

*Champions of Invention* — Study Guide — Questions and Activities

by

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**BY JOHN HUDSON TINER**

To enjoy the best results from this book, the following is recommended:

Each chapter has questions, discussion ideas, research topics and suggestions for further reading to improve students' reading, writing and thinking skills.

The study guide shows the relationship of events in *Champions of Invention* to other fields of learning. The book becomes a springboard for exploration in other fields. Students who enjoy literature, history, art or other subjects will find interesting activities in their fields of interest.

Parents will find that the questions and activities enhance their investments in the Champion books because children of different age levels can use them.

The questions with answers are designed for younger readers. Questions are objective and depend solely on the text of the book itself. The questions are arranged in the same order as the content of each chapter. A student can enjoy the book and quickly check his or her understanding and comprehension by the challenge of answering the questions.

The activities are designed to serve as supplemental material for older students. The activities require greater knowledge and research skills. An older student (or the same student three or four years later) can read the book and do the activities in depth.

**CHAPTER 1 QUESTIONS**

1. T F —John Gutenberg's early life is well known.
2. A B C D — Handwritten manuscripts were checked by (A. counting letters B. reading it twice C. scanning it into a computer D. writing it twice).
3. Copying the Bible by hand took about \_\_\_\_\_ years.
4. A B — In John Gutenberg's day, books were (A. considered unimportant and worthless B. few in number and expensive).
5. A B — Gutenberg's design called for (A. a metal mold of an entire page B. individual letters that could be rearranged to make new pages).
6. T F — Gutenberg's first printing press worked flawlessly.
7. The four main parts of the printing process were metal type, press, paper and \_\_\_\_\_.
8. A B C D — The metal that proved successful for type was (A. copper B. gold C. iron D. lead).
9. A B C — The press was made from a device that (A. removed wrinkles from clothes B. squeezed juice from grapes C. inflated automobile tires).
10. A B — The source of ink was (A. a mixture made by Gutenberg B. the same as that used with wood blocks).

11. A B C D — Parchment is made from (A. bamboo B. silk C. skins D. wood pulp).
12. A B — Expensive books were printed on (A. paper B. parchment).
13. A B C D — In 1454, John Gutenberg began printing (A. Poor Richard's Almanack B. the Constitution of the United States C. the Dead Sea Scrolls D. the entire Bible).
14. T F — John Gutenberg produced crude books but took satisfaction in knowing that his process could be improved in future generations.
15. A B — Compared to other ways of printing books, Gutenberg's method was (A. costly B. less expensive).
16. T F — More than a hundred years passed before 300 books were printed.
17. T F — The book *On the Revolution of the Celestial Sphere* stated that the sun was the center of the planetary system.
18. A B C D — Students of (A. astronomy B. mathematics C. sewing D. medicine) read *Fabric of the Human Body*.
19. A B — In 1543, books by Copernicus and Vesalius mark the start of the (A. Industrial Revolution B. Scientific Revolution).
20. T F — The printing press had a role in increasing an interest in art.
21. A B — Bibles printed in everyday languages helped start the (A. Reformation B. Second Great Awakening).
22. T F — As newspapers became more common, ordinary citizens became better educated and demanded democratic governments.
23. A B — Gutenberg described himself as (A. humble B. wise).

## CHAPTER 1 ACTIVITIES

**Think and Discuss:** Why is John Gutenberg considered the greatest inventor of all time?

**Art:** What is an illuminated manuscript? Copy the page of a book and enhance it with decorative work, colored letters and other illustrations.

**Geography:** The main way that Chinese discoveries became known to Europeans was by trade along the Silk Road. What route does it follow and what countries does it cross? When was it first traveled? Is the route still in use today?

**Literature:** Some of the first books published with Gutenberg's printing method were those of the ancient Greeks and Romans: *The Republic* by Plato, *Prometheus Bound* by Aeschylus, *Ethics* by Aristotle, the *Illiad* and *Odyssey* by Homer, *The Aeneid* by Virgil. Other books that became popular were the *Travels* of Marco Polo and *The Divine Comedy* by Dante. Sample some of the chapters in these books. Choose a paragraph that is difficult to comprehend and translate it into modern English that is easy to understand.

**Science:** What were some of the simple machines in everyday use in Gutenberg's time? Which ones were used in the design of the first printing press? Research the history of papermaking.

**Social Studies:** Some of the great Freedom Documents include the Mayflower Compact (1620), Thomas Paine's 50-page pamphlet, *Common Sense* (1776), Federalist Papers (1788), Declaration of Independence (1776), Constitution of the United States (1787) and Bill of Rights (1791). Choose one of the documents, describe its importance and impact on history and discuss how its effect would have been different if the printing press had not been invented.

**Explore:** Choose one of the individuals below and write a biography of his major achievements.

Marco Polo (1254-1324), Italian traveler to China  
William Caxton (1422-1491), first English printer  
Nicolaus Copernicus (1473-1543), Polish astronomer  
Titian (1488-1576), Italian painter  
Martin Luther (1483-1546), German religious leader  
William Tyndale (1492-1536), English biblical translator  
Andreas Vesalius (1514-1564), Belgian physician

## CHAPTER 2 QUESTIONS

1. For doing work, ancient people used wind, water or \_\_\_\_\_.
2. A B C D — The ancient Hebrews were slaves in (A. Egypt B. Gaul C. Greece D. Rome).
3. A B C D — The inventor who made a practical steam engine was named (A. Hero of Alexandria B. James Watt C. Matthew Boulton D. Thomas Newcomen).
4. T F — James Watt was a science teachers at the University of Glasgow.
5. A B — Hero of Alexandria lived about (A. 200 B. 2,000) years ago.
6. A B — Thomas Newcomen's steam engine moved as steam (A. pressed against a cylinder B. condensed back into water).
7. A B — The steam engine design that had hot and cold chambers was that by (A. James Watt B. Thomas Newcomen).
8. A B C — The purpose of the flywheel was to (A. keep bugs out of the steam engine B. prevent the steam engine from flying away C. store energy).
9. A B C D — Matthew Boulton was a (A. businessman B. coal mine owner C. Glasgow professor D. ship builder).
10. A B C D — The watt is a metric unit that measures (A. energy B. heat C. power D. time).
11. T F — The governor was a mechanical device to run a steam engine at a set speed.
12. A B C D — Robert Fulton made the successful steamship trial on (A. the Atlantic Ocean B. the Hudson River C. Lake Michigan D. the Nile River).

13. The steam locomotive built by George Stephenson carried passengers at \_\_\_\_\_ miles per hour.
14. T F — James Watt and his partner earned no profit from the steam engine.
15. A B C D — James Watt's invention helped start (A. the computer age B. the Industrial Revolution C. the Scientific Revolution D. slave trade).

## CHAPTER 2 ACTIVITIES

**Art:** Magazines often have artists illustrate the world of the future. Find drawings made years ago that purport to show how the world will look today. How do the ideas differ from reality? Sketch how you think your local shopping center or mall will appear in 100 years.

**Geography:** Find the following on a map: Alexandria, Egypt (home of Hero of Alexandria), New York City to Albany, New York, along the Hudson River (where Robert Fulton tested his steamship, *Clermont*), Glasgow, Scotland (where James Watt worked), Liverpool and Manchester, England (Stephenson's steam locomotive the *Rocket* won a competition with other locomotives in traveling a rail line between the two cities).

**Mathematics:** Fulton's steamship *Clermont* made a run of 150 miles up the Hudson River in 32 hours. What was its speed in miles per hour? Consult a book of recent world records and identify the top speed of vehicles on land, in water, in the air and in space. How long would it take each vehicle to go 150 miles?

**Science:** Watt's steam engine governor was the first automatic control of machinery. The term *automation* applies to automatic devices that can operate independently or nearly independently of human control. What are some current applications of automation? Why must an unmanned probe to Mars be capable of automatic control?

**Social Studies:** The industrial revolution changed the world in a fundamental way. What are some of the positive outcomes of the industrial revolution, and what were some the negative ones.

**Explore:** Choose one of individuals below and write a biography about his major achievements.

Hero of Alexander (about AD 62), Greek scientist

James Cook (1728-1779), English explorer

Joseph Black (1728-1799), British chemist

Joseph (1740-1810), and Jacques Montgolfier (1745-1799), French inventors

Robert Fulton (1765-1815), American inventor

George Stephenson (1781-1848), British inventor

Nicolas Léonard Sadi Carnot (1796-1832), French scientist

## CHAPTER 3 QUESTIONS

1. T F — The world of 1750 contained inventions that would be impossible for an ancient Roman to grasp.
2. T F — Because he pursued many professions, Benjamin Franklin was successful at none of them.
3. A B — Benjamin Franklin received (A. an advanced degree at Cambridge B. only two years of formal education).
4. T F — Benjamin Franklin was stranded in London because of the War of 1812.
5. T F — While in London, Benjamin Franklin was hired to teach swimming.
6. A B C D — Benjamin Franklin earned a living in Philadelphia as a (A. candlestick maker B. doctor C. lawyer D. printer).
7. T F — Benjamin Franklin wrote, "A man is no taller than when he is on his knees."
8. T F — Benjamin Franklin's autobiography proved to be a disappointment because of poor sales.
9. During Benjamin Franklin's time, \_\_\_\_\_ became the largest city in North America.
10. A B — A fireplace was (A. good B. poor) at heating a home.
11. Elektron was the Greek word for \_\_\_\_\_.
12. T F — Static charges attract one another but never repel.
13. A B — The symbol - (minus) was used to show that a package was (A. over B. under) weight.
14. A B — A body that gains electrons has a (A. negative B. positive) charge.
15. A B — The first law of static electricity states that like static electric charges (A. attract B. repel) one another.
16. A B — A rubber rod with a negative charge will attract (A. another rubber rod with a negative charge B. a glass rod with a positive charge).
17. T F — Bodies charged with static electricity will attract uncharged ones.
18. T F — Benjamin Franklin showed that lightning and static electricity were vastly different.
19. T F — The experiment of flying a kite during an electric storm was exceptionally dangerous.
20. Benjamin Franklin wrote, "There is one God, who made all things. He \_\_\_\_\_ the world by His providence."

### CHAPTER 3 ACTIVITIES

**Astronomy:** An almanac such as Franklin's *Poor Richard's Almanack* gave information about the time of sunrise and sunset, phases of the moon, start of the seasons, tide information and

predictions about solar and lunar eclipses. Why would this information be of importance to farmers, travelers and businessmen of his day? What is the physical explanation for the seasons? Why are daylight hours longer in summer than in winter? Why are the daylight hours different in northern latitudes than at the equator on the same day of the year?

**Composition:** Keep a notebook and copy down sayings that you see on church and business marquees. Example: "When you manage to open the door of opportunity, leave it open so others can follow." Some may be old-fashioned. Rewrite those in modern language. Some may be negative, make them into positive statements. Example: "Unsuccessful people cannot see beyond the visible" becomes "Successful people see beyond what is visible." Compose your own original sayings.

**Literature:** What is the difference between a biography and autobiography? Illustrate the difference with quotations from Franklin's *Autobiography* and Plutarch's *Lives* (also known as *Parallel Lives*). What is the difference between a fictional story and a religious allegory? Illustrate the difference with quotations from John Bunyan's *The Pilgrim's Progress* and Daniel Defoe's *Robinson Crusoe*.

**Science:** Research the principles of the operation of the following devices and identify the ones that would work without the benefit of electricity: clock, hot air balloon, barometer, photograph, solid fuel rocket, submarine, telegraph and telephone.

**Social Studies:** At different times in history, the most influential cities in North America were Cahokia Mounds (about 1200 A. D.), Boston, Philadelphia and New York. Research the events that caused the changes in population. What role did the Erie canal and the invention of the steamship have in changing the prominence of Philadelphia and New York?

**Explore:** Choose one of the individuals below and write a biography of his major achievements.

Thales of Melitus (624-546 BC), Greek philosopher  
Plutarch (AD 46 -120), Greek biographer  
William Gilbert (1544-1603), English scientist  
John Bunyan (1628-88), English writer  
Daniel Defoe (1660-1731), English novelist  
George Washington (1732-1799), first president of the United States

## CHAPTER 4 QUESTIONS

1. A B C D — Scientists were hindered in their study of electricity because they lacked (A. a dependable supply of electricity B. cooperation among scientists C. insulated copper wire D. laws that protected their discoveries).
2. A B — Electricity in motion is known as (A. current B static) electricity.
3. A B C D — Samuel F. B. Morse traveled to England to study to be (A. a mapmaker B. a printer C. an artist D. an inventor).

4. A B C D — Samuel F. B. Morse's style of painting became known as (A. Baroque B. Democratic Art C. Expressionism D. Gothic).
5. T F — Samuel F. B. Morse took a lead in starting training schools for preachers.
6. A B C — Samuel F. B. Morse learned of the death of his wife (A. eight days B. 11 days C. one month) after it occurred.
7. A B C D — Samuel Morse believed New York City would become more important because of (A. the Erie Canal B. the Holland Tunnel under the Hudson River C. the Panama Canal D. the Suez Canal).
8. Alexander von Humboldt had the unusual ability of recognizing talent and \_\_\_\_\_ people.
9. A B C D — Alexander von Humboldt had explored (A. Antarctica B. Australia C. the Gobi Desert D. South America).
10. The French visual method of sending messages was known as \_\_\_\_\_.
11. A B C D — Samuel Morse sketched his first design of a telegraph (A. as he lectured to students about painting B. while eating a meal with Alexander von Humboldt C. while painting in the Louvre D. while sailing home aboard a ship).
12. The word telegraph means writing at a \_\_\_\_\_.
13. A B — The businessmen who saw the first telegraph were (A. excited about its possibilities B. not impressed).
14. A B C D — Louis Daguerre's process made photographs on sheets of metal coated with (A. black ink B. egg whites C. silver D. table salt).
15. A B C D — Samuel Morse's test line ran between Baltimore and (A. Boston B. New York C. Savannah D. Washington D.C.).
16. T F — The telegraph helped improve weather forecasting.
17. A B C D — The first message sent by the telegraph was (A. a line from the song "Silent Night" B. a passage from the Old Testament C. words from the Bill of Rights D. the Morse Code letters SOS).
18. A B C D — Samuel Morse used the first money from the telegraph to (A. fund a school on photography B. help a church start a Sunday School C. pay back taxes D. take a long sea voyage to the South Pacific).

#### **CHAPTER 4 ACTIVITIES**

**Architecture:** One of Samuel Morse's paintings "Representative Hall" showed lawmakers at work in the Capitol building in Washington D. C.. Who was the architect of the United States Capitol building? Who was responsible for the design of the city of Washington D. C.?

**Art:** Make a labeled drawing showing the main parts of a telegraph. Design a poster advertising the advantages of the telegraph over mail dispatches for carrying important messages.

**Communication:** Write a short article about an event that occurred in the last year in which you were directly involved. Now write it as if sending a telegram in which every word cost money. How briefly can you convey the same information?

**Geography:** List the 13 original colonies and their capital cities at the time the United States gained its independence. Sketch map showing their locations. What city was the capital of the new nation? Which colonies had the best reputation for religious freedom? New York passed a law requiring its citizens to set slaves free. In what year did the law take effect?

**History:** The Battle of New Orleans was fought 14 days after a peace treaty had been signed. In what war did the Battle of New Orleans take place? Who were the combatants? What events led to this war?

**Science:** Research the science of weather forecasting. What instruments are used to collect weather data? When were they invented?

**Explore:** Choose one of the individuals below and write a biography of his major achievements.

Alessandro Volta (1745-1827), Italian scientist

Lafayette(1757-1834), French military leader and statesman

Alexander von Humboldt (1769-1859), German explorer

Washington Allston (1779-1843), American painter

Louis Daguerre (1789-1851), French painter and inventor of photography

Mathew Brady (1823-1896), American photographer

## CHAPTER 5 QUESTIONS

1. A B C D — Faraday's father was a (A. blacksmith B. farmer C. London shop owner D. ship's captain).
2. T F — Michael Faraday attended public school in London.
3. A B C D — Children with slight builds often earned an income (A. as chimney sweeps B. grooming horses C. running errands D. selling newspapers).
4. T F — Michael Faraday was employed at a bookbinder's shop.
5. A B C D — Michael Faraday wanted to attend science lectures by (A. Humphry Davy B. Hans Christian Orested C. James Clerk Maxwell D. James Watt).
6. A B C D — To introduce himself, Faraday presented (A. a business card B. a letter of recommendation C. a notebook D. his college transcript) to Humphry Davy.
7. T F — The first job that Michael Fraday did for Humphry Davy was to read to him.
8. T F — Hans Christian Orested showed that an electric current causes a magnetic field around

- a wire.
9. A B C D — The one who made the first electric motor was (A. Hans Christian Orested B. Humphry Davy C. Michael Faraday D. Samuel F. B. Morse).
  10. T F — Despite years of trying, Michael Faraday never did make an electric generator.
  11. T F — A transformer changes the speed of an electric current.
  12. T F — Michael Faraday made a fortune from his many inventions.
  13. A B C D — At Christmas, Faraday gave free (A. books B. candy C. presents D. science lectures) to children.
  14. T F — Faraday's book *The Chemical History of the Candle* was written especially for children.
  15. T F — Michael Faraday is hardly known among scientists today.

## CHAPTER 5

**Architecture:** Westminster Abbey is the most famous church in Great Britain. Read about it and identify some of the important ceremonies that take place in it? What is the history of its construction? Has its design changed after construction finished? Was it damaged during the bombing of World War II?

**Communication:** How did you or someone you know receive their first paying job? Suppose you want to work for a particular individual who does not know you? What could you do to be favorably considered for the job?

**Health:** During his last years, Michael Faraday suffered from loss of memory and decided to retire. He gave away his scientific research notes so others could benefit from his work. What are some of the medical causes of memory loss? What are the symptoms of Alzheimer's disease? How can it be treated?

**Literature:** Life in London during the time of Michael Faraday are portrayed in books by Charles Dickens, including *David Copperfield*. In what way is the life of David Copperfield similar to that of Michael Faraday?

**Science:** Who invented the electromagnet? What are the advantages of an electromagnet compared to a permanent magnet? What devices use tiny electromagnets? What is Magnetic Resonance Imaging (MRI), and how is it used in medicine?

**Explore:** Choose one of the individuals below and write a biography of his major achievements.

Hans Christian Orested (1777-1851), Danish physicist  
Humphry Davy (1778-1829), British chemist  
Charles Dickens (1812-1870), English writer *A Tale of Two Cities* (1859),  
Queen Victoria (1819-1901), queen of the United Kingdom of Great Britain

James Clerk Maxwell (1831-1879), British physicist  
Albert Einstein (1879-1955), German-born American physicist

## CHAPTER 6 QUESTIONS

1. A B C D — The life of Joseph Henry is similar to that of (A. Benjamin Franklin B. James Watt C. Michael Faraday D. Thomas Edison).
2. A B C D — Joseph Henry had a pair of boots with different shapes for the toes because (A. he could not make up his mind about their shape B. his mother bought cheaper mismatched shoes C. a science experiment went wrong D. a foot was crushed in a carriage accident).
3. T F — Joseph Henry's book about science experiments was given to him by a boarder.
4. A B C — Joseph Henry finished his high school course of study in seven (A. weeks B. months C. years).
5. A B C D — Michael Faraday, and not Joseph Henry, received credit for many inventions because (A. English scientific journals refused to publish papers by an American B. Faraday's friends ensured that he received credit C. Faraday published first D. Faraday took out patents first).
6. A B C D — The electromagnet was invented by (A. Alexander Graham Bell B. Joseph Henry C. Michael Faraday D. William Sturgeon).
7. T F — An electromagnet can be made stronger by increasing the current.
8. T F — An electromagnet can be made stronger by using more turns of wire around the iron bar.
9. A B C D — Joseph Henry used shellac on wires to (A. improve their electrical conductivity B. insulate them C. keep them from melting D. prevent birds from landing on the line).
10. A B C D — Joseph Henry became a teacher at the school that later became (A. College of the Holy Cross B. Harvard University C. Princeton University D. Yale University).
11. T F — The purpose of Henry's electric relay was to send facsimile (FAX) copies of written documents.
12. T F — Joseph Henry's role in making Morse's telegraph successful is well known because of the notes that Henry released after their meeting.
13. T F — Neither Faraday nor Henry patented their inventions.
14. A B C D — Joseph Henry used Smithsonian Institution money to (A. collect weather information B. explore the west and the Grand Canyon C. print books of scientific discoveries D. all of the above).
15. A B C D — The person who assisted Joseph Henry in his late night study of signal lanterns was (A. Abraham Lincoln B. James Smithson C. Samuel F. B. Morse D. William Sturgeon).

16. A B C D — Alexander Graham Bell was a (A. a portrait painter B. an railroad conductor C. medicine salesman D. teacher of speech to the deaf).
17. A B C D — The message "Mr. Watson, please come here. I want you" was first spoken over the telephone in the year (A. 1812 B. 1860 C. 1876 D. 1903).
18. A B — Carbon (A. does B. does not) conduct electricity.
19. A B C D — One of the essential parts of Mr. Bell's telephone was (A. a long pendulum B. a mirror silvered on the front side C. a small electromagnetic D. a small gasoline powered motor).
20. The one hundredth anniversary of what event did the 1876 Centennial Exposition in Philadelphia celebrate? \_\_\_\_\_
21. T F — The Western Union Telegraph Company bought rights to the telephone for \$100,000.
22. A B C D — The pilot of the first public, mile-long airplane flight in the United States was (A. Charles A. Lindburgh B. Glenn Curtiss C. Samuel Pierpont Langley D. the Wright brothers).

## CHAPTER 6 ACTIVITIES

**Art:** Both artists and photographers covered the American civil War. In what ways are photographs more accurate than hand drawn illustrations? Under what circumstances are hand drawn illustrations superior?

**Communication:** The Civil War was one of the first major conflicts in which news dispatches sent by telegraph kept people informed of the daily progress of the fighting. Study one of the battles that lasted three days or more and write newspaper headlines using no more than four or five words to summarize the main events of each day of the battle.

**Geography:** Trace out the route of the Colorado River. Where is its source? What are its major tributaries? Where is its mouth? Are there any dams along its route? What laws have been enacted to control the use of the water that it carries?

**Health and Human Physiology:** Braille printing was invented by Louis Braille, a French teacher of the blind, in 1829. Thomas Gallaudet developed the modern form of American Sign Language for the deaf in 1817. Research the background of the development of Braille printing and American Sign Language. What modern inventions help people who have vision or hearing impairments?

**History:** Research the activities of the Smithsonian Institution. Why is the Smithsonian Institution sometimes called America's Attic? What museums are currently part of the Smithsonian? To celebrate the anniversary of an important event, people put ordinary items from daily life in a "time capsule" to be opened 100 or more years in the future. What objects would you put in a time capsule to demonstrate the history of your life and times?

**Science:** Research the development of heavier-than-aircraft. How did Glen Curtiss's airplane differ from the one developed by the Wright Brothers? What new areas of flight did Curtiss open? Who built the airplane that first carried a passenger? What were some of the early uses for the airplane?

**Social Studies:** Two inventions of this period were the typewriter and sewing machine. Young women who learned how to operate the machines had a source of income and became more independent. How did these and other inventions change the social structure of society in the 1800s.

**Explore:** Choose one of the individuals below and write a biography of his or her major achievements.

Abraham Lincoln (1809-1865), 16th president of the United States  
Samuel Pierpont Langley (1834-1906), American astronomer, aircraft designer  
Wilbur (1867-1912) and Orville (1871-1948) Wright, American inventors  
Glenn Curtiss (1878-1930), American aviator and inventor  
Helen Keller (1880–1968), U.S. author, lecturer

## CHAPTER 7 QUESTIONS

1. T F — William Thomson is the only Scottish scientist of note.
2. A B C D — William Thomson became a science teacher at (A. Cambridge University B. Edinburgh University C. Glasgow University D. the University of Paris).
3. T F — Until the 1800s, most scientists believed heat to be a substance.
4. T F — Count Rumford concluded that heat is a form of energy.
5. A B C D — The person who was fascinated with measuring changes in temperature was (A. Alexander Fleming B. Count Rumford C. James Joule D. Sherlock Holmes).
6. A B — The water of a waterfall was (A. warmer B. cooler) at the bottom.
7. A B C D — James Joule's discoveries about heat were first published (A. as a collection of letters by Michael Faraday B. in a Manchester newspaper C. in a scientific journal D. by the Royal Society).
8. T F — The first scientist to express an interest in James Joule's studies was Cyrus Field.
9. A B — A gas that expands freely will become (A. cooler B. warmer).
10. A B C D — When a substance grows warmer, its atoms (A. become smaller B. change into another substance C. move less quickly D. move more quickly).
11. A B C D — The temperature so cold that all heat energy is removed is called (A. absolute zero B. the cryogenic cascade C. the Curie temperature D. the gamma point).
12. T F — William Thomson calculated that the coldest temperature possible was  $-32^{\circ}\text{C}$ .

13. A B C D — In the expression 291°K, the K stands for (A. Kaibab Plateau B. Kelvin C. Key degree D. kilo).
14. A B — According to the second law of thermodynamics, the universe as a whole is becoming (A. more B. less) disorganized.
15. A B C D — Cyrus Field (A. built the first ocean going steam ship B. developed the first vacuum tubes C. laid a telegraph cable across the Atlantic D. paid William Thomson to build a submarine).
16. A B — William Thomson suggested that the trans-Atlantic telegraph should send messages with (A. faint electric signals B. powerful surges of electricity).

## CHAPTER 7 ACTIVITIES

**Art:** Research the design of the steamship *Great Eastern*, largest steamship in the world from 1858 to 1889. Draw the ship as it battled a storm while laying the transatlantic telegraph cable.

**Communication:** In the 1800s, some newspapers had the word telegraph in their names to show that they were using the latest technology. The London *Daily Telegraph* is one example. Today, news stories can be presented in many different ways: newspapers, magazines, radio, television and the Internet. Select a major story that has just occurred and examine how different media report the event. How does the newspaper differ from the magazine? How is the sound only news of radio different from the sound and pictures of television? How does a 30-minute network news broadcast differ from the broadcast of a 24-hour news cable channel?

**Geography:** Mary Slessor (1848-1915) was a missionary to the area around Calabar in Africa. In what country is the city of Calabar located? David Livingstone (1813-1873) was a Scottish missionary, physician, writer and explorer to Africa. He landed at Port Elizabeth, and traveled to Mabotsa. His exploration took him across the Kalahari desert and then west to Loanda (present day Luanda in Angola). He traveled east to the Zambezi River and to Victoria Falls. He continued east and reached the Indian Ocean at Quilimane. Consult an atlas with a map of Africa and find these locations.

**History:** King James I of England was the monarch who authorized the King James Translation of the Bible. Who was his mother? How did she die? Under what circumstances did he become King of England? What was the Gunpowder Plot? What influence did King James have in the colonization of America? Was Jamestown Colony, Virginia named in his honor?

**Literature:** James Boswell, Robert Burns, Arthur Conan Doyle, Sir Walter Scott and Robert Louis Stevenson are all writers from Scotland who are held in high regard. Choose any two, read some of their material, and contrast and compare their writing styles and subject matter. What are some of the ways that their writing broke new ground? How did their early lives influence their later writing? Which writer do you prefer and why?

**Science:** Some substances undergo a sudden change in properties as they are chilled near absolute zero. Metals become superconductors. What are some of the other properties exhibited

by supercooled metals and gases such as helium? How are temperatures near absolute zero achieved? Has any practical application been found for supercooled materials?

**Explore:** Choose one of the individuals below and write a biography of his major achievements.

Samuel Johnson (1709-1784), English writer

Jacques Charles (1746-1823), French chemist

Count Rumford, Benjamin Thompson, (1753-1814), British-American physicist

Cyrus Field (1819-92), American businessman

John Dunlop (1840-1921), British inventor of the pneumatic tyre

James Dewar (1842-1923), British chemist

Alexander Fleming (1881-1955), British physician who discovered penicillin

## CHAPTER 8 QUESTIONS

1. T F — Thomas Alva Edison was educated at home.
2. T F — Edison's first job was selling apples to passengers on a horse drawn trolley line.
3. A B C D — With income from his work as a telegraph operator, Edison bought (A. a printing press B. a telegraph station C. books about electricity D. private lessons with a speech instructor).
4. A B C D — The invention that Edison sold for \$40,000 was the (A. electric light B. phonograph C. stock ticker D. waxed paper).
5. A B C D — The first phonograph recordings were on a (A. magnetized wire B. plastic disk C. semi-conducting microchip D. cylinder covered with tinfoil).
6. A B C D — "Phono" means (A. distance B. light C. sound D. write).
7. T F — Edison's electric light was the first bright source of light.
8. A B C D — The first light bulb had a filament of (A. copper wire B. iron rust C. scorched cotton thread D. tungsten).
9. T F — The *Great Train Robbery* was the first motion picture with sound.
10. T F — Edison saw no particular use for his discovery that electrons boil away from a hot filament connected to a source of electricity.
11. A B C D — The person who invented the wireless telegraph was (A. Guglielmo Marconi B. John Ambrose Fleming C. Lee De Forest D. Thomas Edison).
12. T F — Fleming's vacuum tube with two electrodes became known as a triode.
13. T F — The first radio broadcast was a Christian hymn.
14. T F — Vacuum tubes have been entirely replaced with semiconductors.

## CHAPTER 8 ACTIVITIES

**Art:** A flip-art animation book is made by drawing pictures on small sheets of heavy paper with each picture slightly different from another. When the pages are flipped in rapid succession, the illusion of motion is created. Choose a simple subject (dog jumping through a hoop, ball rolling down a ramp, etc.) and make a flip art book.

**Chemistry:** The filaments of incandescent lights (regular light bulbs) are made of what metal? What gas surrounds the filament inside the light bulb? Why purpose does the gas serve? How does a halogen lamp differ from an incandescent lamp? Fluorescent tubes are also used for lighting. What chemical coats the inside of fluorescent lamps? What gas is inside a fluorescent tube?

**Geography:** Locate on a map the cities of Cornwall, England; Detroit, Michigan; Menlo Park, New Jersey; Milan, Ohio; St. Johns, Newfoundland. Why did Guglielmo Marconi choose Cornwall and St. Johns as stations for experimenting with wireless communication across the Atlantic? Why is Detroit called the motor city?

**Literature:** Research the format of a movie script. Rewrite a short story you or a friend has written as a screenplay.

**Physics:** Visual light and radio waves are types of electromagnetic waves that are part of a much larger spectrum. What are the names of the other types of electromagnetic waves that make the complete electromagnetic spectrum? What are the primary uses of each? Have communication devices been made that use each of the various kinds of waves?

**Physiology:** Motion pictures appear to show moving objects, but the image is made of a series of still pictures. How is the effect of motion achieved? What is the persistence of vision? Are the number of pictures per second shown by a motion picture projector the same as the number of pictures per second that are displayed on a television screen? How many pictures per second must be shown to prevent the image from appearing jumpy?

**Science:** In radio, what is the difference in AM and FM? What are the advantages and disadvantages of each type of broadcast.

**Explore:** Choose one of the individuals below and write a biography of his major achievements.

Joseph Swan (1828-1914), English physicist

John Ambrose Fleming (1849-1945), English engineer

Heinrich R. Hertz (1857-94), German physicist

Charles Proteus Steinmetz (1865-1923), German-American electrical engineer

Lee De Forest (1873-1961), American inventor

Guglielmo Marconi (1874-1937), Italian electrical engineer

## CHAPTER 9 QUESTIONS

1. T F — When Charles Babbage attended Cambridge University it was the most advanced university in the world.
2. A B C D — Joseph Jacquard's invention used holes punched in cards to (A. control looms for weaving cloth B. input information into computers C. register votes in French elections D. tally the results of census studies).
3. T F — Mathematicians in Europe used a better notation for calculus than the one invented by Newton.
4. T F — Babbage showed that the cost of mailing a half-ounce letter should be based on distance to its destination.
5. A B — The British government (A. did B. did not) adopt Babbage's recommendations about the postal service.
6. T F — England's postal system was the model that other countries followed.
7. T F — Charles Babbage was the first person to try to build a calculating machine.
8. A B — The analytical engine was a (A. mechanical B. electrical) device.
9. A B C D — Babbage's analytical engine used punched cards to (A. to contain instructions for the machine B. to input numbers into the machine C. to store partial answers D. all of the above).
10. T F — Ada Augusta, Countess of Lovelace, was the first person to write a computer program.
11. T F — Ada Augusta believed Babbage's analytical machine might someday be capable of composing music.
12. A B C D — Charles Babbage's analytical engine failed because (A. he lacked the vision of what it could do B. he could raise no money to build it C. the French owned the patent rights and refused to release them D. the technology of his day could not support the intricate design).
13. T F — Atkin's machine, Mark I, was the first electronic cash register.
14. T F — As his life drew to a close, Charles Babbage realized he had been a failure.

## CHAPTER 9 ACTIVITIES

**Art:** Stamps are often used to celebrate important events or honor the achievements of individuals. The design begins as a large illustration that is reduced to stamp size. The design must be simple and uncluttered to be effective at the smaller size of a stamp. Research the accomplishments of Charles A. Lindburgh or one of the other pioneers of airmail and design a stamp to honor his or her achievement.

**Computer science:** Research the different uses of punched cards. What role did they play in the census of 1900? What role did punched cards play in the presidential election of 2000?

**Music:** Ada Augusta suggested that a computer may one day be capable of composing music. Research the use of computers in the composition of music. Is software available so that a person can compose music with a home computer?

**Computer Science:** At one time physicists used a slide rule, a type of analog calculator, for solving mathematical problems. How does an analog calculator such as a slide rule differ from a digital calculator?

**Economics:** What was the cost of sending a letter by Pony Express (1860-1861) from St. Joseph, Missouri to Sacramento, California? Compare the cost for sending a one-page letter through the U. S. Mail with a private carrier such as UPS or FEDEX. When would one be used rather than the other? Suppose a package of one pound must be sent. What are the rates in that case? A letter one-ounce or less in weight can be sent anywhere in the United States for a flat rate. Are any other services offered in this way?

**Explore:** Choose one of the individuals below and write a biography about his or her major achievements.

Gottfried Leibnitz (1646-1716), German mathematician

Edmund Cartwright (1743-1823), British inventor

John Herschel (1792-1871), British scientist

Sir Rowland Hill (1795-1879), originator of the penny postage system

Ada Augusta, Countess of Lovelace (1815-1852), British mathematician

Hollerith, Herman (1860-1929), American inventor

Howard H. Aiken (1900-1973), builder of first modern computer

Grace Murray Hopper (1906-1992), American navy officer, mathematician

## **ANSWERS TO QUESTIONS**

### **CHAPTER 1**

1. F — we know little about his early days
2. A — counting letters
3. seven
4. B — few in number and expensive
5. B — individual letters
6. F — he worked on it for years
7. ink
8. A — copper
9. B — squeezed juice from grapes
10. A — a mixture made by Gutenberg
11. C — skins
12. B — parchment
13. D — the entire Bible
14. F — his first book had excellent workmanship
15. B — less expensive
16. F — within 50 years nine million books were printed
17. T
18. D — medicine
19. B — Scientific Revolution
20. T
21. A — Reformation
22. T
23. A — humble

### **CHAPTER 2**

1. muscles
2. A — Egypt
3. B — James Watt
4. F — James Watt repaired instruments
5. B — 2,000
6. B — condensed back into water
7. A — James Watt
8. C — store energy

9. A — businessman
10. C — power
11. T
12. B — Hudson River
13. 24
14. F — they earned a good profit
15. B — the Industrial Revolution

### **CHAPTER 3**

1. F — the ideas were known to the ancient Romans
2. F — he was successful in many fields
3. B — only two years of formal education
4. F — a dishonest storeowner left him there without return fare
5. T
6. D — printer
7. T
8. F — it became one of the most successful autobiographies ever written
9. C — Philadelphia
10. B — poor
11. amber
12. F — like static charges repel
13. B — under
14. A — negative
15. B — repel
16. B — a glass rod with a positive charge
17. T
18. F — they have the same properties
19. T
20. governs

### **CHAPTER 4**

1. A — a dependable supply of electricity
2. A — current
3. C — an artist
4. B — Democratic Art
5. F — he started Sunday Schools

6. A — eight days
7. A — the Erie Canal
8. encouraging
9. D — South America
10. semaphore
11. D — while sailing home aboard a ship
12. distance
13. B — not impressed
14. C — silver
15. D — Washington D. C.
16. T
17. B — a verse from the Old Testament
18. B — help a church start a Sunday School

## **CHAPTER 5**

1. A — blacksmith
2. F — London had no free schools
3. A — as chimney sweeps
4. T
5. A — Humphry Davy
6. C — a notebook
7. T
8. T
9. C — Michael Faraday
10. F — after ten years he did succeed
11. F — it changes the voltage
12. F — he did not accumulate wealth
13. D — science lectures
14. T
15. F — he is considered one of the top ten scientists of all time

## **CHAPTER 6**

1. C — Michael Faraday
2. A — he could not make up his mind about their shape
3. T
4. B — months

5. C — Faraday published first
6. D — William Sturgeon
7. T
8. T
9. B — to insulate them
10. C — Princeton University
11. F — engage fresh batteries so an electric signal could go over great distance
12. F — he kept secret what they discussed
13. T
14. D — all of the above
15. A — Abraham Lincoln
16. D — teacher of speech to the deaf
17. C — 1876
18. A — does
19. C — a small electromagnetic
20. the Declaration of Independence
21. F — they did not purchase the invention
22. B — Glenn Curtiss

## **CHAPTER 7**

1. F — Scotland has produced many great scientists
2. C — Glasgow University
3. T
4. T
5. C — James Joule
6. A — warmer
7. B — in a Manchester newspaper
8. F — William Thomson
9. A — cooler
10. D — move more quickly
11. A — absolute zero
12. F —  $-273\text{ }^{\circ}\text{C}$
13. B — Kelvin
14. A — more
15. C — laid a telegraph cable across the Atlantic
16. A — faint electric signals

**CHAPTER 8**

1. T
2. F — selling newspapers on a train
3. C — books about electricity
4. C — stock ticker
5. D — cylinder covered with tinfoil
6. C — sound
7. F — acetylene gas and arc light were bright, too, but dangerous
8. C — scorched cotton
9. F — it was a silent movie, the first one to tell a story
10. T
11. A — Guglielmo Marconi
12. F — diode
13. T
14. F — vacuum tubes are in microwave ovens

**CHAPTER 9**

1. F — it was far behind the rest of the world
2. A — control looms for weaving cloth
3. T
4. F — a flat rate regardless of distance was better
5. A — did
6. T
7. F — Kepler and Pascal designed such machines
8. A — mechanical
9. D — all of the above
10. T
11. T
12. D — the technology of his day could not support the intricate design
13. F — it was a general-purpose calculating machine
14. F — he was not unduly troubled