

**8** 1800–1900

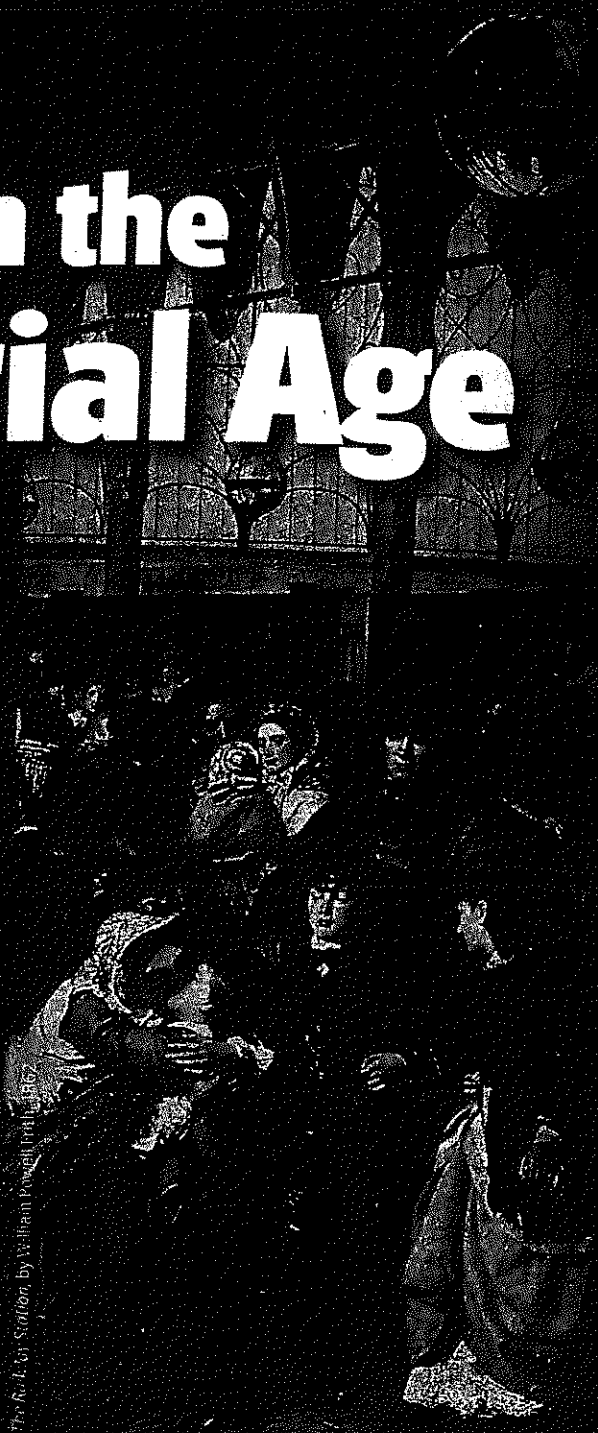
# Life in the Industrial Age

**THE BIG PICTURE**

During the 1700s and 1800s, the Industrial Revolution changed practically everything about the world of work. Many of the changes were technological advances. As the rate of advances increased, many other aspects of daily life besides work were also transformed.

**Theme SCIENCE AND TECHNOLOGY**

Changes in science and technology accelerated rapidly during the 1800s. One discovery or invention led to another. The process repeated over and over, until practically every aspect of human experience was affected.



**TIME LINE**

**CHAPTER EVENTS**

**1803**  
John Dalton develops modern atomic theory.

**1817**  
Beethoven begins composing his Ninth Symphony.

**1837**  
Samuel Morse invents the telegraph.

**1849**  
Steamship service around South America begins.

**WORLD EVENTS**

**1813**  
Mexico declares its independence from Spain.

**1816**  
Shaka Zulu founds the Zulu Empire in southern Africa.

**1850** The Taiping Rebellion, which claims 20 million lives, begins in China.

**1851**  
India's first railroad is built.

# Advances in Technology

## BEFORE YOU READ

### MAIN IDEA

The technological breakthroughs of the Industrial Age included advances in electric power, transportation, and communication.

### READING FOCUS

1. How did electric power affect industry and daily life?
2. What advances in transportation occurred during the Industrial Age?
3. What were the advances in communication, and how were they achieved?

### KEY TERMS AND PEOPLE

Michael Faraday  
 Thomas Edison  
 Bessemer process  
 Henry Ford  
 Wilbur and Orville Wright  
 telegraph  
 Samuel Morse  
 Alexander Graham Bell  
 Guglielmo Marconi

### TAKING NOTES

Use a graphic organizer like the one below to take notes on key technological advances of the Industrial Age.



### INSIDE TRY

**What new technology wowed the world in 1900?** As visitors approached the gates to the Paris Exhibition of 1900,

they wondered what was lighting up the night sky so brilliantly. Many had heard about a new technology that was an improvement over the oil and gas lighting they currently used in their homes. But what they saw was not just a spectacular display of electricity. Multicolored lights lit up an enormous steel and glass building. None of the 10 million people who visited the fair had ever before seen such a display of electric power. Few could imagine how electricity would transform their lives.

**The lights of the Palace of Electricity turned part of the fair into a fantasy land.**

## LIGHTS FANTASTIC



## Electric Power

Before the late 1880s water, coal, and steam had powered industry. As the Industrial Age progressed, though, inventors and scientists were inspired to develop new technologies. One technology drastically changed industry and daily life more than any other—electricity.

**Early Attempts at Electric Power** For many centuries, scientists had known of and been interested in electricity. During the 1700s Benjamin Franklin and other scientists had performed important experiments. Still, no one had developed a way to harness electricity and put it to use. In 1831, however, English chemist **Michael Faraday** discovered the connection between magnetism and electricity. His discovery led to the dynamo, a machine that generated electricity by moving a magnet through a coil of copper wire. Faraday used the electricity to power an electric motor, and his discoveries led to the development of electrical generators.

During the 1800s other scientists also created devices that used electric power. For instance, in 1860 British chemist Joseph Swan developed a primitive electric lightbulb that gave off light by passing heat through a small strip of paper. However, Swan's lightbulb did not shine for very long, and its light was too dim. Swan's work was a beginning, but it was nearly 40 more years before the invention of a usable lightbulb.

### FACES OF HISTORY

## Thomas Edison

1847–1931



Thomas Edison, one of the world's most brilliant inventors, came from a humble background. He had only a few months of formal

schooling. After working as a newsboy, Edison became a telegraph operator, where he got involved in electronic communication. In fact, improvements in the telegraph system were among his first inventions. Eventually, Edison held more than 1,090 patents for new inventions. His goal was to make things that could succeed on the market and, by doing so, prove their usefulness. He also believed in hard work, as he explained in this famous quote. "Genius is one percent inspiration and ninety-nine percent perspiration."

**Draw Conclusions** Do you think Edison saw himself as a genius? Why or why not?

**Edison's Lightbulb** Based on the work of Michael Faraday and Swan, **Thomas Edison** invented the first usable and practical lightbulb. The new invention caused a sensation.

### HISTORY'S VOICES

“Edison's electric light, incredible as it may be, is produced from a tiny strip of paper that would blow away. Through this little strip of paper is passed an electric current, and the result is a bright, beautiful light . . . and this light, the inventor claims, can be produced cheaper than the cheapest oil.”

—Marshall Fox, *New York Herald*

This invention did not come easily to Edison. Instead, it came through trial and error and many hours of work in his laboratory in Menlo Park, New Jersey. As Edison's fame became known, young people who shared his passion for inventing flocked to his laboratory for him. In addition to the lightbulb, Edison and his team made generators, motors, sockets, and other electrical devices.

Edison also played a major role in the development of city electrical utility systems. He built the world's first electric power plant in New York City. The plant produced enough power to light up city blocks. As a result of Edison's work, many aspects of life became easier.

### Effects on Industry and Daily Life

The wide availability of electric power transformed industry in both the United States and Europe. Electric power improved industry in three significant ways. First, by using electric power, factories no longer had to rely on steam engines to power machines. Second, factories did not have to depend on water to power the steam engines. Third, production increased as factories became independent of sunlight. With electricity in factories, workers could stay on the job into the night.

In addition to changing industry, electricity transformed daily life. Before people had electricity, they lit their homes with gaslights, or oil lamps. Electricity provided a cheaper, more convenient light source. Inventors soon created other electrical devices that made daily life more convenient.

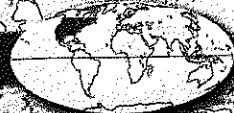
**READING CHECK Analyze** How did electricity change industry and daily life?

## RAILROADS, 1870

International boundary

## RAILROADS, 1850

0 200 Miles  
0 200 Kilometers



ATLANTIC OCEAN

0 200 400 Miles  
0 200 400 Kilometers  
Albers equal-area projection

GEOGRAPHY  
SKILLS

INTERPRETING MAPS

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Interactive Maps  
Keyword: SHL LIF

- 1. Regions** Where did railroads expand rapidly?
- 2. Human-Environment Interaction** How do you think the railroad to San Francisco affected population growth and economic development?

## Advances in Transportation

Due to power technology, the late 1800s saw major improvements in transportation. The development of efficient steam engines led to the invention of steamships, while the internal combustion engine led to cars and airplanes.

**Steam-Powered Trains** Throughout the 1800s, steam boats on canals and rivers provided the best means for long-distance travel. With the development of efficient steam engines, trains began to replace boats. Trains could carry heavy loads, did not require water, and traveled faster than watercraft. By 1825, the world's first rail line linked two major cities, Manchester and Liverpool. By 1860, 30,000 miles of railroad tracks crisscrossed the eastern United States.

Advancements in steel production contributed to the expansion of the railroad system. A new process made steel stronger and was also more efficient. Working separately, Englishman Henry Bessemer and American

the late 1850s. The **Bessemer process** involved forcing air through molten metal to burn out carbon and other impurities that make metal brittle. The process came to be named for Bessemer because he made it a financial success.

Using the Bessemer process, factories increased their production of locomotives and railroad tracks. In addition, engineers used the stronger steel to build bridges that allowed the trains to cross any type of terrain.

As the new steel-making process made building railroads easier, they expanded rapidly. By 1860 a 30,000-mile network of tracks linked the major American cities. West of the Mississippi River, new railroads brought people to unsettled or thinly settled areas of the country. As a result, cities in the American West grew and prospered along the tracks.

Engineers also took railroad technology around the world. India's first train ran in 1851. Just one year later, the first African railroad was built in Egypt. Construction on the world's longest railroad, the Trans-Siberian in Russia, began in 1891.



The rapid expansion of the railroad helped both travel and trade. As a result, markets for goods increased. Because trains could move huge loads efficiently, transportation costs declined, bringing a wide range of low-cost products to market. In addition, new products became available. Shoppers had more food choices. Perishable foods could get to market before they spoiled. For example, merchants in the United States shipped frozen beef by rail from the west to the east.

**THE IMPACT TODAY**

The auto industry continues its technological innovations. For example, in 2002 the Ford Motor Company began production of a car that runs on fuel cells powered by hydrogen. Water is the only emission.

**Steamships** Just as trains revolutionized land transportation, steamships changed ocean travel. Sailing ships depended on wind for power, but steamships could travel through any kind of weather.

In 1849 regular U.S. steamship service began, traveling from the west coast, around South America, to the east coast. Within a few years, engineers had made mechanical improvements to steamships. By 1870, long-distance movement of goods by steamship was economically viable. People also came on board. A long ocean voyage became an option for people looking for jobs or for fun.

**The Automobile** As early as 1769 Europeans had tried to build a form of personal transportation. For more than a century only small advances were made. Finally, German engineers Carl Benz and Gottlieb Daimler both developed practical automobiles. In 1885 Benz built a three-wheeled car. A year later, Daimler put an internal combustion engine on a horse carriage. Daimler also developed the carburetor, which mixed fuel for proper combustion in the engine.

At about the same time, several Americans developed their own automobile models. Early cars were too expensive for most people, but **Henry Ford** wanted to change that. As he announced, "I will build a motor car for the great multitude." He did it. Using mass production methods in modern factories, Ford created a line of affordable cars called the Model T.

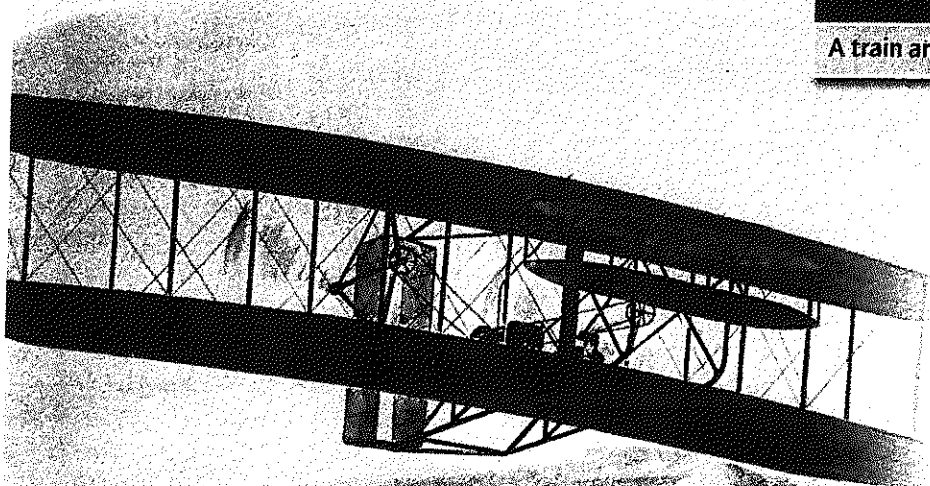
By 1920 the Model T made up 40 percent of U.S. automobile production. As cars became more common, Americans gained a new freedom. They allowed them to travel anywhere at any time. Road builders had to keep up. By 1920 American roads spanned more miles than rail lines.

**New Ways to Travel**

New modes of transportation revolutionized travel in the 1800s and early 1900s. One of the new ways to travel was introduced by Orville and Wilbur Wright, pictured below, when they flew their airplane at Kitty Hawk, North Carolina, in 1903.



A train arriving in a New Mexico station.



Model T Fords in a St. Louis park.

## Telephone Technology

Alexander Graham Bell and his team made the first telephone in 1876. Improvements were made in rural areas and small towns, but they were often behind the cities in technical progress.

At the time, only 50 years ago, telephones still required the help of a person. To place a call, a person would dial the receiver, and an operator would say, "Number, please." The caller would dial a series of numbers. The operator would make the connection, the receiver would ring, and the call was made.

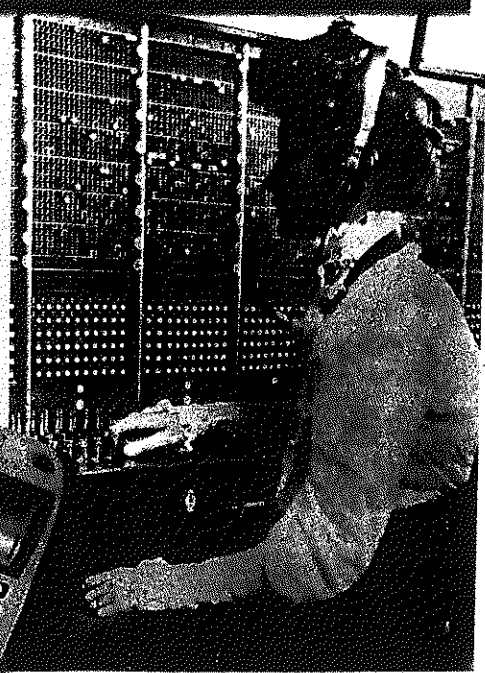
Early telephone operators were women who had experience as telegraph operators. But customers complained

that the boys were rude to them. In 1878 the telephone companies began hiring women operators. Emma Nutt, a Boston woman, was the first one hired.

Today, of course, we can talk, send instant messages, surf the Internet, and take photos on our phones—without any help.

**Analyze** How would your daily life be different if you did not have access to advanced telephone technology?

A modern cell phone ►



An operator connects two callers on a switchboard in about 1900.

**Plane** Advances in transportation were limited to land and sea. People also began to fly. Hot air balloons made their first flight in 1783 and became useful for wartime reconnaissance and aerial photography. However, balloons were at the mercy of the wind.

A big step forward in controlled flight was taken at Kitty Hawk, North Carolina, on December 17, 1903. On that date, American brothers **Wright and Orville Wright** succeeded in making a powered airplane in sustained flight.

Building from the work of earlier aviation pioneers, the Wrights had spent four years studying their lightweight airplane. They applied principles of aerodynamics, which is the study of forces act on solid surfaces moving through the air. The Wrights designed a specially shaped wings. To power the plane, they attached a version of the internal combustion engine. The first powered airplane was only 120 feet, but the plane's performance improved rapidly. This first flight paved the way for the use of airplanes to travel the world, transport goods, and fight wars.

**Identifying Cause and Effect** What did advances in transportation technology lead to?

## Advances in Communication

Today, news and messages travel around the world in mere seconds by e-mail and telephone. In the early 1800s, though, news traveled much more slowly, by boat or by messenger on foot, horseback, or carriage. As a result, entrepreneurs and inventors started to look for better and faster ways to communicate.

**The Telegraph** Putting electricity to use made possible the invention of the **telegraph**, a machine that sent messages instantly over wires. American **Samuel Morse** is credited with inventing the telegraph in 1837. Morse also developed a "language," which became known as Morse code, for sending telegraph messages. Morse code is a series of long and short signals that represent letters and numbers. These telegraph messages were transmitted as electrical pulses of different lengths.

In 1844 Morse received funding from the United States government to lay 35 miles of telegraph wires between Washington, D.C., and Baltimore, Maryland. The first telegraph message Morse tapped out was, "What hath God wrought?" With this message, a new era in communication technology began.

As the United States grew, the importance of the telegraph increased. By 1851 more than 50 telegraph companies were in operation in the United States. About 10 years later, telegraph wires strung on poles along established railroad tracks linked much of the country. At railroad stations, passengers could send messages, or telegrams, to friends and family.

Communication between the United States and Europe also improved with the laying of a telegraph cable on the floor of the Atlantic Ocean in 1866. By 1870 telegraph wires stretched from England to India.

The telegraph revolutionized more than personal communication. In many countries, businesses could keep in close contact with suppliers and markets. News traveled around the world in hours instead of weeks. Newspapers sent correspondents to the front lines of wars, from where they telegraphed back vivid reports of victories and defeats. The reading public was very impressed by these timely reports. The reports were one way in which the telegraph globalized communication.

**The Telephone** As use of the telegraph spread around the world, inventors tried to improve on it. American **Alexander Graham Bell**, a teacher of hearing-impaired students, was one of the scientists working in sound technology. Bell tried to create a way to send multiple telegraph messages at the same time.

While working on that device, Bell made a remarkable discovery. One day in 1875 he was in one room and his assistant Thomas Watson was in another. Bell said, "Mr. Watson, come here, I want to see you!" Watson could hear Bell's voice not just through the air but through the device's receiver. The telephone was born.

During the 1880s demand for telephones increased. Telephone companies laid thousands of miles of phone lines across the United States. By 1900 almost 1.5 million telephones were installed in American homes and businesses.

**The Radio and Phonograph** While the telephone revolutionized communication, the technology was limited. Wires could only stretch so far. A new wireless technology was based on theories about electromagnetic waves. In 1895 Italian physicist **Guglielmo Marconi** used the discoveries to build the first wireless telegraph, or radio. First used as a communication method for ships, the radio was later used for entertainment and news. Entertainment options increased when Thomas Edison recorded sound with one of his many inventions. It was the phonograph, which became the record player. With these inventions, recorded sound was available to everyone.

**READING CHECK Contrast** How did the phonograph differ from the telephone?

## SECTION 1 ASSESSMENT

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Online Quiz

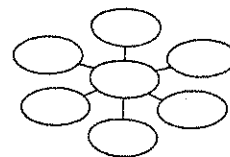
Keyword: SHE

### Reviewing Ideas, Terms, and People

- Recall** What did Michael Faraday invent?
  - Draw Conclusions** What impact did electricity have on industry?
  - Evaluate** Assess the validity of this statement: **Thomas Edison** contributed to all aspects of electrical technology.
- Define** What is the **Bessemer process**?
  - Explain** What advantages did rail travel have over canal and river travel?
  - Develop** What advantages did the automobile provide?
- Define** What is the **telegraph**?
  - Analyze** How did advances in communication technology change the way people lived in the late 1800s?
  - Evaluate** Do you think the telegraph, telephone, radio, and phonograph could have had both positive and negative effects on daily life in the late 1800s? Explain your answer.

### Critical Thinking

- Identify Supporting Details** Use your notes and this organizer like this one to record details that support the main idea about one type of technological advance. Write the subsection's main idea in the center circle.



### FOCUS ON WRITING

- Narrative** Write a paragraph that tells the story of the advances in technology during the 1800s. Include details from this section.

# Focus on Themes

## Science Technology

Human interaction with electricity has a long history. In ancient times, people were probably awed by lightning. In 300 BC a Greek scholar noticed that rubbing a piece of amber produced a spark. More than 1,000 years later a German physicist made a machine that generated static electricity. Then in 1831 Michael Faraday saw the connection between magnetism and electricity, and a new technology was born. Today, electricity has changed practically every aspect of daily life in industrialized countries.

**BEFORE ELECTRICITY** Before the development of electricity, people depended on several sources of power to meet their needs. They burned candles and oil for light. To drive machines, they used the power of wind, water, coal, and steam. For other needs, people depended on themselves and each other. For entertainment, audiences attended live performances. To communicate long distances, they used messengers. Today, it is hard for us to imagine what life was like before the widespread use of electricity.

◀ **THEN** This lightbulb is a replica of the one invented by Thomas Edison in 1879.

The Granger Collection, New York



▲ **NOW** This NASA image shows where artificial lights shine from the earth at night. The composite of satellite images took a year to complete.

**AFTER ELECTRICITY** What aspect of daily life has not been transformed by electricity? Think about how electricity makes your daily routine possible, starting with the alarm clock that wakes you in the morning. Drying your hair, cooking breakfast, checking the weather on the Internet before you decide what to wear—electricity makes it all possible. Throughout your whole day, from lighted classrooms and the computer lab to instant messages on your cell phone and late-night TV talk shows, electricity powers your modern lifestyle.

There is a price to pay for all this convenience. Much of the world's electricity is generated by burning fossil fuels, which pollute air around the world. As a result, even people who live where electricity is not available are affected by its use. Another type of pollution is the result of so much light. In big cities, people cannot see the stars because the lights are so bright. To avoid this light pollution, astronomers must build their telescopes in remote locations or send them into space. Still, there are probably few among us who would want to go back to the "dark" ages.

### Skills FOCUS

### UNDERSTANDING THEMES

- 1. Contrast** How would your daily life be different if you did not have electricity?
- 2. Support a Position** Would you give up some conveniences to reduce the burning of fossil fuels? Explain your answer.



# Scientific and Medical Achievements

## BEFORE YOU READ

### MAIN IDEA

Advances in science, medicine, and the social sciences led to new theories about the natural world and human mind, an improved quality of life, and longer life spans.

### READING FOCUS

1. What were some of the new ideas in the sciences?
2. What medical breakthroughs affected the quality of life?
3. What new ideas developed within the social sciences?

### KEY TERMS AND PEOPLE

Charles Darwin  
Marie and Pierre Curie  
radioactivity  
Albert Einstein  
Louis Pasteur  
pasteurization  
anesthetic  
Ivan Pavlov  
Sigmund Freud

### TAKING NOTES

organize  
record new  
sciences  
the social

Sciences	
Medicine	
Social Sciences	

## Tracking a Killer

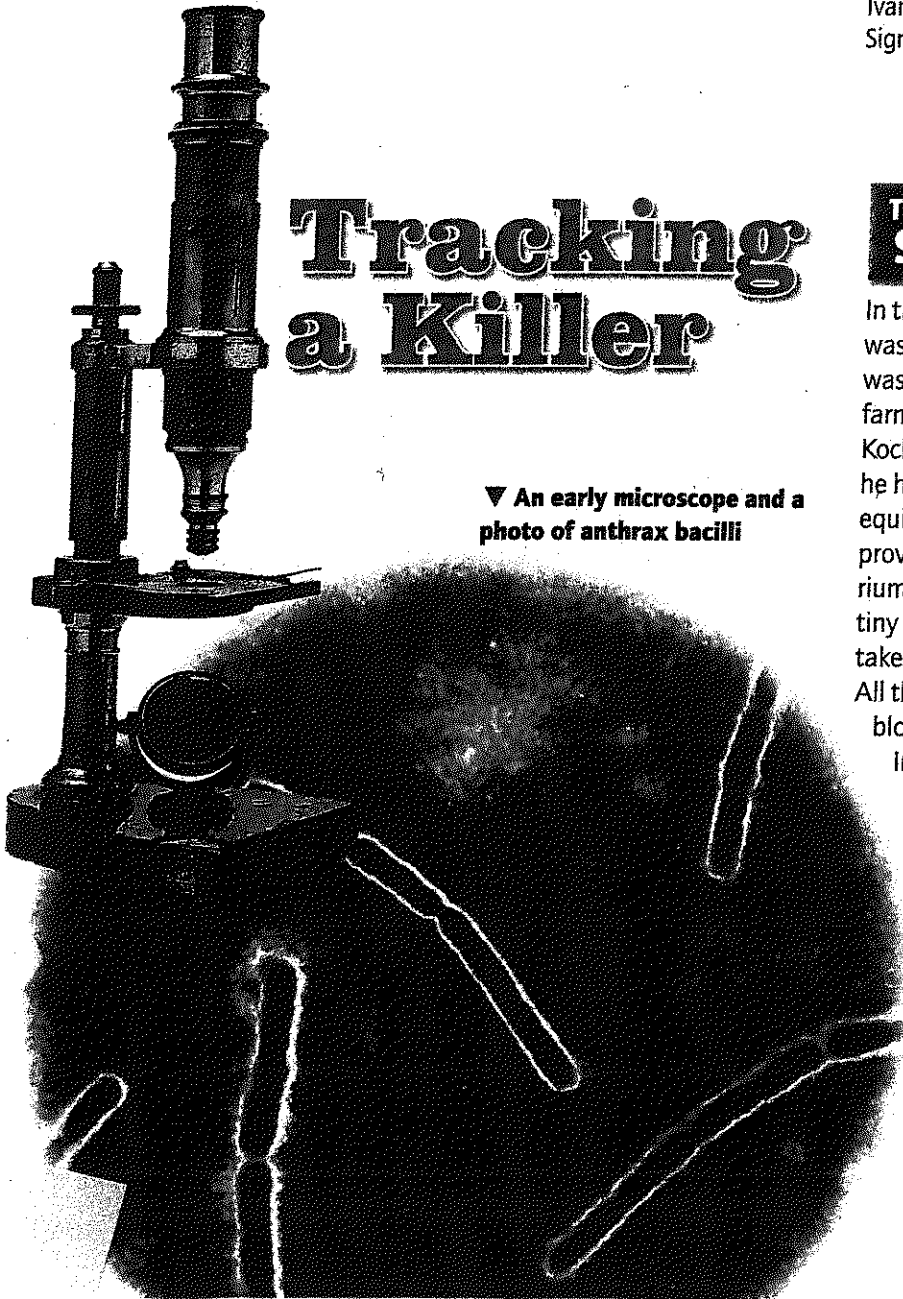
▼ An early microscope and a photo of anthrax bacilli

### THE INSIDE STORY

*How did a poorly equipped country doctor make his discoveries about disease?*

In the 1870s a military doctor named Robert Koch was stationed in the German countryside. The area was plagued by anthrax, a disease that killed off farm animals and could be transmitted to people. Koch wanted to learn more about the disease, but he had no library, no assistants, and practically no equipment besides a microscope. He first had to prove that a previously discovered bacillus of germs did indeed cause anthrax. To do so, Koch used tiny wood slivers to inject mice with anthrax bacteria taken from the blood of animals killed by the disease. All the mice died. Then he injected other mice with blood from healthy animals, and they all survived. In this way, Koch proved that anthrax was indeed transmitted by the blood of infected animals.

Koch went on to discover that the anthrax bacillus produced seedlike bodies called spores that could spread the disease. He also made additional discoveries that led to treatments for malaria, tuberculosis, and other diseases. Koch's discoveries are just a few of the countless scientific advances made during the 1800s. ■



## Scientist's Report on Island Animals

**Primary Sources** During his long voyage on the HMS *Beagle*, Charles Darwin made observations on practically every island he visited and experienced. In the passage below, he describes the iguanas and birds of the Galapagos Islands, which lie in the Pacific Ocean about 600 miles west of South America. As you read, think about how a report from Darwin differs from a present-day scientific report about the same islands. Consider:

- Darwin's background
- Darwin's knowledge at the time
- Darwin's scientific observation

Darwin's comments about the birds' behavior indicate that few if any people had ever visited the islands.

These islands appear paradises for the whole family of Reptiles . . . The black Lava rocks on the beach are frequented by large (2–3 ft) most disgusting, clumsy Lizards. They are as black as the porous rocks over which they crawl & seek their prey from the Sea. Somebody calls them "imps of darkness." They assuredly will become the land they inhabit . . . The birds are Strangers to Man & think him as innocent as their countrymen the huge Tortoises. Little birds within 3 & four feet, quietly hopped about the Bushes & were not frightened.

—Charles Darwin's *Beagle Diary*, 1835

### Skills FOCUS

### READING LIKE A HISTORIAN

1. **Author** What does the passage reveal about Darwin's previous experiences? about knowledge at the time?
2. **Details** What details demonstrate Darwin's skills of scientific observation?

See *Skills Handbook*, p. H25

## Science Ideas in Science

Many of the many new ideas of the 1800s were developed by a young geologist named Charles Darwin. He had taken a long voyage on which he studied variations among plants and animals. Many years later, Darwin published his theories in a book titled *On the Origin of Species*.

**Darwin's Theories** Through careful observation of what he saw on his journey, Darwin developed the concept of natural selection. According to this theory, creatures that are well adapted to their environments have a better chance of surviving to produce offspring. The offspring will inherit the physical features that the creatures survive. Over time, Darwin believed the species will evolve, or change to increase their survival chances. This idea became the theory of evolution.

Darwin's theory was controversial, however. Many indicated that human beings were descended from other animals. Many people thought this possibility was simply ridiculous. Some opposed Darwin because his theory differed from the creation story in the Bible.

## Advances in Chemistry and Physics

In the early 1800s chemists and physicists also made landmark discoveries. For centuries, scientists had proposed that tiny particles, or atoms, made up chemical elements. Moreover, most scientists thought that all elements were made of the same kinds of atoms. But in 1803 English chemist John Dalton developed modern atomic theory. An essential part of this theory is the idea that atoms of different elements are themselves of different size and mass.

In 1871 Russian chemist Dmitri Mendeleev arranged all the chemical elements into a chart called the periodic table. The table revealed previously unknown patterns among the elements. Mendeleev left gaps in the periodic table, knowing that some elements were yet to be discovered. He even described what those elements would be like.

As Mendeleev had predicted, scientists that came after him discovered more elements that fit into the periodic table. For example, in France in 1898 chemists **Marie and Pierre Curie** discovered polonium and radium. The Curies also concluded that certain elements release energy when they break down. Marie Curie called this process **radioactivity**.

### ACADEMIC VOCABULARY

**theories** plausible general principles offered to explain what has been observed

Other scientists developed theories based on the Curies' work. In 1911 British chemist Ernest Rutherford realized that in the center of an atom lay a core called a nucleus. In addition, he found that the nucleus is made up of positively charged particles, which he called protons. These findings disproved the long-held belief that an atom is a solid piece of matter.

**Einstein's Genius** In 1905 German-Jewish scientist **Albert Einstein** revolutionized physics. In an early work, Einstein used mathematics to show that light can act not only as a wave, but also like tiny particles of energy. In another paper, Einstein developed the special theory of relativity, based on two crucial ideas. One was that no particle of matter can move faster than the speed of light. The other is that motion can be measured only from the viewpoint of a particular observer. Therefore, scientists cannot speak of absolute motion, space, or time.

Among Einstein's ideas was a now-famous formula:  $E = mc^2$ . The formula means that a small amount of mass can be converted into a huge amount of energy. Einstein also proposed that space itself is curved and that one must include time in the study of space. These theories overturned what Sir Isaac Newton and many scientists who came after Newton had said about how the universe worked.

**READING CHECK** Summarize What new theories revolutionized science?

### THE IMPACT TODAY

Pasteurization technology is still improving. With ultra-high-temperature (UHT) pasteurization, milk is heated to above the boiling point for one or two seconds. If in a sterile container, UHT milk can be stored without refrigeration for months.

## FACES OF HISTORY

### Marie CURIE

1867–1934



Marie Curie's accomplishments went beyond her discoveries related to radioactivity. At a girls' school, she introduced the idea of

teaching science through experiments. Curie was the first woman to teach at the Sorbonne, the oldest university in Paris. She also helped stockpile rare and valuable radioactive minerals for use in health care and further research.

Curie shared the Nobel Prize for Physics in 1903 with her husband and another physicist. Then in 1911, she received the Nobel Prize for chemistry on her own. Although Curie's work was brilliant, it was ultimately fatal. She died from leukemia caused by exposure to radiation.

**Draw Conclusions** Why do you think Marie Curie is respected and revered by workers in many health care professions?

## Medical Breakthroughs

During the late 1800s breakthroughs in medicine occurred as a result of the advances made earlier in the century. Mental concepts of disease, medical sanitation were revealed.

**Preventing Disease** For thousands of years, people had been mystified by disease. Part of the mystery was solved in 1870 when French chemist Louis Pasteur showed the link between microbes and disease. He also disproved a concept called spontaneous generation—the idea that bacteria or other tiny animals could spring from nonliving matter. Instead, Pasteur showed that bacteria are always present in the air, although we cannot see them, and react like other living things.

Pasteur also discovered that bacteria present in the air cause fermentation, the process that makes grape juice turn into wine and milk turn sour. By heating liquids and foods to high temperatures, Pasteur killed the bacteria and prevented fermentation. His process is now known as **pasteurization**. The process destroys bacteria that cause disease. The most milk, cheese, and juice on our grocery shelves has been sterilized, or made germ-free, through pasteurization.

Pasteur next targeted a deadly disease that was a constant threat to people and their livestock—anthrax. To prevent anthrax, Pasteur injected animals with a vaccine containing weakened anthrax germs, which prevented the animals from getting sick. His vaccine worked because the body builds up substances called antibodies to fight weakened germs when they enter the body.

Preventing rabies was Pasteur's next goal. He developed a vaccine in 1885 and saved the life of a young boy who had been bitten by a rabid dog. Pasteur's fame was secured.

**Improving Medical Care** Other medical practices improved also. One was the management of pain. Surgery patients suffered terribly. American surgeon Crawford Long discovered a solution. Long had his patients breathe in a gas called ether. It was called **anesthetic**, a drug that reduces pain. Large doses makes the patient unconscious.





## NEW IDEAS, ADVANCEMENTS AND DEVELOPMENTS IN THE SCIENCES

QUICK FACTS

<b>New Ideas in Science</b>	Natural selection and evolution Modern atomic theory Mendeleyev's periodic table Radioactivity Atomic nucleus Theory of relativity
<b>Advancements in Medicine</b>	Pasteurization and vaccination Anesthetics Antiseptics Modern hospitals More training for nurses and doctors
<b>Developments in the Social Sciences</b>	Pavlov's theories of conditioned response Freud's theories of the unconscious Scientific approach to archaeology Anthropology Sociology

**Other Social Sciences** Just as scientists study individual organisms, other scientists study individuals, other scientists study individuals, other scientists study individuals as members of groups. These scientists are interested in societies, or communities of people who share a common culture.

One field that received much attention was archaeology, the study of the past through artifacts. Archaeology was not an entirely new field of study. Many early archaeological expeditions, however, had been little more than treasure hunts. Then, starting in the mid-19th century, archaeologists started to take a more scientific approach to their investigations. They meticulously recorded all stages of their work and made their finds for education, not just for profit.

As more evidence of the human past was unearthed, anthropology became a recognized discipline. Anthropology is the study of humanity and human ancestors. Many anthropologists are interested in how *Homo sapiens* developed as a species over time. In the 1920s cultural anthropology, which deals with the structures of societies, became a separate field. In general, cultural anthropologists study cultures other than their own.

Closely related to anthropology is sociology, which emerged as a social science in the mid-1800s. Sociologists also study people in groups. More often, though, the groups are in modern societies. As part of their work, sociologists examine societies' institutions and structures, such as those organized around racial or ethnic identity, gender, or age.

**READING CHECK** Draw Conclusions How do new ideas contribute to the social sciences?

Studies of human behavior continued with the work of Austrian-Jewish physician **Sigmund Freud** (FROYD). Freud argued that an unconscious part of the mind contains thoughts of which one is unaware. Hypnotism was one of the techniques Freud used to explore the unconscious with his patients. He wrote his first paper on hypnotism in 1893. Freud also encouraged patients to tell him about their dreams. He felt that repressed thoughts revealed in dreams could cause mental illness. Freud called his method of therapy psychoanalysis.

### READING SKILLS

#### Identifying Stated Main Ideas

Which sentence states the main idea of this paragraph? How do details contribute to the main idea?

## SECTION 2 ASSESSMENT

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Online Quiz

Keyword: SHU LIP 1P

### Reviewing Ideas, Terms, and People

- a. Define** What are theories?

**b. Explain** What did Albert Einstein say about the connection between space and time?

**c. Evaluate** Why would later discoveries in physics and chemistry depend on Dalton's conclusion?
- a. Describe** How does pasteurization affect bacteria?

**b. Draw Conclusions** How do you think people's opinion of surgery changed after the development of anesthetics?
- a. Describe** How did Sigmund Freud contribute to the field of psychology?

**b. Identify Cause and Effect** What effect did Ivan Pavlov's study of dog behavior have on the study of human behavior?

### Critical Thinking

- Infer** Using your notes and a chart like this one, record the effects of key scientific advances.

Advance	Effects

### FOCUS ON WRITING

- Persuasive** Imagine you are a scientist in the late 19th century working on cures for diseases. Write a letter to a U.S. senator asking for help with funding for your research. Explain how you think your research will benefit society.

# Daily Life in the Late 1800s

## BEFORE YOU READ

### MAIN IDEA

During the late 1800s, cities grew and changed, while education, leisure time activities, and the arts reflected those changing times.

### READING FOCUS

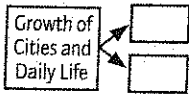
1. How did cities grow and change in the late 1800s?
2. What developments affected education, leisure, and the arts?

### KEY TERMS AND PEOPLE

urbanization  
 romanticism  
 William Wordsworth  
 Ludwig van Beethoven  
 realism  
 Charles Dickens  
 Leo Tolstoy  
 Henrik Ibsen  
 impressionism

### TAKING NOTES

Take notes on the ways in which cities and daily life changed. Add more boxes as needed.



### INSIDE STORY

**How did a new garment and a new sport give women more freedom?** In 1850 American social

reformer Amelia Jenks Bloomer wore a startling new outfit. Instead of the floor-length skirt that most women wore, Bloomer had on long, baggy pants that showed her short skirt. Although she did not invent this outfit, called bloomers, she helped popularize it. By the 1890s the term "bloomers" referred to a different part of the outfit—short, baggy pants worn with long stockings. Women often wore bloomers for a new

sport—bicycling. With clothing that allowed freedom of movement and with the availability of bicycles that were light and safe, thousands of women in Europe and the United States began cycling through city streets and parks. Cycling gave women the freedom to leave their homes alone and travel long distances. Although some people claimed that bike riding might be harmful to women's health because of "the organic weakness of women," riding bikes was fun and provided women with a new form of exercise. Women did give up floor-length skirts, but they did not give up their bikes. ■

## BIKES AND BLOOMERS



In this illustration, women and men enjoy bicycling along the seashore in Belgium.

\*Interactive

## HISTORY CLOSE-UP

Like many cities of the late 1800s New York was a busy, crowded place. To make city life more pleasant and convenient, the age's new technologies were put to use.

## Cities Grow and Change

New activities like reading by electric light and riding bicycles were signs of the changes that occurred during the Industrial Age. Throughout the 1800s, much of Europe and the United States experienced rapid urbanization and growth in the proportion of people living in towns and cities. Not only did cities grow, they underwent a transformation.

Skills  
Focus

### INTERPRETING VISUALS

- 1. Compare and Contrast** Which of the improvements shown were also made in the area where you live?
- 2. Draw Conclusions** How would the technological advances shown have affected the life of a city's residents?

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Interactive

Keyword: cities

The first elevated trains ran on steam, but they were later converted to electricity.

Streetlights were first used on Broadway. Within a few years, streetlights were common. As a result, after dark the city was safer and more lively.

In 1884 the legislature required that utility lines be placed underground.

## Industrial City

Before the Industrial Revolution, most cities existed to serve trade, military, or religious functions. The industrial city, in contrast, did more. In the industrial city raw materials had to be sent to factories, new products manufactured in factories, and the products distributed to markets. To meet these functions, industrial cities needed factories, a large workforce, a transportation network, warehouses, and offices.

Some of the first cities to have all these supports for industry was Lowell, Massachusetts. The start of Lowell's growth was its textile industry, which employed young women from the surrounding countryside and newcomers from Europe.

Other industries besides textiles fueled the growth of cities. Meat-packing was one of several industries that lured workers to Chicago. As a result, Chicago's population grew from 40,000 in 1850 to 1.7 million in 1900. Another city is Pittsburgh, Pennsylvania, where the steel industry attracted workers.

Industrial cities were lively, fast-growing places. For example, in growing cities there was a constant stream of pedestrians com-

peted with electric streetcars and horse-drawn carriages for space on the streets. Merchants advertised their wares by shouting out prices from their doorways. Construction crews produced a constant sound of hammering as they built new banks, office buildings, and homes for the growing population.

With high population density, the health of many city residents suffered. One of the hazards was smoky air from the coal that was burned to run steam engines and to warm homes. London had a special problem with smoke that combined with the fog that is common in damp climates. The word *smog* was coined to describe the thick, choking, lung-burning result. In 1873 a smog episode caused 268 deaths. An 1879 episode lasted for four long months.

**Migration to Cities** Despite the cities' unhealthy conditions, people kept arriving during the late 1800s. They wanted not just jobs, but also to escape hunger, political oppression, or discrimination.

Just as the goals of the new city residents differed, so did their origins. Some people came to the cities from the countryside. Boatloads of people, though, left their own countries behind and went to cities in a different country. Many Europeans sailed to Latin America, Australia, and other places. But the United States drew the most people.

Between 1870 and 1900, about 12 million people immigrated to the United States. Many came from Ireland, England, Germany, Italy, Russia, and China. In 1890, 42 percent of New Yorkers were foreign-born. Immigrants poured into other major U.S. cities, including Boston, Chicago, and San Francisco, where the newcomers gradually created their own unique communities.

When they first arrived, though, most of the immigrants lived in miserable, crowded conditions. Journalist and photographer Jacob Riis described what he saw in New York's dismal apartment buildings, or tenements.

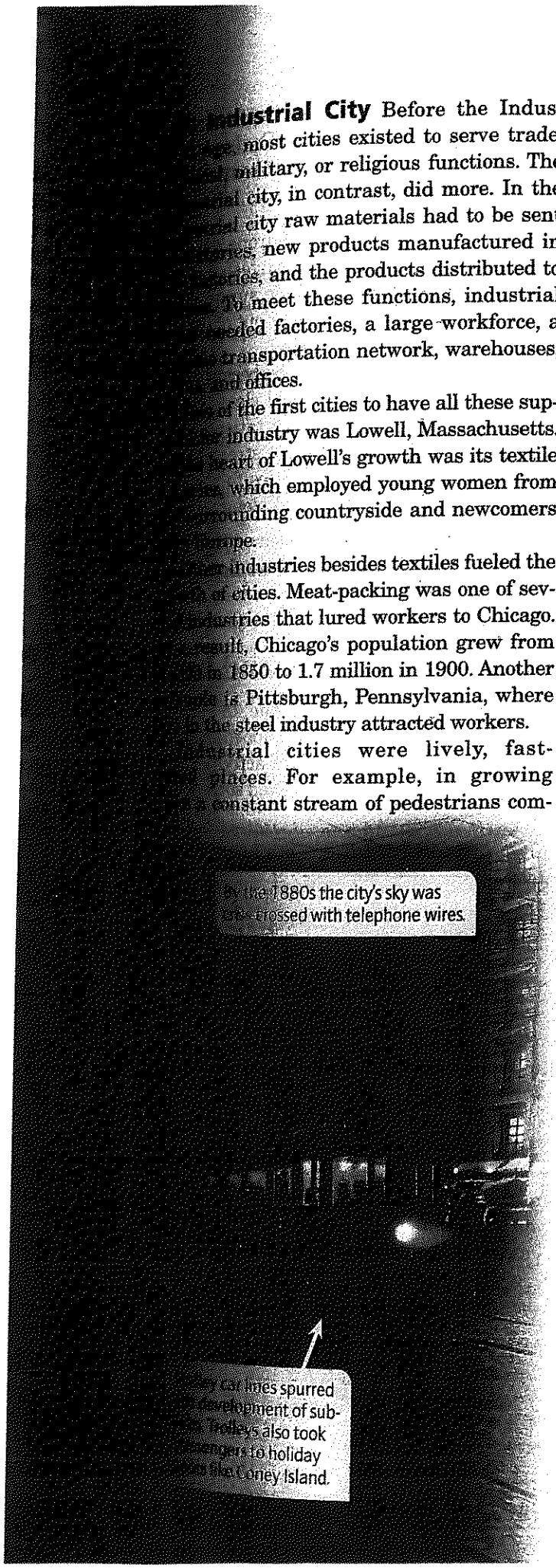
### HISTORY'S VOICES

“Bedrooms in tenements were dark closets, utterly without ventilation. There couldn't be any. The houses were built like huge square boxes, covering nearly the whole of the lot. Some light came in at the ends, but the middle was always black.”

—Jacob Riis, *The Battle with the Slum*, 1902

### ACADEMIC VOCABULARY

**immigrate** to move to another country to live



In the 1880s the city's sky was crisscrossed with telephone wires.

As streetcar lines spurred the development of suburbs, trolley lines also took commuters to holiday spots like Coney Island.



**The Livable City** Eventually, reforms eased the squalid conditions. Improvements were made in cities' infrastructure. For example, cities modernized their water and sewer systems. These improvements also extended to the home. Better plumbing allowed more families to have clean drinking water, toilets, and bathtubs. Sanitation and overall health improved, as a result.

Electricity also made homemaking more convenient. In the early 1900s appliances such as vacuum cleaners, refrigerators, and electric stoves became available.

With more people moving to the cities, working and living space became scarce. Constructing taller buildings was one solution. In 1883 architect William Le Baron Jenney designed the first multistory steel-framed building, or skyscraper, in Chicago. It was 10 stories tall. Four years later, the high-speed elevator was perfected. Skyscrapers could get taller still.

Growing populations caused congestion on city streets. Underground railway systems, or subways, helped relieve the crowding. In 1863 London opened the world's first subway line. Other cities followed. For example, the city of Budapest, Hungary, opened its subway in 1896. The original purpose of this subway was so residents could get to a city park easily.

As cities spread out, city planners made an effort to preserve green spaces within the city. In the 1860s Napoleon III created parks in

Paris to give working people places for recreation. In the United States, Frederick Law Olmsted designed city parks that were accessible to all residents.

**The Suburbs** As cities in Europe and the United States became more congested, boundaries expanded to include surrounding areas. As a result, people moved out of cities to new areas called suburbs.

People moved to the suburbs because they were less crowded, quieter, and cleaner than the central city. Public transportation in the suburbs grew. In the early 1800s streetcars and ferry transportation linked cities to the suburbs. Later, suburbs developed along railroads and bus lines.

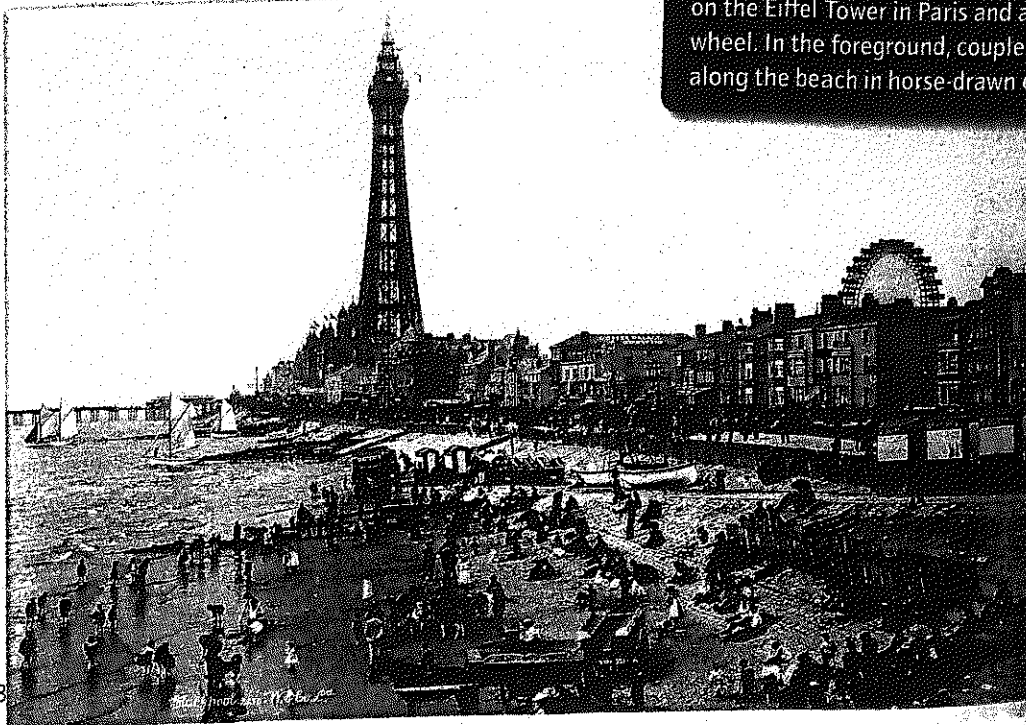
**READING CHECK** Identify Cause and Effect  
Why did people migrate to cities?

## Education, Leisure, and Arts

With the growth of cities in the 1800s, educational opportunities developed. In addition, new sports, other leisure activities, and changes in the arts world affected society.

### A Day at the Beach

Blackpool, in northwestern England, offered working families a holiday. In the background, the photo shows an observation tower similar to the Eiffel Tower in Paris and a giant Ferris wheel. In the foreground, couples enjoy a walk along the beach in horse-drawn carts.



**Education and Information** During the increased industrialization created a more educated workforce. Factories and managers who could read and write and with technical skills. Armed forces and military leaders wanted officers who knew about the wider world. Because they became more involved in politics they supported public education as a way to develop patriotic citizens.

In 1870 governments in western Europe and the United States passed laws requiring education for all children. Many countries had only elementary education. Even some governments funded education through high school.

All social classes were educated equally, but most children of the lower classes went to school only as long as the law required. Many of them quit school to go to work. The establishment of vocational and training schools gave some members of the working class more opportunities. In Tuskegee, Alabama, in 1881, Booker T. Washington founded a private school for African Americans to be teachers.

Education for lower classes lagged behind, so did education for girls. Although industrialized countries guaranteed basic education, some countries did not ensure that girls go beyond elementary school. Even in countries that provided basic education for girls, few girls in high schools took science and math classes that could lead directly to careers in the industrialized world. Because few colleges allowed women as students, educators who thought women should have more opportunities began to open colleges just for women.

With a more educated populace, more people began printing newspapers. The new papers expanded their coverage from current events to the arts and sciences. Lively stories published in weekly installments kept readers coming back to follow the adventures of fictional characters. Political cartoons provided fun at public figures. Because newspapers usually held specific viewpoints, readers often chose a newspaper that agreed with their own political or religious stance. In France, some French papers supported the monarchy while others supported a republican government.

**QUICK FACTS**

## INCREASE IN LEISURE ACTIVITIES

### CAUSES

- Higher incomes, more free time
- Public transportation to recreational areas
- Public funding of cultural activities

### EFFECTS

- Time for sports: soccer, rugby, football, baseball
- More people enjoying vacation spots and resorts
- More opportunities to hear music, enjoy art

New technology, including the linotype machine and the electric press, improved newspaper printing processes. Reporting of foreign affairs improved when the telegraph made up-to-date coverage possible. Foreign correspondence was just one area within a growing profession—journalism.

**Leisure Time** As leisure time increased, people had more time to play and watch sports. In Britain, football—known as soccer in the United States—became more popular. Rugby and American football were also developed. Baseball became a popular pastime for troops during the American Civil War and grew quickly as an amateur and professional sport. With the growth of railroads, sports fans could travel to see their favorite teams play.

In fact, railroads allowed more families to enjoy a range of activities. For example, in Britain in the mid-1800s, working-class families could take the train to vacation spots. Seaside resorts such as Blackpool provided entertainment, relaxation, and fresh air.

Cultural activities, too, became available to more people. Before the 1800s musicians usually performed in private homes or at religious services. During the 1800s, though, city governments began building new concert halls and theaters and supporting more orchestras, bands, and choral groups. With public funding, ticket prices were within the budget of more audience members.

### READING SKILLS

#### Identifying Stated Main Ideas

**Idea** In the first paragraph about leisure time, what indicates that the first sentence contains the main idea?

Just as performances moved from private homes to new spaces, so did art. Museums such as the Louvre (LOOV) in Paris made great works of art available to all. Public libraries also opened their doors. For example, the reading room of London's British Museum opened, making its huge collection of books accessible to scholars.

**Changes in the Arts** With all the discoveries, inventions, and new ideas of the 1800s, it is no wonder that the world of the arts underwent change as well. Artists, writers, and musicians developed new styles in response to what was going on around them.

A literary and artistic development of the early 1800s was called **romanticism**. With an emphasis on intuition and feeling, the romantic movement was a reaction to Enlightenment rationalism and the early abuses of the Industrial Revolution. Major characteristics of the movement were love of nature, deep emotions, value of the individual, affection for the past, and the importance of the imagination. Political revolutions that swept through Europe in the 1800s released a spirit of liberty and equality that were also common in works of the romantic era.

Poet **William Wordsworth** expressed the romantic spirit in his definition of poetry as "the spontaneous overflow of powerful feelings from emotions recollected in tranquility." In music, nature inspired composers such as German **Ludwig van Beethoven**, who also celebrated human freedom in his work. Among

many great romantic painters was French painter **Theodore Gericault** (zhay-REE-KOH). He painted scenes of suffering heroes caught the public attention. **William Blake**, an English poet and writer, painted scenes of mystical beauty.

In the mid-1800s, a movement called **realism** developed in reaction to romanticism. The realist movement revealed the details of everyday life, no matter how unpleasant. For example, in his novel *Hard Times* English writer **Charles Dickens** wrote about the struggles of London's poor. That novel also described pollution, exploitation, and miseries caused by industrialization. In the novel *War and Peace* Russian writer **Leo Tolstoy** showed that war was chaotic and horrible. Norwegian playwright **Henrik Ibsen** broke new ground in *A Doll's House*. The play revealed the unfair treatment of women within families.

Painters also turned to realism as a reaction against romanticism. Instead of painting imaginary or emotional scenes, they painted ordinary working people as they really were. Many realist paintings show people of the lower classes as possessing quiet dignity.

Later in the century, beginning in the 1860s, a group of French painters introduced a new way of looking at the world. They started a movement that came to be called **impressionism**. These artists wanted to capture an impression of a scene using light, vivid color, and movement rather than just showing its realistic details.

**READING CHECK** Find the Main Idea How did the arts reflect how people viewed the world in the 1800s?

**THE IMPACT TODAY**

Original impressionist paintings are still immensely popular—and expensive. For example, in 1990 a painting by Auguste Renoir sold for more than \$78 million.

**SECTION 3 ASSESSMENT**

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Online Quiz

Keyword: SHL LIFE

**Reviewing Ideas, Terms, and People**

1. **a. Describe** What were industrialized cities of the 1800s like?
  - b. Explain** How did technological innovations help make cities more livable?
  - c. Evaluate** Do you think the industrialized cities were better places to live than the countryside in the late 1800s? Why or why not?
2. **a. Identify** What literary style did **William Wordsworth** follow? What style did **Charles Dickens** follow?
  - b. Contrast** How did **realism** differ from **romanticism**?
  - c. Elaborate** How might increased educational opportunities have benefited society in general in the 1800s?

**Critical Thinking**

3. **Identifying Cause and Effect** Copy the chart below and your notes to describe causes and effects of urbanization.

Causes of Urbanization	Effects of Urbanization

**FOCUS ON WRITING**

4. **Persuasive** Imagine that you live in a big city in the 1800s. Write a letter to the editor of your local newspaper arguing for or against the development of suburbs.

# Impressionism

**What?** Several painters caused a sensation in the art world in the 1860s. They were rebelling against the tradition of art promoted by France's official art academy, the Academy of Fine Arts. The Academy wanted the subject matter to be clear and the painting method to be precise. The rebel painters, who shared a style of painting called impressionism, were more concerned about the effects of shadows and light, the use of color, and the suggestion of movement. They tried to capture these effects by painting outdoors, rather than in a studio. They wanted to show an "impression" of a scene rather than an exact record of it, and they experimented with different kinds of brushstrokes to achieve that effect. Although impressionism was controversial when it first appeared, it has become one of the best-loved artistic styles of all time.

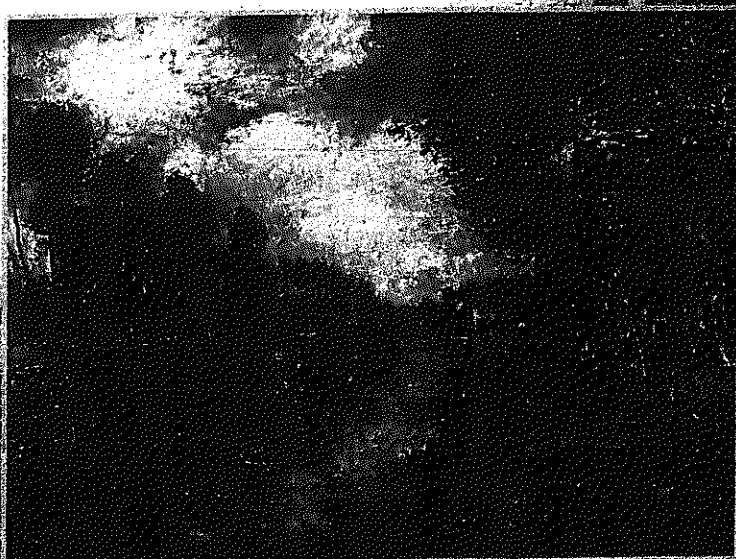
**Why important?** Impressionism helped artists and the general public see the world in new ways. This new style freed artists to paint as they wished, not as they were told.

**Characteristics:**  
 Impressionist painters focused on  
 everyday life and ordinary people  
 in outdoor settings  
 the effects of weather, and atmosphere  
 and visible brushstrokes



*Young Girl Lying in the Grass, by Auguste Renoir*

The scene in this painting by Auguste Renoir is dappled with light and shade, and the outline of the figure is blurry. The combination of these techniques gives the impression of a warm, hazy, summer day.



*Banks of the Loing River, by Alfred Sisley, 1885*

Claude Monet painted many views of water lilies. The play of light on water was a favorite subject of the impressionist painters.

**Skills Focus** INTERPRETING VISUALS

- 1. Summarize** How did the impressionists' style vary from the style that the Academy approved?
- 2. Predict** How do you think the impressionists' rebellion affected other artists over time?



## Artistic Responses to the Industrial Age

**Historical Context** These four documents show examples of two major artistic movements of the Industrial Age—romanticism and realism.

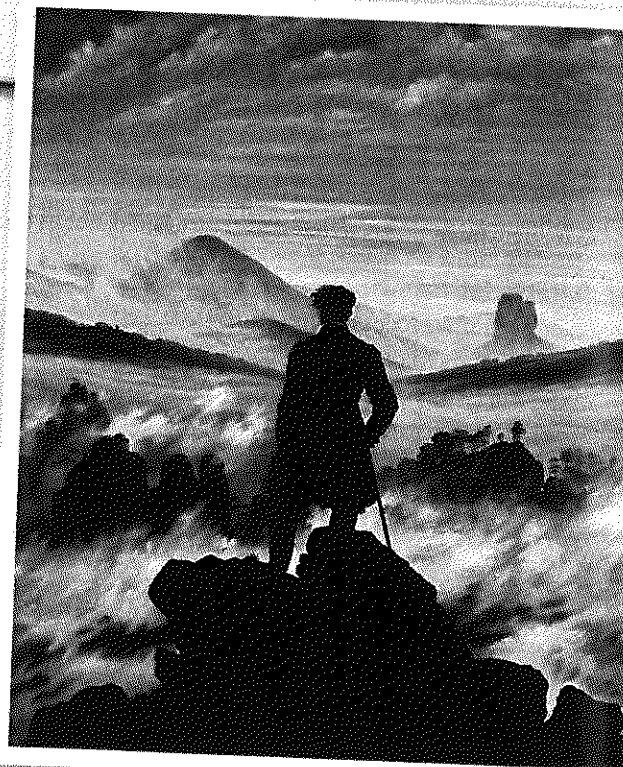
**Task** Study the selections and answer the questions that follow. After you have studied the documents, you will be asked to write an essay analyzing why writers and artists responded to the Industrial Age in various ways.

### DOCUMENT 1

#### A German Painter's View

Caspar David Friedrich was one of Germany's foremost artists in the early 1800s. The painting shown is one of his most famous. But Friedrich did not just paint. He also wrote about painting. On the issue of subject matter, Friedrich had this to say:

The artist should paint not only what he sees before him, but also what he sees within him. If, however, he sees nothing within him, then he should also refrain from painting that which he sees before him.



### DOCUMENT 2

#### A Medieval Tale

Sir Walter Scott wrote several novels set during the Middle Ages. One of the most famous, *Ivanhoe*, was published in 1819. It relates the adventures of bold knights, fair ladies, and wicked nobles. In the passage here, the author describes the scene as a tournament, or contest between knights, begins.

The trumpets had no sooner given the signal, than the champions vanished from their posts with the speed of lightning, and closed in the centre of the lists with the shock of a thunderbolt. The lances burst into shivers up to the very grasp, and it seemed at the moment that both knights had fallen, for the shock had made each horse recoil backward upon its haunches. The address of the riders recovered their steeds by use of the bridle and spur; and having glared on each other for an instant with eyes which seemed to flash fire through the bars of their visors, each . . . received a fresh lance from the attendants.

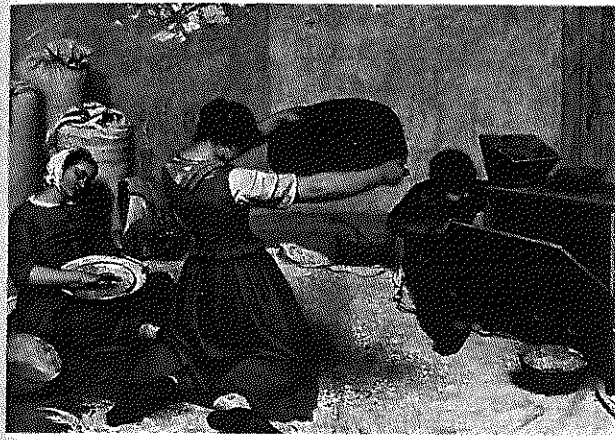
## DOCUMENT 3

### A French Painter's View

Gustave Courbet (kooor-BAY) painted common people he saw in the French countryside. The painting here is titled *Girls Sifting Corn*. Like Friedrich, Courbet had something to say about an artist's subject matter:

"An *abstract* object, invisible or nonexistent, does not belong to the domain of painting."

"Show me an angel and I'll paint one."



Girls Sifting Corn by Gustave Courbet, 1855

## DOCUMENT 4

### A Norwegian Playwright's View

Henrik Ibsen's 1883 play *An Enemy of the People* focuses on Dr. Stockman, a man who has found that his town's public baths are badly polluted. He feels that people should be alerted to the danger. However, because the baths are a major source of income, the townspeople agree that Dr. Stockman must be silenced. In fact, they insist that he be declared "an enemy of the people." In this excerpt, Stockman defends himself at a public meeting and attacks the townspeople's way of thinking.

No, it's ignorance and poverty and ugliness in life that do the devil's work! In a house that isn't aired and swept every day—my wife Katherine maintains that the floors ought to be scrubbed as well, but that's debatable—anyway—I say in a house like that, within two or three years, people lose all power for moral thought and action. Lack of oxygen dulls the conscience. And there must be a woeful dearth of oxygen in the houses of this town, it seems, if the entire solid majority can numb their consciences enough to want to build this town's prosperity on a quagmire [swamp] of duplicity and lies.

## Skills Focus

### READING LIKE A HISTORIAN

#### DOCUMENT 1

- Explain** To which movement did Friedrich belong? What elements in the painting provide clues?
- Infer** What connections can you make between the quote from Friedrich and the scene in the painting?

#### DOCUMENT 2

- Categorize** How does Scott's choice of words show that he wrote within the romantic movement?
- Develop** How might a realist writer have described the scene? Provide examples to illustrate your answer.

#### DOCUMENT 3

- Explain** How does Courbet's choice of subject matter indicate the movement he helped found? How does the style of painting indicate the movement?
- Compare and Contrast** How do Courbet's statements about subject matter compare to Friedrich's statements?

#### DOCUMENT 4

- Identify** According to Dr. Stockman, what does "the devil's work"?
- Support a Position** Defend or dispute this statement: "Ibsen probably thought that the new middle class was too pleased with its own success." Support your argument.

### DOCUMENT-BASED ESSAY QUESTION

The Industrial Revolution and the Industrial Age affected both individuals and societies. Recall what you have learned about the many positive and negative effects. Write an essay in which you discuss the results of industrialization and later changes and how writers and authors responded to those results. Discuss what drove or inspired them to respond as they did.

See *Skills Handbook*, pp. H25–H26

## VISUAL STUDY GUIDE

## New Ideas of the Industrial Age

## Technology

- Faraday and electrical power
- Swan, Edison, and the lightbulb
- Bessemer process
- Expansion of railroads
- Steamships
- Benz, Daimler, Ford, and cars
- Wright Brothers and the airplane
- Morse and the telegraph
- Bell and the telephone
- Marconi and the radio
- Edison and the phonograph

Science and  
Medicine

- Darwin and evolution
- Dalton and atomic theory
- Mendeleyev and periodic table
- Curies and radioactivity
- Einstein's theories
- Pasteur's fight against disease
- Anesthetics and antiseptics
- Pavlov, Freud, and the mind
- Advances in archaeology
- Anthropology and sociology

## Daily Life

- Growth of industrial cities
- Migration to cities
- Improvements in utilities
- Skyscrapers, subways, parks
- Growth of suburbs
- More education and newspapers
- Sports, other uses of leisure time
- Public museums and libraries
- Romanticism
- Realism
- Impressionism

## Key Events of the Industrial Age

- 1803** ■ John Dalton develops modern atomic theory.
- 1830** ■ Railroad links Manchester and Liverpool.
- 1831** ■ Michael Faraday discovers connection between magnetism and electricity.
- 1835** ■ Charles Darwin's *Beagle* diary describes discoveries made about animals on voyage.
- 1842** ■ Crawford W. Long performs surgery using ether as anesthetic.
- 1844** ■ Samuel Morse sends telegram.
- 1871** ■ Dmitri Mendeleyev's periodic table reveals patterns among elements.
- 1873** ■ London smog kills 268 people.
- 1876** ■ Bell and Watson invent the telephone.
- 1881** ■ Booker T. Washington opens school.
- 1883** ■ First skyscraper is built in Chicago.
- 1885** ■ Carl Benz builds three-wheeled vehicle.  
■ Pasteur develops vaccine against rabies.
- 1891** ■ Trans-Siberian Railroad construction starts.
- 1893** ■ Sigmund Freud publishes first paper on use of hypnotism.
- 1898** ■ Curies discover polonium and radium.
- 1900** ■ Paris Exhibition displays power of electricity.
- 1903** ■ Wright Brothers fly at Kitty Hawk.
- 1908** ■ Henry Ford announces the Model T.

## Review Key Terms and People

Identify the correct term or person from the chapter that best fits each of the following descriptions.

1. invented the telegraph and a code for sending messages by telegraph
2. great German composer of the romantic movement
3. a drug that dulls pain
4. Italian who invented the radio
5. French scientist who used his knowledge of germs to develop vaccines against anthrax and rabies
6. scientist who died because of her research with radioactivity
7. scientist whose new theories about the universe disagreed with those of Sir Isaac Newton
8. artistic style that used light, movement, outdoor settings, and ordinary people as subject matter
9. to take up residence in a new country