</tr>
<tr>
<td>Character data, 24</td>
<td>116</td>
</tr>
<tr>
<td>Client, 18</td>
<td>116</td>
</tr>
<tr>
<td>Cloud computing, 9</td>
<td>116</td>
</tr>
<tr>
<td>Compiler, 30</td>
<td>116</td>
</tr>
<tr>
<td>Compute-intensive, 19</td>
<td>116</td>
</tr>
<tr>
<td>Computer, 14</td>
<td>116</td>
</tr>
<tr>
<td>Computer network, 8</td>
<td>116</td>
</tr>
<tr>
<td>Computer program, 15</td>
<td>116</td>
</tr>
<tr>
<td>Control unit, 31</td>
<td>116</td>
</tr>
<tr>
<td>Convergence, 9</td>
<td>116</td>
</tr>
<tr>
<td>CPU, 15</td>
<td>116</td>
</tr>
<tr>
<td>Data, 15</td>
<td>116</td>
</tr>
<tr>
<td>Data processing, 6</td>
<td>116</td>
</tr>
<tr>
<td>Data representation, 22</td>
<td>116</td>
</tr>
<tr>
<td>Dictionary attack, 36</td>
<td>116</td>
</tr>
<tr>
<td>Digital data, 22</td>
<td>116</td>
</tr>
<tr>
<td>Digital divide, 13</td>
<td>116</td>
</tr>
<tr>
<td>Digital revolution, 4</td>
<td>116</td>
</tr>
<tr>
<td>Digitization, 5</td>
<td>116</td>
</tr>
<tr>
<td>Download, 18</td>
<td>116</td>
</tr>
<tr>
<td>EBCDIC, 24</td>
<td>116</td>
</tr>
<tr>
<td>Extended ASCII, 24</td>
<td>116</td>
</tr>
<tr>
<td>File, 15</td>
<td>116</td>
</tr>
<tr>
<td>Gigabit, 26</td>
<td>116</td>
</tr>
<tr>
<td>Gigabyte, 26</td>
<td>116</td>
</tr>
<tr>
<td>Globalization, 12</td>
<td>116</td>
</tr>
<tr>
<td>Identity theft, 36</td>
<td>116</td>
</tr>
<tr>
<td>Input, 15</td>
<td>116</td>
</tr>
<tr>
<td>Instruction cycle, 32</td>
<td>116</td>
</tr>
<tr>
<td>Instruction set, 30</td>
<td>116</td>
</tr>
<tr>
<td>Integrated circuit, 27</td>
<td>116</td>
</tr>
<tr>
<td>Intellectual property, 12</td>
<td>116</td>
</tr>
<tr>
<td>Internet, 8</td>
<td>116</td>
</tr>
<tr>
<td>Interpreter, 30</td>
<td>116</td>
</tr>
<tr>
<td>Keylogger, 37</td>
<td>116</td>
</tr>
<tr>
<td>Kilobit, 26</td>
<td>116</td>
</tr>
<tr>
<td>Kilobyte, 26</td>
<td>116</td>
</tr>
<tr>
<td>Local software, 7</td>
<td>116</td>
</tr>
<tr>
<td>Machine code, 30</td>
<td>116</td>
</tr>
<tr>
<td>Machine language, 30</td>
<td>116</td>
</tr>
<tr>
<td>Mainframe computer, 19</td>
<td>116</td>
</tr>
<tr>
<td>Megabit, 26</td>
<td>116</td>
</tr>
<tr>
<td>Megabyte, 26</td>
<td>116</td>
</tr>
<tr>
<td>Memory, 15</td>
<td>116</td>
</tr>
<tr>
<td>Microcontroller, 20</td>
<td>116</td>
</tr>
<tr>
<td>Microprocessor, 15</td>
<td>116</td>
</tr>
<tr>
<td>Numeric data, 23</td>
<td>116</td>
</tr>
<tr>
<td>Object code, 30</td>
<td>116</td>
</tr>
<tr>
<td>Op code, 31</td>
<td>116</td>
</tr>
<tr>
<td>Open source, 12</td>
<td>116</td>
</tr>
<tr>
<td>Operand, 31</td>
<td>116</td>
</tr>
<tr>
<td>Operating system, 16</td>
<td>116</td>
</tr>
<tr>
<td>Output, 15</td>
<td>116</td>
</tr>
<tr>
<td>Password, 35</td>
<td>116</td>
</tr>
<tr>
<td>Password manager, 40</td>
<td>116</td>
</tr>
<tr>
<td>Personal computer, 17</td>
<td>116</td>
</tr>
<tr>
<td>Personal computing, 7</td>
<td>116</td>
</tr>
<tr>
<td>Phishing, 37</td>
<td>116</td>
</tr>
<tr>
<td>Processing, 15</td>
<td>116</td>
</tr>
<tr>
<td>Programming language, 29</td>
<td>116</td>
</tr>
<tr>
<td>Registers, 31</td>
<td>116</td>
</tr>
<tr>
<td>Semiconducting materials, 27</td>
<td>116</td>
</tr>
<tr>
<td>Server, 18</td>
<td>116</td>
</tr>
<tr>
<td>Sniffing, 37</td>
<td>116</td>
</tr>
<tr>
<td>Social media, 10</td>
<td>116</td>
</tr>
<tr>
<td>Software, 15</td>
<td>116</td>
</tr>
<tr>
<td>Source code, 29</td>
<td>116</td>
</tr>
<tr>
<td>Storage, 15</td>
<td>116</td>
</tr>
<tr>
<td>Stored program, 16</td>
<td>116</td>
</tr>
<tr>
<td>Supercomputer, 19</td>
<td>116</td>
</tr>
<tr>
<td>System board, 28</td>
<td>116</td>
</tr>
<tr>
<td>System software, 16</td>
<td>116</td>
</tr>
<tr>
<td>Unicode, 25</td>
<td>116</td>
</tr>
<tr>
<td>Upload, 18</td>
<td>116</td>
</tr>
<tr>
<td>User ID, 34</td>
<td>116</td>
</tr>
<tr>
<td>Videogame console, 17</td>
<td>116</td>
</tr>
<tr>
<td>Web, 8</td>
<td>116</td>
</tr>
<tr>
<td>Workstation, 18</td>
<td>116</td>
</tr>
</tbody>
</table>
Interactive Summary

To review important concepts from this chapter, fill in the blanks to best complete each sentence. When using the NP2014 interactive eBook, click the Check Answers buttons to automatically score your answers.

SECTION A: The ___________ revolution is an ongoing process of social, political, and economic change brought about by technologies such as computers and networks. The ___________ is a global computer network originally developed as a military project, adapted for research and academic use, and then for commercial use. ___________ , a form of electronic communication, was an application for the masses and finally a reason to buy a computer and join the digital revolution. Another aspect of the digital revolution is ___________ , a process by which several technologies with distinct functionalities evolve to form a single product. Technology has the potential to spread ideas, such as freedom and democracy, but it might have a chilling effect on ___________ , or “the right to be left alone.” It might also affect intellectual ___________ because digital technology has made it easy to produce copies with no loss in quality from the original. Technology-driven ___________ has an effect on the economy, as consumers gain access to products and services from countries other than their own. Activists worry about the digital ___________ that separates people who have access to technology and those who do not.

SECTION B: A(n) ___________ is a multipurpose device that accepts input, processes data, stores data, and produces output according to a series of stored instructions. The data a computer is getting ready to process is temporarily held in ___________. This data is then processed in the central processing ___________. The series of instructions that tells a computer how to carry out processing tasks is referred to as a computer ___________ , which forms the ___________ that sets up a computer to do a specific task. Data is typically stored in a(n) ___________ , which is a named collection of data that exists on a storage medium, such as a hard disk, CD, DVD, Blu-ray disc, or USB flash drive. The idea of a(n) ___________ program means that a series of instructions for a computing task can be loaded into a computer's memory. ___________ software is a set of computer programs that helps a person carry out a task. ___________ software helps the computer system monitor itself in order to function efficiently. For example, a computer ___________ system (OS) is essentially the master controller for all the activities that take place within a computer. Computers can be grouped into categories. A(n) ___________ computer is a type of microcomputer designed to meet the needs of an individual. The term ___________ can refer to an ordinary personal computer that is connected to a network or to a powerful desktop computer designed for high-performance tasks. A(n) ___________ is, at the time of its construction, one of the fastest computers in the world. A(n) ___________ computer is large, expensive, and capable of simultaneously processing data for hundreds or thousands of users. Small, portable digital devices that allow you to install apps can be classified as ___________ computers. A(n) ___________ is a special-purpose microprocessor that can control a device, such as a refrigerator or microwave oven.

CHECK ANSWERS
SECTION C: Data is processed, stored, and transmitted as a series of 1s and 0s. Each 1 or 0 is called a(n) __________. A series of eight 0s and 1s, called a(n) __________, represents one character—a letter, number, or punctuation mark. Data becomes __________ when it is presented in a format that people can understand and use. __________ data consists of numbers that might be used in arithmetic operations. It can be represented digitally using the __________ number system. __________ data is composed of letters, symbols, and numerals that are not used in arithmetic operations. Computers represent this type of data using __________, EBCDIC, or Unicode. Data is quantified using terms such as __________ or kibibyte (1024 bytes), and prefixes, such as __________ or mebi (1,048,576), and giga or __________ (1,073,741,824). The bits that represent data travel as electronic pulses through __________ circuits, sometimes called computer chips. These chips are made from __________ materials and are housed in chip carriers that can be plugged into the __________ board of a digital device.

SECTION D: Software is usually written in high-level languages, such as C, BASIC, COBOL, and Java. The human-readable version of a program, created in a high-level language by a programmer, is called __________ code. A(n) __________ or an interpreter converts this high-level code into __________ code. A microprocessor is hard-wired to perform a limited set of activities, such as addition, subtraction, counting, and comparisons. This collection of preprogrammed activities is called a(n) __________ set. Each instruction begins with a(n) __________ code, which is a command word for an operation such as add, subtract, compare, or jump. Most instructions also include a(n) __________ that specifies the data, or the address of the data, for the operation. The processor’s ALU uses __________ to hold data that is being processed. The processor’s __________ unit fetches each instruction, sends data to the registers, and then signals the ALU to begin processing.

SECTION E: Passwords and user IDs are the most common authentication __________. Password theft has become a serious security problem that has led to many cases of __________ theft, when unauthorized individuals gain access to personal data. Hackers guess, discover, and steal passwords using a variety of techniques. A(n) __________ attack tries passwords from a list of commonly used passwords. A(n) __________ force attack tries every possible combination of letters and numbers. __________ intercepts information sent out over computer networks. __________ uses fraudulent Web sites or e-mail messages to fool unsuspecting readers into entering passwords and other personal information. A(n) __________ is software that secretly records a user’s keystrokes and sends them to a hacker. To keep passwords safe, you should consider using tiered passwords or standalone password __________ software that generates secure passwords and keeps track of which password corresponds to each site you access.
Interactive Situation Questions

Apply what you’ve learned to some typical computing situations. When using the NP2014 interactive eBook, you can type your answers, and then use the Check Answers button to automatically score your responses.

1. Suppose that you walk into an office and see the devices pictured to the right. You would probably assume that they are the screen, keyboard, and mouse for a(n) __________ computer, workstation, or server.

2. You receive an e-mail message asking you to join a circle of friends. You assume that the message was generated in conjunction with an online __________ network, such as Facebook, and if you become a member, you will be able to socialize online.

3. You’re planning a trip to Finland, but when you access the hotel site, the prices are listed in euros. To find the price in U.S. dollars, you access a currency converter from your mobile phone. That’s an example of __________ computing, representative of the fourth phase of the digital revolution.

4. You’re visiting an antique shop and notice a collection of old-fashioned radios. They actually feature a dial for tuning in different radio stations. You immediately recognize this as a(n) __________ device because it deals with an infinite scale of values, rather than discrete values.

5. While attending a meeting at work, you hear one of the executives wondering if “unit code” would be helpful. After a moment of puzzlement, you realize that the executive really meant __________, and that it would allow your company software to be translated into the Cyrillic alphabet used by the Russian language.

6. You have a storage device that offers 2 GB of storage space. It is currently empty. Your friend wants to give you a large digital photo that’s 16 MB. Will it fit on your storage device? ________

7. Your bank is giving customers the choice of using a four-digit PIN or a password that can contain up to ten letters and numbers. The __________ is more secure, so that’s what you decide to use.

8. You need to select a password for your online PayPal account. Which of the following passwords would be the LEAST secure: jeff683, hddtmrutc, gargantuan, fanhotshot, bb#ii22jeffry, or high348? ________

Interactive Practice Tests

Practice tests that consist of ten multiple-choice, true/false, and fill-in-the-blank questions are available in your NP2014 interactive eBook. Test questions are selected at random from a large test bank, so each time you take a test, you’ll receive a different set of questions. Your tests are scored immediately, and you can print study guides that help you find the correct answers for any questions that you missed.
Learning Objectives Checkpoints

Learning Objectives Checkpoints are designed to help you assess whether you have achieved the major learning objectives for this chapter. You can use paper and pencil or word processing software to complete most of the activities.

1. List the four phases of the digital revolution.
2. Define the term convergence and provide examples of at least five devices that are converging.
3. Describe at least two social, political, and economic effects of the digital revolution.
4. Draw a diagram to explain how a computer makes use of input, processing, storage, memory, output, and stored programs.
5. Describe the difference between system software, an operating system, application software, and a computer program.
6. List, briefly describe, and rank (in terms of computing capacity) the characteristics of each computer category described in Section B of this chapter.
7. List three handheld devices that would be classified as personal computers and three that would not be.
8. Define the term microcontroller and provide three examples of devices in which microcontrollers are found.
9. Explain the technical difference between data and information.
10. Provide three examples of digital devices and three examples of analog devices.
11. List the ASCII representation for B and the binary representation for 18; draw a stepped waveform showing a digital sound; and draw a diagram showing how color is represented in a graphic.
12. List and define all the chapter terms, such as bit, byte, and kibibyte, that pertain to quantifying data.
13. Use the terms integrated circuits, microprocessor, and system board in a meaningful sentence.
14. Describe how compilers and interpreters work with high-level programming languages, source code, and object code.
15. Make a storyboard showing how a microprocessor’s ALU would add the numbers 2 and 8.
16. Explain how hackers use dictionary and brute force attacks.
17. Provide examples of five secure passwords and five passwords that might be easy to crack.

Study Tip: Make sure you can use your own words to correctly answer each of the purple focus questions that appear throughout the chapter.

Concept Map

Fill in the blanks to show that you understand the relationships between programming concepts presented in the chapter.

Programmers

a. ____________

use

Programming

b. ____________

to create

c. ____________

converted by

Interpreter

d. ____________
to create

e. ____________

set

Op

f. ____________

contains

g. ____________

j. ____________

unit

h. ____________

processes

i. ____________

holds data in

ALU

check answers

Copyright 2013 Cengage Learning. All Rights Reserved. May not be copied, scanned, or duplicated, in whole or in part. Due to electronic rights, some third party content may be suppressed from the eBook and/or eChapter(s).
Editorial review has deemed that any suppressed content does not materially affect the overall learning experience. Cengage Learning reserves the right to remove additional content at any time if subsequent rights restrictions require it.