

Label a page: “Achievements of the Industrial Revolution” and create the chart:

Placard Letter	Achievement	Key Information	Impact on the Industrial Revolution
There are 16 placards each with a unique letter.	There are 16 achievements explained on the walls. This is the title of the wall readings.	Take notes on the development of this achievement.	How did this achievement change the world or people's lives?

Come into tutoring to get the placard letters. Discussion questions at the end.

Cotton Gin and Spinning Jenny

Textiles were the first product of the Industrial Revolution. Prior to the Industrial Revolution, the average English person owned four articles of clothing. Today, the average westerner owns over 200 articles of clothing. By far, the most economic and comfortable material for clothing is cotton. (Try wearing a wool sweater with no shirt below- this was the most common form of clothing prior to cotton). However, cotton is difficult to process by hand. Cotton grows from plants but the cotton is full of tiny seeds. Removing the seeds by hand is labor intensive and made cotton very expensive. In 1791, an American invented the cotton gin. The cotton gin was a machine that easily removed the seeds from the cotton which drastically reduced the labor and hence price of cotton. This single invention led to a cotton boom in the American south and increased demand for more slaves to harvest the cotton. This cotton was sold to British and northeastern factories where the cotton could be spun and weaved on the spinning jenny. The spinning jenny could run up 120 yarns of cotton at once. The spinning jenny allowed for cotton to be mass produced into clothing and and later gun powder.

The Steam Engine

The steam engine was the first new source of power of the Industrial Revolution. Previously, to move an object one needed wind, water, human or animal muscle. All proved to have certain disadvantages and things moved slowly. The steam engine was able to harness the power of fossil fuels to move objects and generate great power. Invented by the Scottish inventor James Watt, the steam engine made the Industrial Revolution possible. It provided large quantities of cheap and abundant energy to power textile mills, factories, boats, and trains. Even today, nearly 80% of the world's electricity is generated by modern steam turbines. Steam is produced by heating a boiler through the burning of coal or other fossil fuels. Although the steam engine improved power generation, the burning of coal to power it also began to change the chemical makeup of the atmosphere which leads to climate change.

Railroads

Since the beginning of time, humans could move across the land only as fast as the fastest domesticated animal could carry them. Trains and railroads provided the first improvement in land transportation. The first steam powered trains were developed in Great Britain in 1804 and traveled at 20 miles per hour. By the 1850's, Great Britain had over 11,000 miles of track and trains were exceeding 50 miles an hour. They were the fastest things in the world at the time and were the first man-made objects faster than the fastest animals. In 1869 the first railroad to cross a continent was completed in the United States. A trip that had once taken 5 months in a covered wagon was reduced to one week in a comfortable rail car. Railroads made products cheaper as they reduced transportation costs and allowed for the mass movements of people across the land. People became connected in new ways.

Steamboats

Since the invention of the first sailboats in Mesopotamia, the speed of water travel was based on how hard the wind blew, which way the water flowed or how hard a human could row. These sources of power were inconsistent or expensive and limited transportation on the waterways of the world. This all changed when the steam engine was added to boats. Steamboats reduced transportation costs and travel times. The trip from Great Britain to China by sailboat took four months. The steamboat reduced this travel time to 40 days. Crossing from the United States to Europe in a sailboat took a month. The steamship could do it a week. Steamboats also made transportation upriver much easier. The Mississippi River became a major water way in the United States when it became possible to go both downriver and upriver. Cheaper transportation allowed for cheaper products and the mass movements of people across the oceans.

Canals

Transportation was key to the Industrial Revolution and major canal building projects reduced ocean voyages. The two most important canals were the Suez Canal and the Panama Canal. The Suez Canal was a 100 mile canal completed in 1869 that connected the Mediterranean Sea with the Red Sea and Indian Ocean. The canal shortened the voyage from Britain to India by 7,200 miles. The Panama Canal was built through the Americas and was opened in 1914. It reduced the trip around the Americas by 8,000 miles. Although it took 34 years to build and cost the lives of 27,000 workers, the Panama Canal would transform transportation in the Americas.

Telegraph & Telephone

Before the invention of the telegraph, long distance communication traveled at the speed a human could move across land and sea. For example, a message from Great Britain to Australia took over 8 months to get back and forth. It made for very long conversations! As scientists began to understand the properties of electricity in the 19th century, inventors experimented with ways to transmit signals over long distances using wire. Simple pings like Morse code could be sent across the wires and understood by a receiver. By the late 19th century, telegraphic wires crisscrossed the world's land and oceans. They were the first text messages! In 1876, an American named Alexander Graham Bell figured out how to transmit the human voice electronically. The telephone quickly became indispensable to business, government, and households and the most popular small appliance.

Photography and Movies

The history of photography has roots in remote antiquity with the discovery of the principle of the camera obscura and the observation that some substances are visibly altered by exposure to light. However, nobody thought of bringing these two phenomena together to capture camera images in permanent form until the 1820's. The earliest images were crude and unclear but by 1839, with the development of daguerreotype, clear, finely detailed results were being produced. Exposure time was long and human subjects had to sit still for several minutes to be captured. Significant improvements in film paper and exposure speed led to modern photography. By the 1890's, photographers in France had improved exposure and shutter speed so much they could make the pictures move. The first movies were less than a minute long and sound was not added until 1927, but an entire new form of art, entertainment and documentation had been created.

Charles Darwin

In 1859, Charles Darwin published his book, *On The Origin of Species*. The book originated the theory of organic evolution by means of natural selection, revolutionized the entire field of biology, and altered our view of humanity's place in the world. It also created an uproar. It is perhaps the most widely discussed scientific book ever written. While Darwin did not originate the theory of evolution, he was the first to be able to explain a mechanism- natural selection- and produce a large quantity of convincing evidence to support his hypothesis. He gathered his evidence on an around the world trip that began when he was 22. He visited the Galapagos Islands and several other islands of the Pacific. Here he could see natural selection at play on the various islands. Though his ideas would be debated by religious figures who saw his theory as a threat, and by politicians and economists who attempted to apply "the survival of the fittest" to their fields, the vast majority of scientists had accepted the basic correctness of Darwin's theory by the time of his death in 1882.

Louis Pasteur

Why do people get sick? This question confounded the world's doctors until the 19th century. The most popular theory said that illness spread from rotting organic matter which released poison gases. In 1864, a French chemist named **Louis Pasteur** developed a new theory. He wanted to explain the ancient process of fermentation. His experiments led him to conclude that certain types of microorganisms fermented beverages and food. This discovery led him to the idea that some species of microorganisms could also produce harmful effects on humans and food. This is known as the germ theory of disease. Pasteur reasoned

that if you could eliminate or reduce these microorganisms you could eliminate disease. Soon doctors were sterilizing their instruments, milk was being boiled and people were routinely getting immunized. Within a few decades, life expectancy had doubled and diseases were being eliminated. Louis Pasteur is one of the few people in history who saved over a billion lives.

The Chemical Revolution

The Industrial Revolution would not have been possible without significant advances in chemistry. In 1803, a British chemist John Dalton theorized that all matter is made of tiny particles called atoms. Dalton showed that elements contain only one kind of atom, which has a specific weight. Compounds, on the other hand, contain more than one kind of atom. In 1869, Dmitri Mendeleev, a Russian chemist, organized a chart on which all the known elements were arranged in order of weight, from lightest to heaviest. He left gaps where he predicted new elements would be discovered. By the end of the century, most of the major elements had been discovered. This growth in chemical knowledge had a major impact on the Industrial Revolution and chemical engineering eventually impacted all aspects of life including weaponry, medicine, cleaning and industrial products. Natural materials such as stone, wood, cotton and glass would soon be replaced with chemically created products such as steel, plastic, vulcanized rubber and synthetic fibers.

Marie Curie

Marie Curie was history's most significant female scientist. The winner of the Nobel Prize in physics and chemistry, she is the only person to win the prize in multiple sciences. In a time in which barriers were thrown up to female education, Marie Curie became the first female professor at the University of Paris, then the world's most prestigious school. She opened the way for Einstein and the great achievements of atomic physics in the 20th century. Along the way, she transformed medicine and chemistry. Her achievements included a theory of *radioactivity* (a term that she coined), techniques for isolating radioactive isotopes, and the discovery of two elements, polonium and radium. During World War I, she established the first military field radiological centers to provide X-rays for wounded soldiers. Due to her experiments with radioactivity she got cancer and then developed chemotherapy to fight it. Radioactivity proved to be a powerful new source of energy for the Industrial Revolution, eventually used for both civilian and military purposes. Marie Curie proved that women could achieve in the sciences and make important scientific contributions.

The Electric Grid

The great American inventor Thomas Edison did not invent the light bulb, but he is most responsible for the vast amount of electricity which powers our lives. Born in 1847 in Ohio, Edison had his first invention at the age of 21. By the age of 25 he was wealthy and famous. Probably his most original invention, he had thousands, was the phonograph (an early record player) in 1877. However, his biggest impact was on the field of electricity. Edison developed the first cheap and reproducible light bulb and more importantly, a distribution system which made electric lighting practical for ordinary home use. After 1882, the use of electricity to light up the night spread rapidly around the world. Its applications seemed to multiply for the next hundred years. Today, we can hardly see a world without it.

Bicycle

Today, there are over 2 billion bicycles in the world. After walking, they are the most common form of transportation. However, the bicycle, a simple yet elegant machine, did not come along until the Industrial Revolution. The first bicycle was developed in 1817 in Germany but it was made of wood and was foot propelled. In 1866, the French attached a pedal to the front wheel and developed a steel frame, but it was so uncomfortable it earned the nickname “the boneshaker.” The pedal attached to the front wheel also made it difficult to steer. The modern bicycle, first called “the safety bicycle,” was developed around 1885. It had a chain drive which powered the rear wheel and pneumatic tires which made the ride more comfortable. In the 1890’s, Europe and America experienced a “bicycle craze.” Men and women of all classes wanted one and the streets became clogged with them. It seemed clear that the horse had been replaced forever. What could possibly top the bicycle for transportation?

Automobile

The “horseless carriage” began as a steam engine on wheels as early as 1769. The first ones were dangerous and intrusive and earned the nickname “the puffing devil.” They were mostly toys for the rich. In England, it was required that any steam powered vehicle be preceded by a man waving a red flag and blowing a horn. Steam powered vehicles advanced throughout the 19th century, but the key development on the road to the modern automobile was the development of the internal combustion engine using gasoline as a fuel source. The first to successfully incorporate the internal combustion engine into an automobile was Karl Benz of Germany in 1886. His Benz Motorwagen is considered the first modern automobile (his wife Bertha took the first long distance drive traveling 121 miles across Germany in 1888). By 1900, automobiles were being mass produced and a revolution in convenience and mobility had begun. The United States took the lead. In 1927 there were about 32 million* automobiles in the world- 90% of them were built in the United States.

*By 2011, there were over 1 billion automobiles on the roads.

Maxim Gun

The Maxim gun, invented in 1883, was the world’s most effective rapid firing machine gun. Prior to the Maxim gun, armies used rifles which could produce 1 or 2 shots a minute. In contrast, the Maxim gun could fire 10 shots a second or 600 rounds a minute. This made armies more powerful and warfare more violent. The Maxim gun proved its worth at the Battle of Shangani. In this battle against an African tribe, 700 British soldiers fought off 3,000 warriors with just four Maxim guns. This powerful technology played a key role in the European colonization of Africa.

Airplane

The dream of flight is likely as old as humanity. Humans have always wanted to fly like the birds. The ancient Chinese built kites that could lift a man. Leonardo da Vinci dedicated hundreds of pages of notes to the subject. By the late 1700’s, hydrogen balloons were beginning to lift people but it was the experiments with gliders that would eventually lead to the airplane. Understanding of the theory of flight advanced throughout the 19th century but the practical balance of power, control and lift was not figured out until the 20th century. The first powered, sustained and controlled flight was made by the Wright Brothers in North Carolina in 1903. The World Wars would encourage further development in airplanes including the addition of guns to aircraft in World War I and the development of the jet engine in World War II. In the 1950’s, these old military

aircraft were converted to commercial use and commercial airlines began to rapidly develop and proliferate. Today, people can be mass transported around the world in ways imagined, but never accomplished, before the Industrial Revolution.

These are the questions for understanding discussed in class. You do not have to answer these on a separate sheet but they are good for review and some could form the basis of test questions. They are good for review.

What invention expanded slavery in the American south? Why?

What invention made the Industrial Revolution possible? Why?

What achievements reduced transportation costs? Why?

How did transportation costs impact prices? Why?

What were the two most important canals? Why?

What were the “world’s first text messages”?

What important developments led to modern photography and film?

What major improvements led to the “safety bicycle?”

What invention had early nicknames of “horseless carriage” and “puffing devil?”

What key development led to the first modern automobile?

What technology played a key role in the European colonization of Africa? Why?

What invention studied “power, control and lift”?

What were the achievements of the following?

- James Watt
- Charles Darwin
- Louis Pasteur
- Marie Curie
- Thomas Edison
- Alexander Graham Bell
- John Dalton
- Dmitri Mendeleev
- Karl Benz
- Wright Brothers