

Innovations in Chemistry During the same period, chemists created hundreds of new products, from medicines such as aspirin to perfumes and soaps. Newly developed chemical fertilizers played a key role in increasing food production.

In 1866, the Swedish chemist **Alfred Nobel** invented dynamite, an explosive much safer than others used at the time. It was widely used in construction and, to Nobel's dismay, in warfare. Dynamite earned Nobel a huge fortune, which he willed to fund the famous Nobel prizes that are still awarded today.

Electricity Replaces Steam Power In the late 1800s, a new power source—electricity—replaced steam as the dominant source of industrial power. Scientists like Benjamin Franklin had tinkered with electricity a century earlier. The Italian scientist Alessandro Volta developed the first battery around 1800. Later, the English chemist **Michael Faraday** created the first simple electric motor and the first **dynamo**, a machine that generates electricity. Today, all electrical generators and transformers work on the principle of Faraday's dynamo.

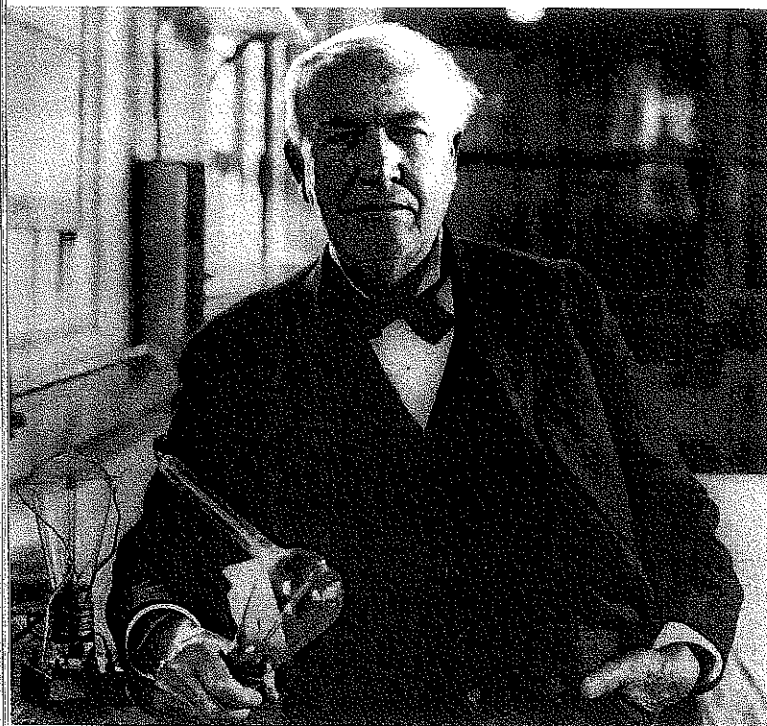
In the 1870s, the American inventor **Thomas Edison** made the first electric light bulb. Soon, Edison's "incandescent lamps" illuminated whole cities. The pace of city life quickened, and factories could continue

to operate after dark. By the 1890s, cables carried electrical power from dynamos to factories.

Improved Methods of Production The basic features of the factory system remained the same during the 1800s. Factories still used large numbers of workers and power-driven machines to mass-produce goods. To improve efficiency, however, manufacturers designed products with **interchangeable parts**, identical components that could be used in place of one another. Interchangeable parts simplified both the assembly and repair of products. By the early 1900s, manufacturers had introduced another new method of production, the **assembly line**.

Workers on an assembly line add parts to a product that moves along a belt from one work station to the next. A different person performs each task along the assembly line. While not all factories used assembly lines, the factory system always relied on the division of labor. Each worker was assigned one task, such as putting the sole on a shoe or sewing a collar on a shirt. Once that task was done, the worker handed the product to the next person, who then performed his or her task. Interchangeable parts, the division of labor, and the assembly line all made production more efficient. They also lowered the price of factory goods, making them affordable to more people.

2 IDENTIFY CAUSE AND EFFECT How did the assembly line and division of labor affect manufacturing?



>> After inventing the light bulb, Thomas Edison supervised the building of the first electric power system in New York City.

Advances in Transportation and Communication

During the second Industrial Revolution, transportation and communications were transformed by technology. Steamships replaced sailing ships, and railroad building took off. In Europe and North America, rail lines connected inland cities and seaports, mining regions, and industrial centers. In the United States, a transcontinental railroad provided rail service from the Atlantic to the Pacific. In the same way, Russians built the Trans-Siberian Railroad, linking Moscow in European Russia to Vladivostok on the Pacific. Railroad tunnels and bridges crossed the Alps in Europe and the Andes in South America. Passengers and goods rode on rails in India, China, Egypt, and South Africa.

The Age of the Automobile The transportation revolution took a new turn when a German engineer, Nikolaus Otto, invented a gasoline-powered internal combustion engine. In 1886, Karl Benz received a

patent for the first automobile, which had three wheels. A year later, Gottlieb Daimler (DYM lur) introduced the first four-wheeled automobile. People laughed at the "horseless carriages," but they quickly changed the way people traveled.

The French nosed out the Germans as early automakers. Then the American Henry Ford started making models that reached the breathtaking speed of 25 miles per hour. In the early 1900s, Ford began using the assembly line to mass-produce cars, making the United States a leader in the automobile industry.

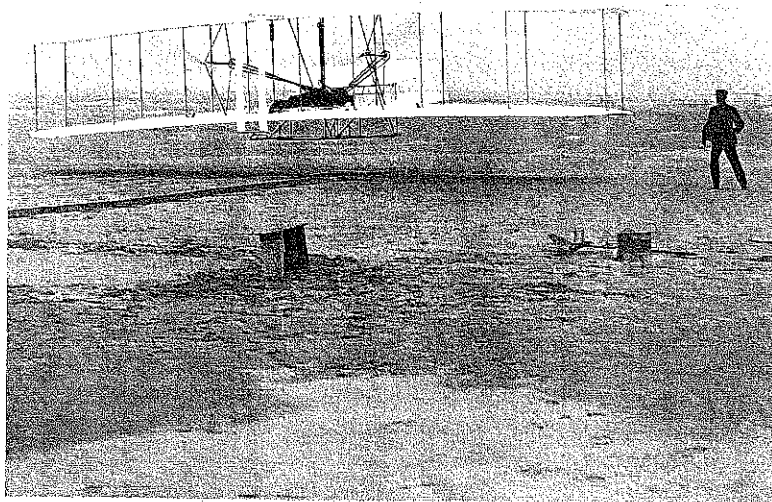
The First Airplane The invention of the internal combustion engine changed life and industry in other ways. Motorized threshers and reapers boosted farm production. Even more dramatically, the internal combustion engine made possible sustained, pilot-controlled flight. In 1903, American bicycle makers **Orville and Wilbur Wright** designed and flew a flimsy airplane at Kitty Hawk, North Carolina. Although their flying machine stayed aloft for only a few seconds, it ushered in the air age.

Soon, daredevil pilots were flying airplanes across the English Channel and over the Alps. Commercial passenger travel, however, would not begin until the 1920s.

A Communications Revolution A revolution in communications also made the world smaller. An American inventor, Samuel F. B. Morse, developed the telegraph, which could send coded messages over wires by means of electricity. His first telegraph line went into service between Washington, D.C., and Baltimore in 1844. By the 1860s, an undersea cable was relaying messages between Europe and North America. This trans-Atlantic cable was an amazing engineering accomplishment for its day.

Communication soon became even faster. In 1876, the Scottish-born American inventor Alexander Graham Bell patented the telephone. By the 1890s, the Italian pioneer **Guglielmo Marconi** had invented the radio, which allowed wireless communication over long distances. In 1901, Marconi received a radio message, using Morse code, sent from Britain to Canada. As Marconi had predicted, radio soon became a key part of a global communications network that linked every corner of the world.

2 IDENTIFY CAUSE AND EFFECT How did Nikolaus Otto's invention of the internal combustion engine affect the Industrial Revolution? What can you infer about its impact on Western nations?



>> In 1903, Orville and Wilbur Wright tested their flying machine at Kitty Hawk, North Carolina. By 1905, they had built an airplane that could stay in the air for 39 minutes.

Interactive Timeline

The Rise of Big Business

By the late 1800s, what we call "big business" came to dominate industry. Big business refers to an establishment that is run by entrepreneurs who finance, manufacture, and distribute goods or services on a large scale. As time passed, some big businesses came to control entire industries.

Investors Form Corporations The latest technologies required the investment of large amounts of money, or capital. To get the needed capital, owners sold **stock**, or shares in their companies, to investors. Each stockholder became owner of a tiny part of a company. Large-scale companies, such as steel foundries, needed so much capital that they sold hundreds of thousands of shares. These businesses formed giant **corporations**, businesses that are owned by many investors who buy shares of stock. With large amounts of capital, corporations could expand into many areas.

Monopolies Dominate Industry Some powerful business leaders created monopolies and trusts, huge corporate structures that controlled entire industries or areas of the economy. In Germany, Alfred Krupp inherited a steelmaking business from his father. He

bought up coal and iron mines along with the supply lines that carried raw materials to feed the steel business. Later, he and his son acquired plants that made tools, railroad cars, and weapons.

In the United States, John D. Rockefeller dominated the petroleum industry by gaining control of oil wells, oil refineries, and oil pipelines. Andrew Carnegie, who started out as a poor immigrant from Scotland, worked his way up to build an American steel empire. He later used his wealth to fund libraries, universities, and other charities.

Sometimes, a group of corporations would join forces and form a **cartel**, an association to fix prices, set production quotas, or control markets. In Germany, a single cartel fixed prices for 170 coal mines.

Opposing Views of Big Business The rise of big business sparked a stormy debate. Admirers saw the Krupps, Rockefellers, and Carnegies as "captains of industry" and praised their vision and skills. They pointed out that capitalists invested their wealth in worldwide ventures, such as railroad building, that employed thousands of workers and added to the general prosperity. They also claimed that monopolies

increased efficiency by driving out less efficient corporations.

To critics, the aggressive magnates were "robber barons" who ruthlessly destroyed competing companies in pursuit of profit. With the competition gone, they were free to raise prices. Destroying competition, critics argued, damaged the free-enterprise system. Reformers called for laws to prevent monopolies and regulate large corporations. By the early 1900s, some governments did move against monopolies. However, the political and economic power of business leaders often hindered efforts at regulation.

DRAW CONCLUSIONS Why was there a move toward developing monopolies?

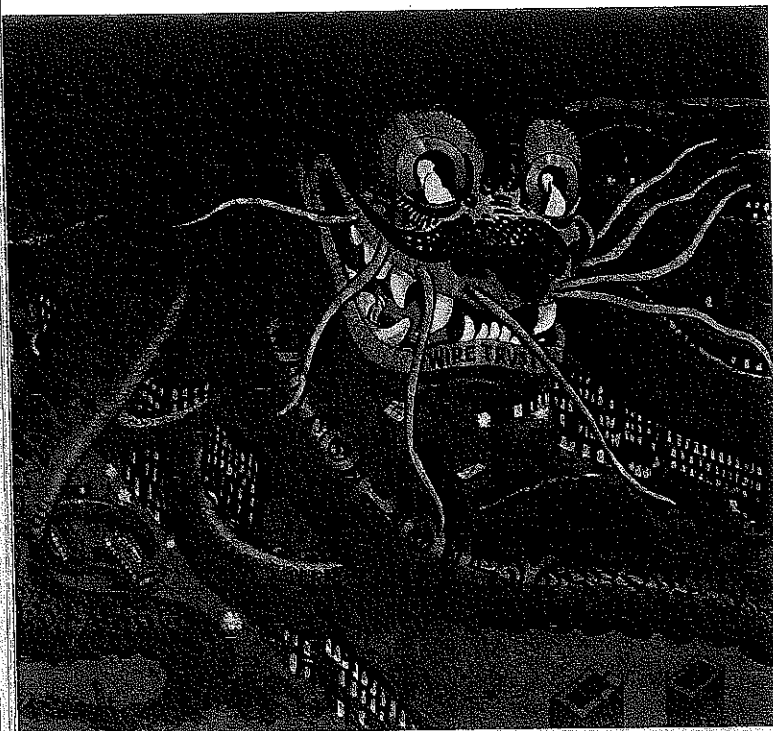
Better Medicine, Nutrition, and Health

The population explosion that had begun during the 1700s continued through the 1800s. Between 1800 and 1900, the population of Europe more than doubled. This rapid growth was not due to larger families. In fact, families in most industrializing countries had fewer children. Instead, populations soared because the death rate fell. Nutrition improved, thanks in part to improved methods of farming, food storage, and distribution. Medical advances and improvements in public sanitation also slowed death rates.

Combating Disease Since the 1600s, scientists had known of microscopic organisms, or microbes. Some scientists speculated that certain microbes might cause specific infectious diseases. Yet most doctors scoffed at this **germ theory**. Not until 1870 did French chemist **Louis Pasteur** (pas TUR) clearly show the link between microbes and disease. Pasteur went on to make other major contributions to medicine, including the development of vaccines against rabies and anthrax. He also discovered a process called pasteurization that killed disease-carrying microbes in milk.

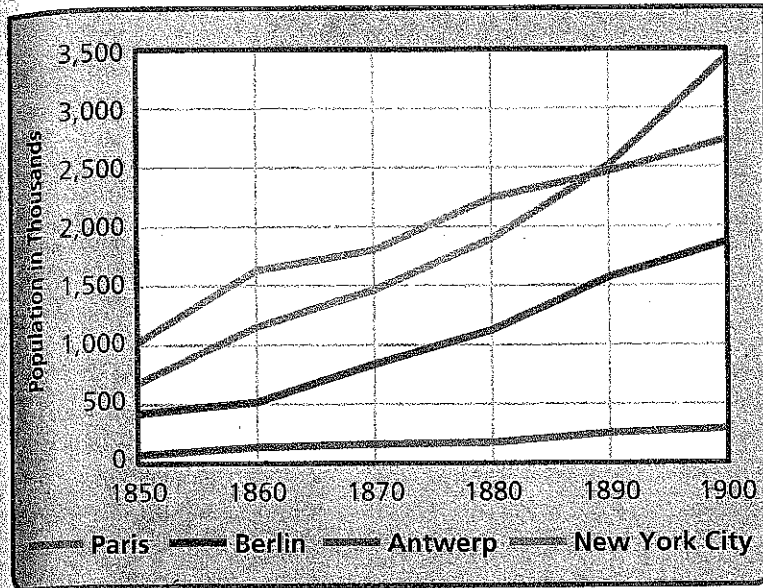
In the 1880s, the German doctor **Robert Koch** identified the bacterium that caused tuberculosis, a respiratory disease that claimed about 30 million human lives in the 1800s. The search for a tuberculosis cure, however, took half a century. By 1914, yellow fever and malaria had been traced to microbes carried by mosquitoes.

As people understood how germs caused disease, they bathed and changed their clothes more often. In European cities, better hygiene helped decrease the rate of disease.

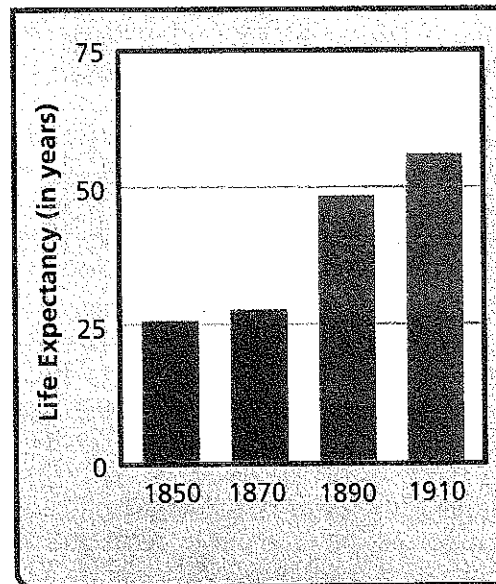


>> This 1899 American political cartoon shows a monopoly as an octopus-like monster covering a city. **Analyze Political Cartoons** Which side of the debate about the effects of monopolies does this cartoon support? Explain.

Population Growth of Major Cities During the Industrial Revolution



Life Expectancy During the Industrial Revolution



>> Longer life expectancies contributed to population booms in major cities. **Analyze Graphs** Which city's population grew the most? How did life expectancy change between 1850 and 1910?

Interactive Gallery

Improving Hospital Care By the 1840s, anesthesia was being widely used to relieve pain during surgery. The use of anesthetic gas allowed doctors to experiment with operations that had never before been possible.

Yet, throughout the century, hospitals could be dangerous places. Surgery was performed with dirty instruments in dank rooms. Often, a patient would survive an operation, only to die days later of infection. For the poor, being admitted to a hospital was often a death sentence. Wealthy or middle-class patients insisted on treatment in their own homes.

"The very first requirement in a hospital," said British nurse **Florence Nightingale**, "is that it should do the sick no harm." As an army nurse during the Crimean War, Nightingale insisted on better hygiene in field hospitals. After the war, she worked to introduce sanitary measures in British hospitals. She also founded the world's first school of nursing.

The English surgeon **Joseph Lister** discovered how antiseptics prevented infection. He insisted that surgeons sterilize their instruments and wash their hands before operating. Eventually, the use of antiseptics drastically reduced deaths from infection.

2 DRAW CONCLUSIONS Why was the improvement in hospital care especially important to the poor?

City Life Changes

As industrialization progressed, cities came to dominate the West. Cities grew as rural people streamed into urban areas for work. By the end of the 1800s, European and American cities had begun to take on many of the features of cities today.

New Cityscapes Growing wealth and industrialization altered the basic layout of European cities. City planners created spacious new squares and boulevards. They lined these avenues with government buildings, offices, department stores, and theaters.

The most extensive **urban renewal**, or rebuilding of the poor areas of a city, took place in Paris in the 1850s. Georges Haussmann, chief planner for Napoleon III, destroyed many tangled medieval streets full of tenement housing. In their place, he built wide boulevards and splendid public buildings.

The project was designed after Paris had experienced frequent uprisings, where poor city dwellers and their leaders set up barricades across narrow streets to battle the authorities. Haussmann's plan provided jobs, and the wide new boulevards made it harder for rebels to block streets and easier for troops to move around the city.

Gradually, settlement patterns shifted. In most American cities, the rich lived in pleasant neighborhoods on the outskirts of the city. The poor

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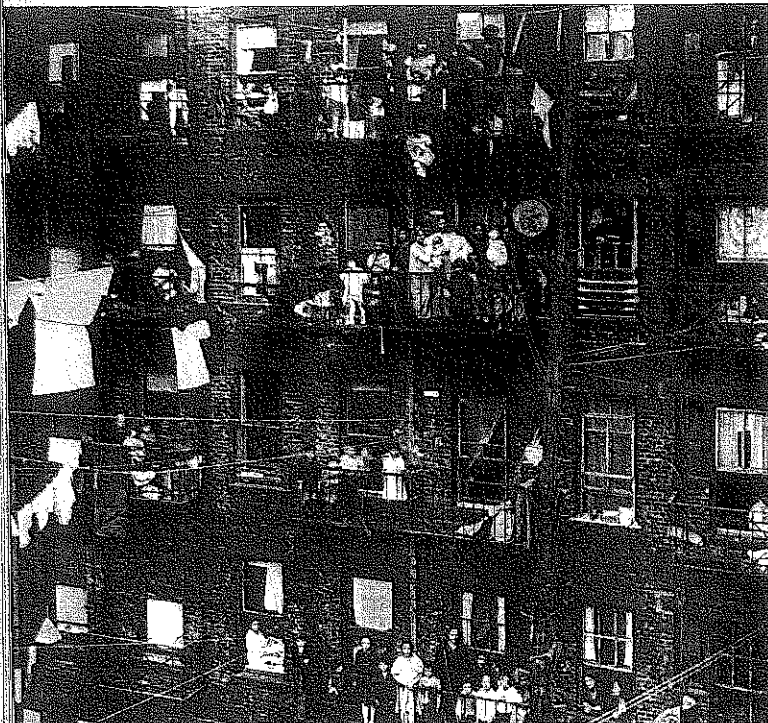
crowded into slums near the city center, within reach of factories. Trolley lines made it possible to live in one part of the city and work in another.

Safety, Sanitation, and Skyscrapers Paved streets made urban areas much more livable. First gas lamps, and then electric street lights illuminated the night, increasing safety. Cities organized police forces and expanded fire protection.

Beneath the streets, sewage systems made cities much healthier places to live. City planners knew that clean water supplies and better sanitation methods were needed to combat epidemics of cholera and tuberculosis.

In Paris, sewer lines expanded from 87 miles (139 kilometers) in 1852 to more than 750 miles (1200 kilometers) by 1911. The massive new sewer systems of London and Paris were costly, but they cut death rates dramatically.

By 1900, architects were using steel to construct soaring buildings. The Eiffel Tower became the symbol of Paris and the heights to which modern structures could reach. American architects like Louis Sullivan pioneered a new structure, the skyscraper. In large cities, single-family middle-class homes gave way to multistory apartment buildings.



>> It was not uncommon for more than one family to share a tiny apartment in tenement buildings. **Analyze Images** What evidence does this photograph provide about the lives of the urban poor?

Life in the Slums Despite efforts to improve cities, urban life remained harsh for the poor. Some working-class families could afford better clothing, newspapers, or tickets to a music hall. But they went home to small, cramped row houses or tenements in overcrowded neighborhoods.

In the worst tenements in cities such as London and New York, whole families were often crammed into a single room that had little light and almost no ventilation. Less than one foot of space separated the buildings, and most tenements did not have running water. Bathrooms outside in the back might be shared by as many as twenty people.

Unsanitary conditions and overcrowding meant diseases spread quickly. Unemployment or illness meant lost wages that could ruin a family, leaving it homeless. High rates of crime and alcoholism were a constant curse. Conditions had improved somewhat from the early Industrial Revolution, but slums remained a fact of city life.

The Lure of City Life Despite their drawbacks, cities attracted millions. New residents were drawn as much by the excitement as by the promise of work. For tourists, too, cities were centers of action.

Music halls, opera houses, and theaters provided entertainment for every taste. Museums and libraries offered educational opportunities. Sports, from tennis to bare-knuckle boxing, drew citizens of all classes. Tree-lined parks offered a chance for fresh air, walks, and picnics, while reminding people of life in the country.

DRAW CONCLUSIONS How did industrialization change the face of cities?

The Working Class Wins New Rights

Workers tried to improve the harsh conditions of industrial life. They protested low wages, long hours, unsafe conditions, and the constant threat of unemployment. At first, business owners and governments tried to silence protesters. By mid-century, however, workers began to make progress.

The Growth of Labor Unions Workers formed **mutual-aid societies**, self-help groups to aid sick or injured workers. Men and women joined socialist parties or organized unions. In 1830 and 1848, revolutions had broken out across Europe, sparked by political and social unrest. The revolts left vivid images

of widespread worker discontent that governments could no longer ignore.

By the late 1800s, most Western countries had granted all men the vote. Workers also won the right to organize unions to bargain on their behalf. Germany legalized labor unions in 1869. Britain, Austria, and France followed. By 1900, Britain had about three million union members, and Germany had about two million.

The main tactic of unions was the strike, or work stoppage. Workers used strikes to demand better working conditions, wage increases, or other benefits from their employers. Violence was often a result of strikes, particularly if employers called in the police or hired nonunion workers to keep their operations going.

Pressured by unions, reformers, and working-class voters, governments passed laws to regulate working conditions. Early laws forbade employers to hire very young children. Later laws outlawed child labor entirely and banned the employment of women in mines. Other laws limited work hours and improved safety. By 1909, British coal miners had won an eight-hour day, setting a standard for workers in other countries.

In Germany, and then elsewhere, Western governments established old-age pensions, as well as disability insurance for workers who were hurt or became ill. These programs protected workers from dying in poverty once they were no longer able to work.

An Improved Standard of Living Wages varied throughout the industrialized world, with unskilled laborers earning less than skilled workers. Women received less than half the pay of men doing the same work. Farm laborers barely scraped by during the economic slump of the late 1800s. Periods of unemployment brought desperate hardships to industrial workers and helped boost union membership.

Overall, though, standards of living for workers did rise. Working-class people began to benefit from higher wages and better working conditions. They, too, were able to afford a larger variety of goods and services. Many benefited from the growing movement to provide public education. Some were able to get access to health care. Efforts to curb diseases led to vaccination programs that reached into poor communities. Some workers were able to move out of overcrowded slums into the outer ring of cities and travel to work on subways and trolleys. Despite improvements in the standard of living, however, a large gap divided workers from the middle class.

2 DRAW CONCLUSIONS What were some ways that life improved for workers?



>> Miners and steelworkers go on strike in Belgium. **Draw Conclusions** Who do you think the men on horseback are? Why are they there? Explain.

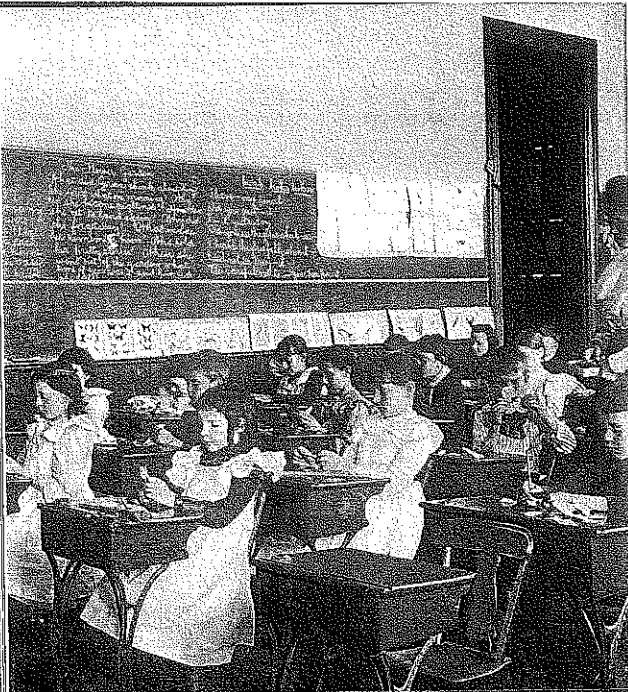
ASSESSMENT

1. **Identify Main Ideas** Identify the major effects of new technology and transportation on industry during the Industrial Revolution.
2. **Draw Conclusions** Why did big business emerge during the Industrial Revolution, and how did it affect free enterprise?
3. **Identify Central Issues** How did the Industrial Revolution bring about important changes to human life in cities? Identify changes for the better and for the worse.
4. **Apply Concepts** How did the working class begin to improve its conditions during the late 1800s?
5. **Identify** Describe the contributions of Louis Pasteur and how they impacted society during the Industrial Revolution.

13.4

The Industrial Revolution

slowly changed the old social order in the Western world. For centuries, the two main classes were nobles and peasants. While middle-class merchants, artisans, and lawyers played important roles, they still had a secondary position in society. With the spread of industry, a more complex social structure emerged.



>> Until the late 1800s, the only education available for British students was at either religious schools or "ragged schools," which were schools for poor children. The Education Act of 1902 established a system of public grammar schools.

 Interactive Flipped Video

TEKS

8.B, 17.A, 24.A, 26.B, 26.C

>> Objectives

Identify what values shaped the new social order.

Describe how the role of women changed in the Industrial Revolution.

Explain the impact of education, new scientific ideas, and religion.

Analyze how romanticism, realism, and impressionism reflected the culture of the Industrial Age.

>> Key Terms

cult of domesticity

temperance

movement

Elizabeth Cady

Stanton

women's suffrage

Sojourner Truth

John Dalton

Charles Darwin

racism

social gospel

William Wordsworth

romanticism

Lord Byron

Victor Hugo

Ludwig van

Beethoven

realism

Charles Dickens

Gustave Courbet

Louis Daguerre

impressionism

Claude Monet

Vincent van Gogh

Changing Ways of Life and Thought

The New Social Order

The New Class Structure By the late 1800s, a new upper class emerged in western Europe. It came to include not only the old nobility but also wealthy families who had acquired their riches from business and industry. Rich entrepreneurs married into aristocratic families, gaining the status of noble titles. Nobles needed the money brought by the industrial rich to support their lands and lifestyle. By tradition, the upper class held the top jobs in government and the military.

Below this tiny elite, a growing middle class was pushing its way up the social ladder. At its highest rungs were the upper middle class, made up of mid-level business people and professionals such as doctors and scientists. With comfortable incomes, they enjoyed a wide range of material goods. Next came the lower middle class, which included teachers, office workers, shop owners, and clerks. On much smaller incomes, they struggled to keep up with their "betters."

Industrial workers and rural peasants were at the base of the social ladder. The size of this working class varied across Europe. In highly industrialized Britain, workers made up more than 30 percent of the population in 1900. In western Europe and the United States, the



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number of farmworkers dropped, but many families still worked the land. The rural population was higher in eastern and southern Europe, where industrialization was more limited.

Middle Class Values By midcentury, the growing middle class had developed its own way of life. A strict code of etiquette governed social behavior.

Rules dictated how to dress for every occasion, how to give a dinner party, how to pay a social call, when to write letters, and how long to mourn for relatives who had died.

Parents strictly supervised their children, who were expected to be "seen but not heard." A child who misbehaved was considered to reflect badly on the entire family. Servants, too, were seen as a reflection of their employers. Even a small middle-class household was expected to have at least a cook and a housemaid.

The Ideal Home and Family Middle-class families tended to include just the nuclear family, parents and children, rather than the larger extended families of the past. They lived in a large house, or perhaps one of the new apartment houses. Rooms were crammed with large, overstuffed furniture. Clothing reflected middle-class tastes for luxury and respectability.

Within the family, the division of labor between wife and husband changed. Earlier, middle-class women had helped run family businesses out of the home.

By the later 1800s, most middle-class husbands went to work in an office or shop. A successful husband was one who earned enough to keep his wife at home. Women spent their time raising children, directing servants, and doing religious or charitable service.

Books, magazines, and popular songs supported a **cult of domesticity** that idealized women and the home. Women and girls stitched sayings like "home, sweet home" into needlework that was hung on parlor walls. The ideal woman was seen as a tender, self-sacrificing caregiver who provided a nest for her children and a peaceful refuge for her husband to escape from the hardships of the working world.

This ideal rarely applied to the bottom rungs of the social ladder. Lower-middle-class women might work alongside their husbands in stores. Working-class women labored for low pay in garment factories or worked as domestic servants. Young women might leave domestic service after they married, but often

had to seek other employment. Despite long days working for wages, they were still expected to take full responsibility for child care and homemaking.

IDENTIFY MAIN IDEAS How did the roles of men and women in middle-class households change as a result of the Industrial Revolution?

The Struggle for Women's Rights

Some individual women and women's groups protested restrictions on women's lives. They sought a broad range of rights. Across Europe and the United States, politically active women campaigned for fairness in marriage, divorce, and property laws. Women's groups also supported the **temperance movement**, a campaign to limit or ban the use of alcoholic beverages. Temperance leaders pointed out that drinking threatened family life. They also argued that banning alcohol would create a more productive and efficient workforce.

These reformers faced many obstacles. In Europe and the United States, women could not vote. They were barred from most schools and had little, if any,



>> In industrialized cities, many members of the working class lived in tenement buildings like this. **Infer** What can you infer about working-class life from the way these people are dressed indoors?

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protection under the law. A woman's husband or father controlled all of her property.

The Campaign Begins In the late 1700s, women such as Olympe de Gouges in France and Mary Wollstonecraft in England had begun to call for women's rights. Later, their successors—mostly from the middle class—took up the struggle. In the United States, Lucretia Mott, **Elizabeth Cady Stanton**, and Susan B. Anthony campaigned for the abolition of slavery. In the process, they realized the severe restrictions on their own lives. They became the founders of the American women's rights movement.

Over time, women began to break the barriers that kept them out of universities and professions. By the late 1800s, a few women trained as doctors or lawyers. Others became explorers, researchers, or inventors, often without recognition. For example, Julia Brainerd Hall worked with her brother to develop an aluminum-producing process. Their company became hugely successful, but Charles Hall received almost all of the credit.

The Suffrage Movement By the late 1800s, married women in some countries had won the right to

control their own property. The struggle for political rights proved far more difficult. In the United States, the Seneca Falls Convention of 1848 demanded that women be granted the right to vote. In Europe, groups dedicated to **women's suffrage**, or women's right to vote, emerged in the later 1800s.

Among men, some liberals and socialists supported women's suffrage. In general, though, suffragists faced intense opposition. Some critics claimed that women were too emotional to be allowed to vote. Others argued that women needed to be "protected" from grubby politics or that a woman's place was in the home, not in government.

To such claims, **Sojourner Truth**, an African American suffragist, is credited with replying, "Nobody ever helps me into carriages, or over mud puddles, or gives me any best place! And ain't I a woman?"

On the edges of the Western world, women made faster strides. In New Zealand, Australia, and some western territories of the United States, women won the vote by the early 1900s. There, women who had "tamed the frontier" alongside men were not dismissed as weak and helpless. In the United States, Wyoming became the first state to grant women the right to vote. In much of the Western world, however, the women's suffrage struggle took much longer. By 1920, women in Britain and the United States had finally won the vote.

IDENTIFY MAIN IDEAS What were the arguments against women's suffrage?

ELPS 4.F.5 Demonstrate your understanding of how to use pictures and other visuals to deepen your understanding of the suffrage movement.



>> In Britain, the first petition for women's suffrage was presented to Parliament in 1867. The suffragist movement continued until Parliament finally granted women over 30 the right to vote in 1918. Women gained the same voting rights as men in 1928.

Interactive Gallery

The Rise of Public Education

By the late 1800s, reformers persuaded many governments to set up public schools and require basic education for all children. Teaching "the three Rs"—reading, writing, and arithmetic—was thought to produce better citizens. In addition, industrialized societies recognized the need for a literate workforce. Schools taught punctuality, obedience to authority, disciplined work habits, and patriotism. In European schools, children also received basic religious education.

Improving Public Schools At first, elementary schools were primitive. Many teachers had little schooling themselves. In rural areas, students attended

class only during the times when they were not needed on the farm or in their parents' shops.

By the late 1800s, a growing number of children were in school, and the quality of elementary education improved. Teachers received training at normal schools, where the latest "norms and standards" of educational practices were taught. By the late 1800s, more schools were being set up in western Europe and elsewhere to train teachers.

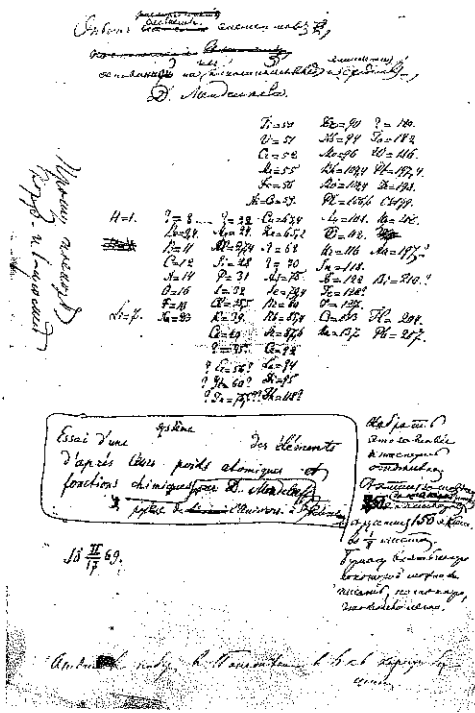
In England, schooling girls and boys between the ages of five and ten became compulsory after 1881. At the same time, governments began to expand secondary schools, known as high schools in the United States. In secondary schools, students learned the "classical languages," Latin and Greek, along with history and mathematics.

In general, only middle-class families could afford to have their sons attend these schools, which trained students for more serious study or for government jobs. Middle-class girls were sent to school primarily in the hope that they might marry well and become better wives and mothers. Generally, girls' schools did not teach much science or mathematics, which were considered unnecessary and inappropriate for young women.

Higher Education Grows Colleges and universities expanded in this period, too. Most university students were the sons of middle or upper-class families. The university curriculum emphasized ancient history and languages, philosophy, religion, and law. By the late 1800s, universities added courses in the sciences, especially in chemistry and physics. At the same time, engineering schools trained students who would have the knowledge and skills to build the new industrial society.

Some women sought greater educational opportunities. By the 1840s, a few small colleges for women opened, including Bedford College in England and Mount Holyoke in the United States. In 1863, the British reformer Emily Davies campaigned for female students to be allowed to take the entrance examinations for Cambridge University. She succeeded, but as late as 1897, male Cambridge students rioted against granting degrees to women.

DRAW CONCLUSIONS Why did more children attend school in the late 1800s than before?



>> This image shows Dmitri Mendeleev's 1869 manuscript of the periodic table. In 1871, he created a version with gaps where he believed elements that had not yet been discovered would fit.

New Directions in Science

Science in the service of industry brought great changes in the later 1800s. At the same time, researchers advanced startling theories about the natural world. Their new ideas challenged long-held beliefs.

Modern Atomic Theory A crucial breakthrough in chemistry came in the early 1800s when the English Quaker schoolteacher **John Dalton** developed modern atomic theory. The ancient Greeks had speculated that all matter was made of tiny particles called atoms. Dalton showed that each element has its own kind of atoms. Earlier theories put forth the idea that all atoms were basically alike. Dalton also showed how different kinds of atoms combine to make all chemical substances. In 1869, the Russian chemist Dmitri Mendeleev (men duh LAY ef) drew up a table that grouped elements according to their atomic weights. His table became the basis for the periodic table of elements used today.

The Question of Earth's Age The new science of geology opened avenues of debate. In *Principles of Geology*, Charles Lyell offered evidence to show that Earth had formed over millions of years. His successors

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concluded that Earth was at least two billion years old and that life had not appeared until long after Earth was formed. These ideas did not seem to agree with biblical accounts of creation.

Archaeology added other pieces to an emerging debate about the origins of life on Earth. In 1856, workers in Germany accidentally uncovered fossilized Neanderthal bones. Later scholars found fossils of other early modern humans. These archaeologists had limited evidence and often drew mistaken conclusions. But as more discoveries were made, scholars developed new ideas about early humans.

Darwin's Theory of Natural Selection Some of the most controversial new ideas came from the British naturalist **Charles Darwin**. In 1859, after years of research, he published *On the Origin of Species*. Darwin argued that all forms of life, including human beings, had evolved into their present state over millions of years. To explain the extremely long, slow process of evolution, he put forward a startling new theory.

Darwin adopted Thomas Malthus's idea that all plants and animals produced more offspring than the food supply could support. As a result, he said, members of each species constantly competed to survive. Natural forces "selected" those with physical

traits best adapted to their environment to survive and to pass the trait on to their offspring. Darwin called this process natural selection. Later, some people called it "survival of the fittest."

The Uproar Over Darwin Like the ideas of Nicolaus Copernicus and Isaac Newton in earlier times, Darwin's theory ignited a furious debate between scientists and theologians. To many Christians, the Bible contained the only true account of creation. It told that God created the world and all forms of life within seven days. Darwin's theory, they argued, reduced people to the level of animals and undermined belief in God and the soul. While some Christians eventually came to accept the idea of evolution, others did not. Controversy over Darwin's theories has continued to the present day.

Social Darwinism Although Darwin himself never promoted any social ideas, some thinkers used his theories to support their own beliefs about society. The idea that natural selection applied to human society, especially to warfare and economic competition, became known as Social Darwinism. It was British philosopher Herbert Spencer who coined the phrase "survival of the fittest."

Social Darwinists argued that industrial tycoons earned their success because they were more "fit" than those they put out of business. War brought progress by weeding out weak nations. Victory was seen as proof of superiority.

Social Darwinism encouraged **racism**, the unscientific belief that one racial group is superior to another, and had horrific consequences for people throughout the world. For example, Social Darwinism was used to justify harsh treatment of the mentally ill and countless acts of violence toward people of "different" religions, races, and ethnicities. By the late 1800s, many Europeans and Americans claimed that the success of Western civilization was due to the supremacy of the white race. Such powerful ideas would have a long-lasting impact on world history.

2 IDENTIFY CENTRAL IDEAS How did science begin to challenge existing beliefs in the late 1800s?

The Role of Religion

Despite the challenge of new scientific ideas, religion continued to be a major force in Western society. Christian churches and Jewish synagogues remained at the center of communities. Religious leaders influenced political, social, and educational developments.

The grim realities of industrial life stimulated feelings of compassion and charity. Christian and



>> Darwin's theories about evolution sparked much debate. **Analyze Political Cartoons** How does the portrayal of Darwin as a monkey relate to his theories? Do you think the cartoonist accepts the theories?

Jewish labor unions and political parties pushed for reforms. Individuals, church groups, and Jewish organizations all tried to help the working poor. Catholic priests and nuns set up schools and hospitals in urban slums. Many Protestant churches backed the **social gospel**, a movement that urged Christians to social service. They campaigned for reforms in housing, healthcare, and education.

Motivated by their religious values, Christians and Jews founded many organizations to help those in need. In Paris, Frédéric Ozanam established the St. Vincent de Paul Society in 1833. By 1878, William and Catherine Booth had set up the Salvation Army in London.

It both spread Christian teachings and provided social services. Their daughter, Evangeline Booth, later helped bring the Salvation Army to North America. In 1881, the Jewish community in New York founded the Hebrew Immigrant Aid Society, which provided shelter, food, employment, and education to many new immigrants.

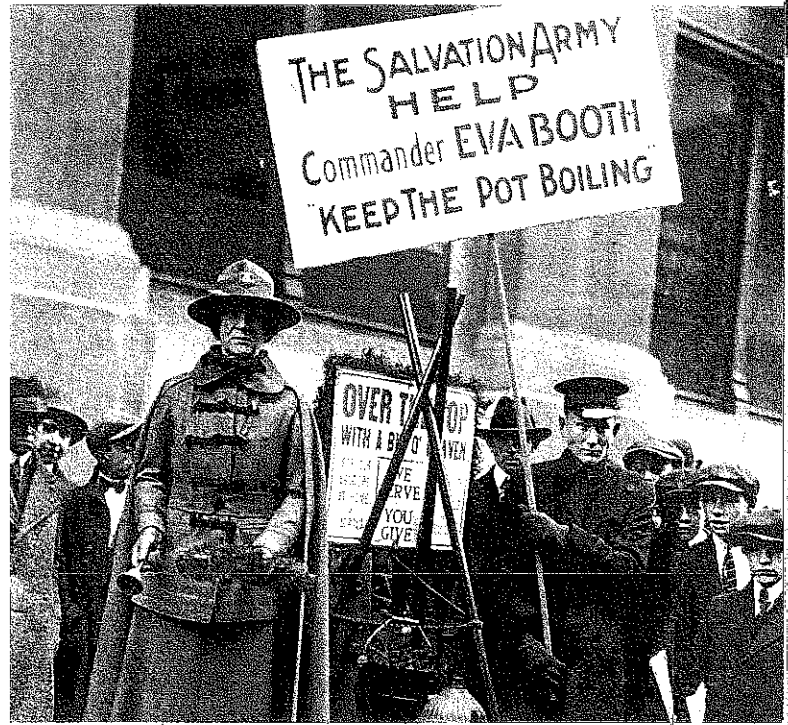
IDENTIFY SUPPORTING DETAILS What social services did religious organizations provide?

The Romantics Turn from Reason

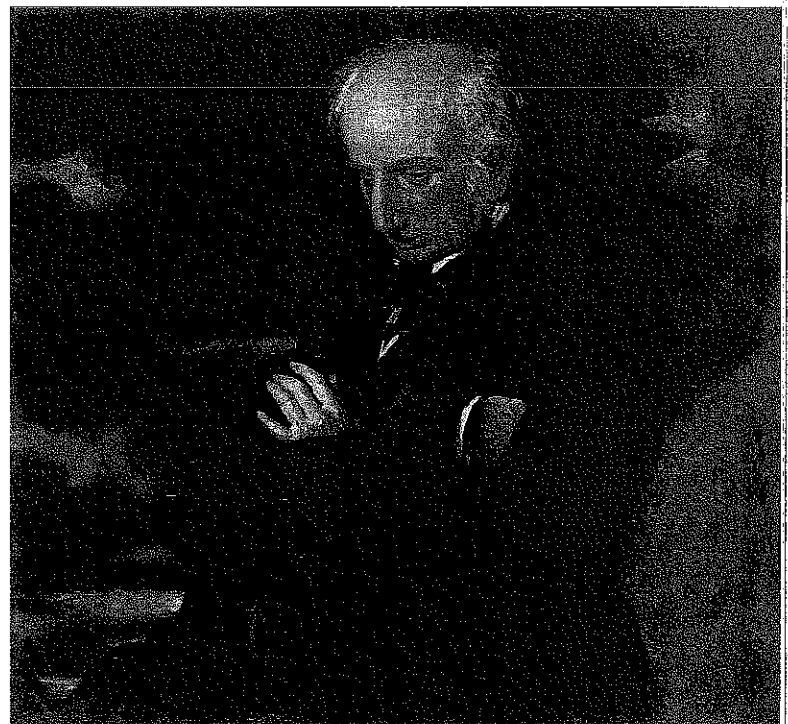
The Industrial Age shaped the arts as well as society and science. Many writers turned away from the harsh realities of industrial life to celebrate the peace and beauty of nature. These writers were part of a cultural movement called romanticism. **Romanticism** emphasized imagination, freedom, and emotion. (Romance, in the sense of romantic love, was not the focus of the movement.) From the late 1700s to 1850, romanticism shaped much of Western literature and arts.

Romantic Poetry Romantic writers, artists, and composers rebelled against the Enlightenment emphasis on reason, order, and emotional restraint. Instead, romantic writers focused on simple, direct language that conveyed intense feelings and glorified nature.

English poet **William Wordsworth** helped launch this cultural movement with the publication of *Lyrical Ballads* in 1789. Wordsworth rejected formal styles and conventions, and instead experimented with poetic forms and focused on common people and subjects, like the peace and beauty of the sunset.



>> The hardships of industrial life led to the creation of numerous charitable organizations, including the Salvation Army, which provided many services to the needy.



>> Romantic paintings often focused on nature and emotion. Note the romantic features of this portrait of William Wordsworth. His arms are crossed, and his head is down as though he is brooding about something. A dramatic landscape looms behind him.

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It is a beautiful evening, calm and
free,

The holy time is quiet as a Nun

Breathless with adoration; the broad
sun

Is sinking down in its tranquillity

—William Wordsworth, *Complete Poetical Works*

Poets such as William Blake, Samuel Taylor Coleridge, John Keats, and Percy Bysshe Shelley were also leading lights of the romantic movement.

Mysterious Heroes Romantic writers created a new kind of hero—a mysterious, melancholy figure who felt out of step with society. “My joys, my grief, my passions, and my powers, / Made me a stranger,” wrote Britain’s George Gordon, **Lord Byron**. He himself was a larger-than-life figure equal to those he created.

After a rebellious, wandering life, he joined Greek forces battling for independence from Turkish rule. When he died of a fever there, his legend bloomed.

Moody, isolated romantic heroes came to be described as “Byronic.”

The romantic hero often hid a guilty secret and faced a grim destiny. German writer Johann Wolfgang von Goethe (GUR tuh) wrote the dramatic poem *Faust*. The aging scholar Faust makes a pact with the devil, exchanging his soul for youth. After much agony, Faust wins salvation by accepting his duty to help others. In *Jane Eyre*, British novelist Charlotte Brontë weaves a tale about a quiet governess and her brooding, Byronic employer, whose large mansion conceals a terrifying secret.

Glorifying the Past Romantic writers combined history, legend, and folklore. Sir Walter Scott’s novels and ballads evoked the turbulent history of Scottish clans or medieval knights. Alexandre Dumas (doo MAH) and **Victor Hugo** re-created France’s past in novels like *The Three Musketeers* and *The Hunchback of Notre Dame*.

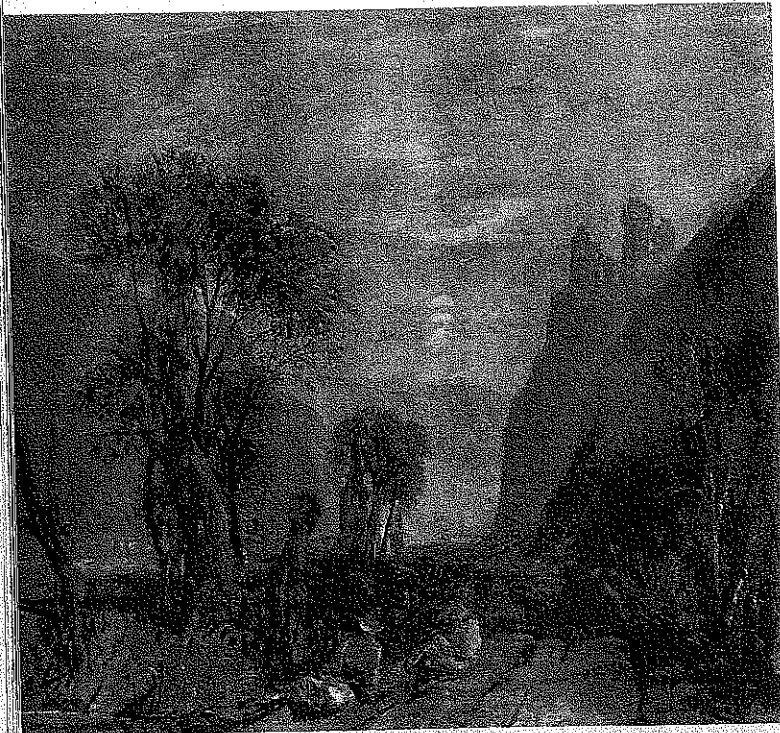
Architects, too, were inspired by old styles and forms. Churches and other buildings, including the British Parliament, were modeled on medieval Gothic styles. To people living in the 1800s, medieval towers and lacy stonework conjured up images of a glorious past.

Romanticism in Music The orchestra, as we know it today, took shape in the early 1800s. The first composer to take full advantage of the broad range of instruments was the German composer **Ludwig van Beethoven**. Beethoven’s stirring music transcended his own time and culture by conveying universal emotions such as love, loss, death, joy, and fear. For example, the famous opening of his Fifth Symphony conveys the sense of fate knocking on one’s door.

His Sixth Symphony captures a joyful day in the countryside, interrupted by a violent thunderstorm. In all, Beethoven produced nine symphonies, five piano concertos, a violin concerto, an opera, two masses, and dozens of shorter pieces that are still popular today.

Romantic composers also tried to stir deep emotions. The piano music and passionate playing of the Hungarian composer Franz Liszt moved audiences to laugh or weep. Other composers wove traditional folk music into their works to glorify their nations’ past. In his piano works, Frederic Chopin (shoh PAN) used Polish peasant dances to convey the sorrows and joys of people living under foreign occupation.

Romanticism in Art Painters, too, broke free from the discipline and strict rules of the Enlightenment. Landscape painters like J.M.W. Turner sought to capture the beauty and power of nature. Using bold



>> In many of his paintings, romantic artist J.M.W. Turner focused on the effects of light and color. **Analyze Images** How does *A View on the Rhine* exemplify the characteristics of romantic art?

brush strokes and colors, Turner often showed tiny human figures struggling against sea and storm.

Romantics painted many subjects, from simple peasant life to medieval knights to current events. Bright colors conveyed violent energy and emotion. The French painter Eugène Delacroix (deh luh KRWAH) filled his canvases with dramatic action. In *Liberty Leading the People*, the Goddess of Liberty carries the revolutionary tricolor as French citizens rally to the cause.

IDENTIFY CAUSE AND EFFECT How was romanticism a reaction to the Enlightenment and the Industrial Revolution?

Artists Represent Real Life

By the mid-1800s, a new artistic movement, **realism**, took hold in the West. Realism was an attempt to represent the world as it was, without the heightened sentiment and idealized emotions of the romantics. Realists often stressed the harsh side of life in urban slums or peasant villages. Many writers and artists were committed to improving the lot of the unfortunates whose lives they depicted.

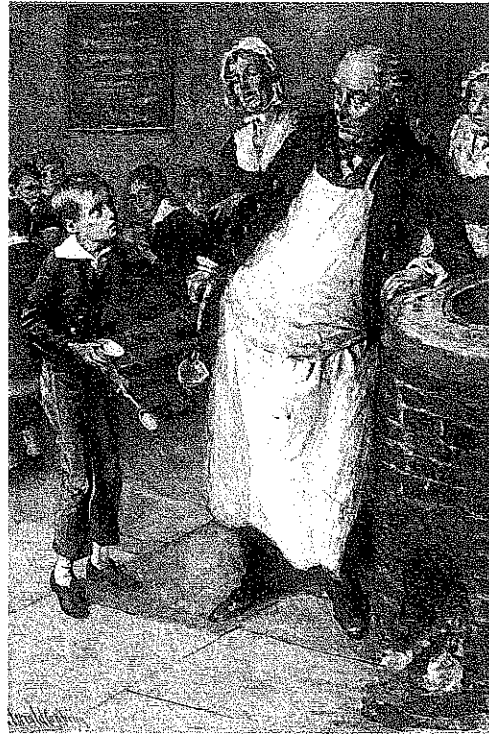
Novelists Expose Social Wrongs The English novelist **Charles Dickens** vividly portrayed the lives of slum dwellers and factory workers, including children. In *Oliver Twist*, Dickens tells the story of a nine-year-old orphan raised in a grim poorhouse. When a desperately hungry Oliver asks for more food, he is smacked in the head by his well-fed master and sent off to work. Later, he runs away to London. There he is taken in by Fagin, a villain who trains homeless children to become pickpockets.

The book shocked many middle-class readers with its picture of poverty, mistreatment of children, and urban crime. Yet Dickens's humor and colorful characters made him one of the most popular novelists in the world.

French novelists also portrayed the ills of their time. With *Les Misérables* (lay miz ehr AHB), Victor Hugo moved from romanticism to realism. The novel showed how hunger drove a good man to crime and how the law hounded him ever after. The novels of Émile Zola painted an even grimmer picture. In *Germinal*, Zola exposed class warfare in the French mining industry. To Zola's characters, neither the Enlightenment faith in reason nor the romantic emphasis on feelings mattered at all.



>> Romantic painter Eugène Delacroix turned to foreign lands and ancient times to portray the exotic or simpler ways of life. Although the painting focuses on peasant musicians rather than nature, it still seems idealized rather than harshly realistic.



>> Social injustice was a focus of realism. In this illustration from Charles Dickens's *Oliver Twist*, orphan Oliver asks for more porridge. Analyze Images How does the illustration help you understand the goals of the realist movement?

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LES MISÉRABLES En Vente Partout
 par **Victor HUGO**
 10^e LA LIVRAISON - 2 LIVRAISONS PAR SEMAINE - LA 1^{re} LIVRAISON GRATIS
 Librairie OLLENDORFF 53, Chaus. de l'Arm. PARIS 2 x 3 LIVRAISONS VENDUES ENSEMBLE 5

>> This poster shows characters from a play based on Victor Hugo's novel *Les Misérables*. In the center is Jean Valjean, who was arrested for stealing a loaf of bread to keep his sister's child from starving.

Realism on Stage Norwegian dramatist Henrik Ibsen brought realism to the stage. His plays attacked the hypocrisy he observed around him. *A Doll's House* shows a woman caught in a straitjacket of social rules. In *An Enemy of the People*, a doctor discovers that the water in a local spa is polluted. Because the town's economy depends on its spa, the citizens denounce the doctor and suppress the truth. Ibsen's realistic dramas had a wide influence in Europe and the United States.

Realism in Art Realist painters also rejected the romantic emphasis on imagination. Instead, they focused on ordinary subjects, especially working-class men and women. "I cannot paint an angel," said the French realist **Gustave Courbet** (kooor BAY), "because I have never seen one." Instead, he painted works such as *The Stone Breakers*, which shows two rough laborers on a country road. Later in the century, *The Gross Clinic*, by American painter Thomas Eakins, shocked viewers with its realistic depiction of an autopsy conducted in a medical classroom.

2 CONTRAST How did realism differ from romanticism?

New Directions in the Visual Arts

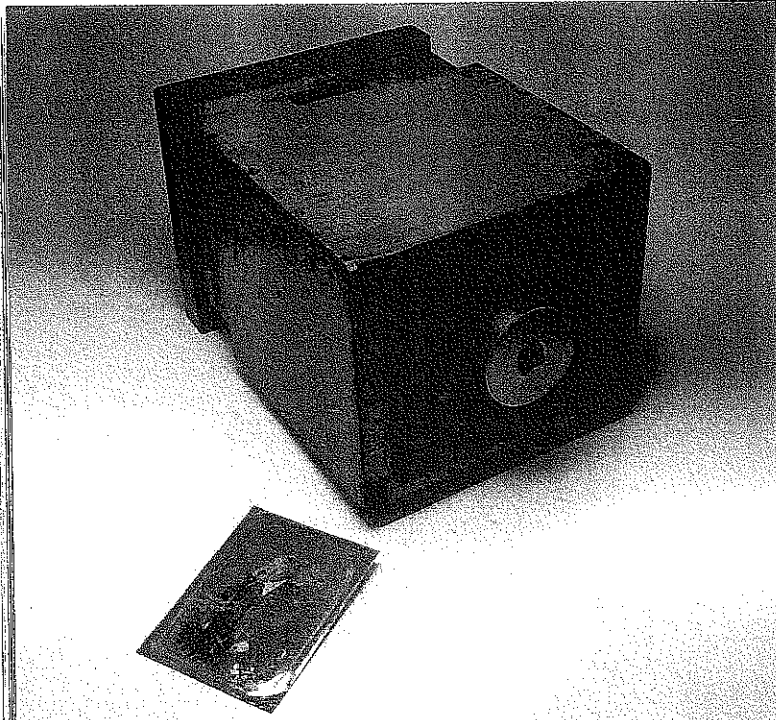
By the 1840s, a new art form, photography, was emerging. **Louis Daguerre** (dah GEHR) in France and William Fox Talbot in England had improved on earlier technologies to produce successful photographs. At first, many photos were stiff, posed portraits of middle-class families or prominent people. Other photographs reflected the romantics' fascination with faraway places.

In time, photographers used the camera to present the grim realities of life. During the American Civil War, Mathew B. Brady preserved a vivid, realistic record of the corpse-strewn battlefields. Other photographers showed the harsh conditions in industrial factories or slums.

The Impressionists Photography posed a challenge to painters. Why try for realism, some artists asked, when a camera could do the same thing better?

By the 1870s, a group of painters took art in a new direction, seeking to capture the first fleeting impression made by a scene or object on the viewer's eye. The new movement, known as **impressionism**, took root in Paris, capital of the Western art world.

Since the Renaissance, painters had carefully finished their paintings so that no brush strokes



>> In 1839, Louis Daguerre perfected an effective method of photography. His camera changed both art and society.

showed. But impressionists like **Claude Monet** (moh MAY) and Edgar Degas (day GAH) brushed strokes of color side by side without any blending. According to new scientific studies of optics, the human eye would mix these patches of color.

By concentrating on visual impressions rather than realism, artists achieved a fresh view of familiar subjects. Monet, for example, painted the cathedral of Rouen (roo AHN), France, dozens of times from the same angle, capturing how it looked in different lights at different times of day.

The Postimpressionists Later painters, called postimpressionists, developed a variety of styles. Georges Seurat (suh RAH) arranged small dots of color to define the shapes of objects.

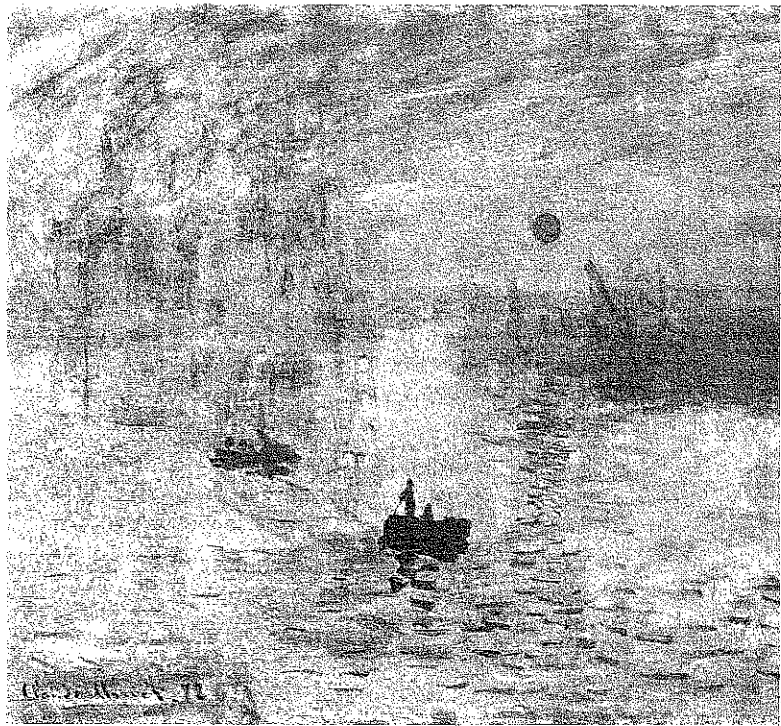
Vincent van Gogh experimented with sharp brush lines and bright colors. His unique brushwork lent a dreamlike quality to everyday subjects. Desperately poor, he sold few paintings in his short, unhappy life. Today, Van Gogh's masterpieces sell for millions of dollars each.

Paul Gauguin (goh GAN) also developed a bold, personal style. He rejected the materialism of Western life and went to live on the island of Tahiti in the South Pacific. His most famous works depict the people of Tahiti. In his paintings, people look flat, as in "primitive" folk art. But his brooding colors and black outlining of shapes convey intense feelings and images.

CONNECT How did photography influence the development of painting?

ASSESSMENT

1. **Identify Cause and Effect** In what ways were the new artistic styles of the 1800s a reaction to changes in society?
2. **Draw Conclusions** Why did the movement to change women's roles in society face strong opposition?



>> After being rejected by France's most prestigious art exhibition, a group of painters held their own exhibition in 1874. One of the paintings, Claude Monet's *Impression: Sunrise*, gave the impressionist movement its name.

Interactive Gallery

3. **Infer** Why did reformers think free public education would lead to social change?
4. **Identify Supporting Details** How did the Industrial Revolution change the old social order and long-held traditions in the Western world?
5. **Infer** Referring to *Oliver Twist*, Charles Dickens wrote that "to show [criminals] as they really are, for ever skulking uneasily through the dirtiest paths of life . . . would be a service to society." How does his claim reflect the goals of realism?

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