Study Guide — Questions and Activities for Champions of Science
by John Hudson Tiner

In order to get the most out of this book, the following is recommended:

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

The study guide shows the relationship of events in *Champions of Science* 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 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.

Answers to the questions begin on page 16.

Chapter 1 questions

1. A B C D — Students of the 1500s answered scientific questions by (A. asking questions of experts B. doing experiments C. looking them up in ancient Greek books D. observing nature).

2. A B C D — Copernicus was (A. British B. French C. Polish D. Spanish).

3. T F — Nicolaus Copernicus was educated in the best schools.

4. One practical reason to study astronomy was to produce an accurate _____.

5. List five types of information found in almanacs: _____ _____
_____ _____ _____

6. T F — The Bible makes no mention of the purpose of the sun, moon and stars.

7. A B C D — Copernicus calculated celestial events with (A. a computer B. pen and paper C. pocket calculator D. slide rule).

8. What object did Aristotle place at the center of the planetary system? _____.

9. T F — To explain all of the motions in the heavens, Ptolemy needed a total of 12 circles.

10. To simplify his calculations, what object did Copernicus place at the center of the planetary system? _____.

11. A B — Copernicus explained the backward motion of Mars (retrograde motion), by assuming that Mars was (A. closer B. farther) from the sun than the earth.

12. T F — When Copernicus began using his sun-centered planetary system, he immediately published his theory as a book.

13. A B — The planetary system that provided an explanation as to why Mars changed in brightness was the one by (A. Aristotle B. Copernicus).

14. T F — Copernicus' theory was based on reasonable ideas and not any actual evidence.

15. A B C D — The author of *On the Revolution of the Celestial Sphere* was (A. Aristotle B. Copernicus C. Kepler D. Ptolemy).

16. A B C D — The moon revolves around (A. Mars B. Saturn C. the earth D. the sun).

17. T F — Copernicus' book had little impact on science.

Chapter 1 activities

Art: Draw a model of each of the planetary systems: the Greek model and Copernicus' model.

Communication: Compose a poem that contrasts the two models of the planetary system. Write a short play between two students, one who supports the Greek view and the other who supports Copernicus' view.

Mathematics: Identify the parts of a circle (center, radius, diameter, cord, circumference, interior, and exterior). Explain how the value of pi is related to the diameter and circumference of a circle.

Science: Read about the science of the ancient Greeks. Identify areas in which they were successful and areas where their science fell short.

Social Studies: Investigate why kings claimed to occupy positions of authority by "divine right."

Explore: The following people lived at about the same time as Copernicus. What contributions did they make to the revolution in science, art, politics, and religion?

> John Gutenberg (1400–1468), German inventor of printing press
> Christopher Columbus (1451–1506), navigator
> King Ferdinand of Aragón (1452–1516) and Queen Isabella I (1451–1504) of Castile,
>   Spanish rulers who sponsored the voyages of Columbus
> Leonardo da Vinci (1452–1519), Italian artist
> Michelangelo (1475–1564), Italian artist
> Sir Thomas More (1478–1535), English writer
> Martin Luther (1483–1546), German religious reformer

Chapter 2 questions

1. A B C D — Aristotle was born (A. at Athens B. in Crete C. in Macedonia D. on the Iberian peninsula).

2. T F — Plato's Academy was in Alexandria, Egypt.

3. A B C D — Which of the following did Plato NOT encourage: (A. experimentation B. observation C. questioning D. reasoning).

4. A B — Wealthy students were not expected to work with their hands because (A. they were unskilled B. slaves did manual labor).

5. T F — Aristotle stayed at Plato's academy until Plato died.

6. A B C D — After leaving Plato's Academy, Aristotle studied (A. animals that lived in the sea B. medicine C. the mathematics of music D. the stars).

7. T F — One of the key steps in science is to summarize and categorize information.

8. A B C D — Aristotle became the private tutor of (A. Alexander the Great B. Attila the Hun C. Eric the Red D. James I of England).

9. T F — Aristotle never returned to Athens.

10. Aristotle said, "The fate of empires depends on the _____ of youth."

11. The age of Alexander the Great when he died was _____ years.

12. A B C D — The city of Alexandria was in (A. Africa B. Asia C. Europe D. North America).

13. A B C D — Alexandria was noted for its (A. libraries B. museums C. universities D. all of the above).

14. A B — Compared to the Greeks, the Romans made (A. more B. fewer) scientific discoveries.

15. A B C D — In A.D. 640, Alexandria fell to the (A. Arabs B. Huns C. Moors D. Vikings).

16. A B C D — In Europe, the period A.D. 650 to 1450 is known as the (A. Dark Ages B. renascence C. Roman Emporium D. scientific revolution).

17. A B C D — What skill did Charlemagne try to learn: (A. to fly B. to speak Latin C. to read and write D. to recite the Iliad).

18. T F — Marco Polo spent 4 years in China.

19. A B — Marco Polo lived (A. before B. after) the invention of the printing press.

20. A B — During the Dark Ages of Europe, the Arab world (A. also suffered from ignorance and poverty B. flourished).

21. A B C D — The one who invented the printing press with moveable type was (A. Alexander the Great B. Aristotle C. Johann Gutenberg D. Marco Polo).

22. A B C D — People of the 1500s thought of Aristotle's ancient books as (A. interesting but filled with error B. the final authority C. too difficult to understand D. woefully out of date).

Chapter 2 activities

Art: In his dialogues, Plato contends that some music is harmful to the listener. In what ways can music benefit and harm the listener? Design a poster advertising the advantages of study at Plato's school. Draw a map of the Mediterranean Sea and the principle countries around it when Alexander the Great began his conquests.

Communication: Select a leaf, feather, or other small object and write a dialogue between teacher and student. Write the questions the teacher asks and the answers the student gives.

Geography: Find the following cities and provinces on a map: Macedonia, Athens, Alexandria

Health and Physical Education: What were some of the events in the Greek Olympics? What purpose did the aqueducts that the Romans built serve?

Mathematics: The Greeks believed buildings would be more pleasing if constructed with a shape that matched the golden ratio (also known as the golden section). What is the golden ratio? Draw a rectangle with sides that have the golden ratio.

Science: What traits do dolphins and whales have that would cause them to be placed with land mammals rather than fish of the sea? Taxonomy is the classification of living things in such a way

as to show their similar design. Describe the system developed by the Swedish botanist Carolus Linnaeus.

Social Studies: What kind of government did Athens have at the time of Plato?

Explore: Choose one of the Greeks below and write a biography of his major achievements:

Homer (about 900 B.C.), author of *Iliad and Odyssey*
Herodotus (484–425 B.C.), Greek historian
Socrates (470–399 B.C.), Greek philosopher
Plato (428–347 B.C.), Greek philosopher
Euclid (about 300 B.C.), mathematician who wrote *Elements of Geometry*
Eratosthenes (276–196 B.C.), Greek scientist and poet

Chapter 3 questions

1. A B — Galileo was born (A. before B. after) Copernicus published his book that put the sun at the center of the planetary system.

2. The age at which Galileo made his first major discovery was _____ years.

3. A B C D — Galileo was at the University of Pisa to study to become (A. an astronomer B. a doctor C. a minister of the Gospel D. a statesman).

4. T F — Galileo began the day by going to chapel.

5. A B C — In Galileo's observation of the swinging lamp, each small swing of the lamp took (A. more B. less C. the same) time as a large swing.

6. T F — Galileo's discovery about the pendulum was well known to the ancient Greeks.

7. A B C D — Galileo became convinced that observations and (A. appeal to authorities B. argumentation C. experimentation D. reasoning) was the way to learn new facts.

8. A B C D — Galileo was given the nickname "The Wrangler" because he (A. argued with teachers and students B. could herd cattle C. could tie intricate knots in ropes D. was the first to wear blue jeans).

9. A B C — A heavy ball fell (A. faster B. slower C. at the same speed) as a light ball.

10. In a _____ where there is no air resistance, a feather would fall as fast as a lead ball.

11. T F — Galileo proved that a moving object would naturally tend to slow down and a force had to keep it moving.

12. T F — Moving bodies can follow paths other than straight lines or circles.

13. T F — Galileo received a telescope from a student who sent him one from Holland.

14. T F — Galileo was the first to turn the telescope to the heavens.

15. T F — Galileo's telescope was too primitive to show him craters on the moon.

16. A B C D — The one who taught that the moon was perfectly smooth and polished was (A. Aristotle B. Galileo C. Gutenberg D. Lippershey).

17. A B C D — The writer of the book *The Starry Messenger* was (A. Aristotle B. Copernicus C. Galileo D. Lippershey).

18. A B C D — The fact that Venus and Mercury had phases supported the planetary system proposed by (A. Aristotle B. Copernicus C. Gutenberg D. Ptolemy).

19. T F — The fact that Jupiter had four large moons revolving around it supported the idea that the earth could move without leaving its moon behind.

20. A B — Galileo's disagreement was with (A. the books of pagan writers B. Scripture).

21. T F — Galileo died in jail.

Chapter 3 activities

Art: Sketch the interior of a chapel showing a lantern being pulled to one side to be lighted. Draw pictures of some of the subjects Galileo saw through his telescope.

Communication: As the lawyer for Galileo, write and deliver a closing argument that defends his ideas against those who clung to the authority of the ancient Greeks.

Geography: Find the following localities on a map: Pisa, Padua, Holland, and Germany.

Geometry: Define the conic sections (circle, ellipse, parabola, and hyperbola) and describe the mathematical properties of each.

Literature: Aristotle wrote *Poetics*, one of the most respected books on drama and literature. How did this book influence William Shakespeare, John Milton, and other writers and playwrights of the 1600s?

Science: How did the principle of the pendulum come into use in making accurate clocks? A United States quarter coin weighs about two and a half times as much as a dime; drop both from a height of five feet and observe which one strikes the floor first.

Explore: Investigate the changes caused by the following events that took place during Galileo's lifetime.

> English defeat the Spanish armada, 1588
> Shakespeare's plays performed at the Globe Theater, 1599
> Jamestown, Virginia first permanent British settlement in America, 1607
> Invention of the telescope, 1608
> King James Version of the Bible published, 1611
> Pilgrims establish Plymouth colony, 1620

Chapter 4 questions

1. A B C D — Johann Kepler lived during the same time as (A. Archimedes B. Copernicus C. Galileo D. Isaac Newton).

2. A B C D — Kepler was from (A. England B. France C. Germany D. Italy).

3. A B C D — Kepler attended college to become a (A. doctor B. lawyer C. mathematician D. minister of the Gospel).

4. A B C D — Those who traveled at night consulted an almanac to learn when (A. frost would be absent B. the moon would be full C. the sun would be in eclipse D. the stars of summer shone).

5. Kepler said, "I fear astrology is nothing but a _____ superstition."

6. A B — The one that is a true science is (A. astronomy B. astrology).

7. A B — The first well-known scientist to publicly support the sun-centered theory of Copernicus was (A. Galileo B. Kepler).

8. A B C D — The person with observations of planets was (A. Galileo B. Isaac Newton C. Ptolemy D. Tycho Brahe).

9. A B — It is better to base a scientific theory on (A. facts B. speculation).

10. A B — Tycho had an artificial (A. leg B. nose).

11. Tycho's observatory was on a private island in _____.

12. T F — Tycho made all of his observations with a telescope.

13. A B C D — Tycho's most careful observations were of the planet (A. Jupiter B. Mars C. Saturn D. Venus).

14. Tycho and Kepler met in _____, a city that is now in the Czech Republic.

15. A B C D — The great treasure that Kepler received was (A. a royal appointment in Prague B. Galileo's telescope C. Tycho's gold and silver D. Tycho's lifetime observations).

16. Copernicus and other astronomers believed that the orbit of Mars around the sun was a _____.

17. A B C D — Kepler showed that Mars traveled in (A. a circle B. a parabola C. an ellipse D. an oval) around the sun.

18. Kepler summarized his findings in how many laws of planetary motion? _____

19. T F — Kepler's laws of planetary motion became the foundation of modern astronomy.

20. On any list of the greatest scientists, Kepler is usually in the top _____.

21. T F — Johannes Kepler believed in a universe designed by God.

Chapter 4 activities

Art: Draw a cover for Kepler's Almanac. Include scenes from each of the four seasons, a stylized face of the sun and phases of the moon.

Geography: Find the following localities on a map: Copenhagen, Denmark, and Prague, Czech Republic. What is the distance from Copenhagen to Prague?

Geometry: Draw an ellipse; identify the major axis, semimajor axis, two foci, and give the equation for the eccentricity. Use a loop of string, two tacks, and a pencil or pen to draw an ellipse.

Literature: In the United States, Benjamin Franklin published *Poor Richard's Almanack*. What are some of the pithy sayings that he wrote for his publication?

Science: Experiment with magnifying glasses and reading lenses to project images of bright objects such as a light bulb or the light from an open window onto a white wall or sheet of paper. How do you find the focal length of a lens? Using a long focal length main lens and a short focal length eye lens, make a low-power telescope.

Social Sciences: The Gregorian calendar was introduced in Europe in 1582. The British did not adopt it until 1752. To change to the new calendar in England, 11 days had to be dropped. The day after September 2 became September 14. How did the rulers and leaders prepare the people for the change in the calendar?

Explore: The individuals below lived about the same time as Kepler. What were their contributions to the world?

> Ambroise Paré (1510–1590), French surgeon
> Gerardus Mercator (1512–1594), mapmaker
> Cervantes (1547–1616), author of *Don Quixote*
> Henry Hudson (1565–1611), English sailor
> Rembrandt (1606–1669), Dutch painter

Chapter 5 questions

1. A B — Mathematics allows complex laws to (A. become too difficult for scientists to understand B. be stated briefly and concisely).

2. A B C D — René Descartes developed a way to combine geometry and (A. astronomy B. mathematics C. medicine D. biology).

3. A B C D — René Descartes was born in (A. England B. France C. Germany D. Poland).

4. A B — The more René Descartes studied, the more he realized that the scientific knowledge of his day was (A. reliable B. not very reliable).

5. A B C D — René Descartes earned a degree in (A. law B. mathematics C. medicine D. theology).

6. T F — René Descartes joined the army because he enjoyed warfare.

7. A B C D — René Descartes settled in Holland because (A. court life in Paris was distracting B. court life in Paris was expensive C. Holland enjoyed more liberty D. all of the above).

8. T F — René Descartes' first book, *Rules for the Direction of the Mind,* was published soon after he finished writing it.

9. A B C D — René Descartes' second book, *The World*, was not published (A. because he could not afford to have it printed B. because it contained errors C. because he never finished writing it D. to avoid a possible trial).

10. A B C D — René Descartes is called the father of (A. geometry B. modern philosophy C. religious intolerance D. the New Math).

11. A B — The prefix "geo" in geometry means (A. earth B. lines).

12. A B — The word meter means (A. music B. to measure).

13. A B — Geometry is one of the (A. newest B. oldest) branches of mathematics.

14. A B C D — The mathematician who put geometry on a firm footing was (A. Archimedes B. Euclid C. Isaac Newton D. René Descartes).

15. Algebra is a branch of mathematics in which letters represent relationships between _____.

16. Analytical geometry replaced geometrical figures with mathematical _____.

17. A B — Pi, circumference of a circle divided by its diameter, is (A. the same for all circles B. different for circles of different sizes).

18. A B C D — The equation $y = x^2$ is the equation for a (A. circle B. ellipse C. hyperbola D. parabola).

19. A B C D — René Descartes did his best thinking (A. while drinking tea on a cold morning B. while resting comfortably in a soft, warm bed C. while taking his morning jog D. while teaching a student).

20. A B C D — René Descartes died four months after moving to (A. England B. Portugal C. Sweden D. the New World).

21. A B C D — René Descartes believed laws of science applied to everything in the universe except to (A. comets B. God C. inanimate objects D. microscopic life).

Chapter 5 activities

Geography: Locate Holland (Netherlands), France, and Sweden on a map. What are their capital cities?

Geometry: Compare the geometric definitions of a circle, ellipse, parabola, and hyperbola with the equations of the same figures as given by analytical geometry.

Health: René Descartes is believed to have died of pneumonia. What are the causes and prevention of that disease? What measures should a person take who is going to be exposed to extremely cold temperatures?

History: Queen Christina of Sweden was educated as a prince and became one of the most influential leaders of her time. Research her life and give some of the reasons she stepped down as the queen of Sweden after ten years.

Literature: One of René Descartes' best-known statements is "I think, therefore I am." What do you think he meant by this statement? Research how others interpret this quotation.

Science: René Descartes believed the planets went around the sun because of a vortex or whirlpool effect. He thought the force of gravity acted at right angles to the line connecting the sun to a planet. Scientists today know that this idea is incorrect. In what direction does the force of gravity act between the sun and planets?

Social Studies: At the time René Descartes lived, kings and queens were sometimes described as "patrons of the arts and sciences." What does the word patron mean? What steps did rulers take to ensure that their country stayed competitive in a rapidly changing world?

Explore: Investigate the impact caused by the following events that took place during René Descartes' lifetime.

    Thirty Years War (1618–1648)
    Circulation of blood discovered (1628)
    English Civil War (1642–1652)
    Invention of mercury barometer (1643)
    Invention of air pump (1650)

Chapter 6 questions

1. A B — Archimedes was born a few years before (A. Euclid B. Descartes) died.

2. Greek philosophers liked to talk, observe, and reason but not _____.

3. T F — Archimedes understanding of science was far behind that of Galileo and Kepler.

4. A B C D — Archimedes studied in (A. Alexandria B. Athens C. Cairo D. Rome).

5. A B C D — Archimedes lived in Syracuse on the island of (A. Crete B. Ireland C. Rhodes D. Sicily).

6. A B — Prying up a heavy weight with a pry bar works because the smaller effort is applied through a much (A. greater B. shorter) distance.

7. A B — A claw hammer, bicycle wheel, and wrench are described as (A. simple B. compound) machines.

8. A B C D — Archimedes did his best thinking while (A. drawing figures in the sand B. drinking lemonade C. soaking in his bath D. traveling in a chariot).

9. A B — A stone that is dropped in water becomes (A. heavier B. lighter).

10. A B — The one that would lose more weight when immersed in water is a crown of (A. pure gold B. gold mixed with silver).

11. A B C D — The Greek word *eureka* means (A. a vacuum has formed B. I have found it C. silver is in the crown D. the water is too hot).

12. A B C D — In 215 B.C., Syracuse was laid siege by an army from (A. Persia B. Carthage C. Portugal D. Rome).

13. A B C D — Archimedes died (A. by being killed by a soldier B. of pneumonia C. of starvation D. while on a pilgrimage to the Holy Land).

Chapter 6 activities

Art: Make a collage of well-known examples of Greek art. Although examples of Greek sculpture, mosaics, vase painting, and architecture are in existence today, there are few mural paintings or paintings on other surfaces. Why is this?

Communication: Write a commercial that extols the advantages of a block and tackle (series of pulleys) for lifting heavy loads from the hole of a ship.

Geometry: What is the Archimedes spiral?

Geography: Trace out the route of the Silk Road.

History: List the seven wonders of the ancient world. Which ones, if any, are still in existence today?

Science: What is an Archimedes screw? What purpose does it serve? Research a lever, identify the fulcrum (sometimes called the pivot point), load arm, effort arm, and state the formula for mechanical advantage.

Explore: Identify the contributions of these ancient Greeks.

Thales of Miletus (624–546 B.C.), Greek philosopher
Sophocles (496–406 B.C.), Greek playwright
Herodotus (484–430 B.C.), Greek historian

Chapter 7 questions

1. A B C D — Blaise Pascal's father instructed the tutor not to teach his son about (A. geometry B. politics C. religion D. sports).

2. A B C D — Blaise Pascal and his father attended scientific gatherings in (A. Amsterdam B. London C. Paris D. Rome).

3. A B C D — To help his father who was a tax collector, Pascal invented a (A. cash register B. mechanical calculator C. typewriter D. voice recorder).

4. A B C D — Torricelli was a student of (A. Galileo B. Kepler C. Newton D. Pascal).

5. A B — A water pump operated because (A. a vacuum drew the water B. air pressure pushed water) up the pipe.

6. A B C D — Mercury is (A. 13.5 B. 14.7 C. 34 D. 760) times as heavy as an equal volume of water.

7. A B C D — A barometer measures (A. air pressure B. air temperature C. blood pressure D. wind speed).

8. A B — Blaise Pascal showed that the air pressure at the top of a mountain was (A. greater B. less) than at the bottom of the mountain.

9. T F — Water, mercury, and other fluids exert pressure in all directions.

10. A B C D — Pascal invented the (A. barometer B. hydraulic press C. lever D. pendulum clock).

11. A B — An event almost certain to happen is given a probability near (A. 0 B. 1).

12. A B C D — Blaise Pascal developed the laws of probability (A. entirely by himself B. with the help of his father C. with the help of Pierre de Fermat D. with the help of René Descartes).

13. T F — Probability allows scientists to predict the action of a large number of particles such as atoms and molecules.

14. T F — Blaise Pascal had not been interested in the Christian faith until he had a frightening accident.

15. A B C D — At age 32, Blaise Pascal devoted himself full time to (A. his Christian faith B. proving that nature abhors a vacuum C. the study of music D. writing his biography).

16. T F — Although Pascal wrote about pain, God had mercifully spared him from suffering.

17. T F — René Descartes and Blaise Pascal could not stand each other's company.

18. A B C — A servant found one of Pascal's prayers sewed in his (A. bed sheets B. coat C. pajamas).

19. T F — Because of his short life, Blaise Pascal had little impact on science.

Chapter 7 activities

History: Review the history of personal and religious freedom during this time (1600s) in Europe. What countries had the best reputation for freedom?

Literature: After Pascal's construction of a mechanical calculator, writers speculated about the possibility of thinking machines and robots. What are some of the stories that have been written about mechanical men? What is the origin of the word robot?

Mathematics: Pierre de Fermat together with Blaise Pascal developed the principles of probability. Fermat was a lawyer and amateur mathematician. He stated a problem that became known as Fermat's Last Theorem. What is the theorem and has it been solved?

Science: In addition to a barometer for measuring air pressure, what other instruments are employed by weather observers to collect data about the weather?

Explore: Describe the contributions of the following individuals in developing aids to ease the burden of mathematical computations

> John Napier (1550–1617), Scottish mathematician and theological writer
> William Oughtred (1574–1660), English mathematician and minister
> Charles Babbage (1791–1871), English mathematician and inventor
> Ada, Countess of Lovelace (1815–1852), English mathematician
> Herman Hollerith (1860–1929), American inventor
> Howard Aiken (1900–1973), American inventor
> Konrad Zuse (1910–1995), German inventor

Chapter 8 questions

1. A B C D — Robert Boyle was born in (A. France B. in New England C. Ireland D. on the Isle of Wight).

2. T F — Robert Boyle's father was a humble blacksmith.

3. A B C D — Until he began school, Robert Boyle lived (A. at Buckingham Palace B. at Versailles in France C. in the home of a peasant family D. with his mother and six brothers).

4. T F — Science at Eton was taught primarily by use of experiments.

5. T F — The motto "nothing by mere authority" rejected the idea that answers would be found in books by Greek philosophers.

6. A B C D — Robert Boyle moved to Oxford to (A. be near other scientists B. learn the skills of being a court official C. study music D. use the large library of Greek books).

7. A B C D — Otto von Guericke built the first (A. air pump B. barometer C. microscope D. telescope).

8. A B — The two hemispheres in Otto von Guericke's experiment were held together by (A. the vacuum inside B. air on the outside pushing them together).

9. A B — The one who designed the improved air pump was (A. Robert Boyle B. Robert Hooke).

10. A B — The one who actually built the improved air pump was (A. Robert Boyle B. Robert Hooke).

11. A B — Boyle and Hooke showed that sound (A. would B. would not) carry in a vacuum.

12. A B C — In a vacuum, the lump of lead fell (A. faster B. slower C. at the same speed) as a feather.

13. A B — When more pressure is put on a gas, the volume (A. increases B. decreases).

14. A B — Alchemy was a (A. false B. true) science.

15. A B C D — Alchemists tried to combine two ordinary substances and make (A. a cure for the common cold B. a substance to make them invisible C. diamond D. gold).

16. T F — Alchemists published their results quickly and completely.

17. A B C D — The Royal Society was patterned after scientific discussions held at the (A. Acropolis at Athens B. invisible college C. Roman senate D. marketplace at Eton).

18. A B — The first group of scientists to hold regular meetings was the (A. French Academy B. Royal Society).

19. A B C D — Robert Boyle suggested that each ship of the East India Trading Company carry (A. a historian B. a science officer C. a tutor for the sailors D. an ambassador).

20. T F — Victims of the Great Fire of London erected a statue to Robert Boyle to honor the help he gave them.

21. A B C D — The title Robert Boyle preferred was (A. headmaster at Eton B. Mr. Robert Boyle, Christian gentleman C. Sir Robert Boyle, knight of the roundtable D. the Great Earl of Cork).

Chapter 8 activities

Chemistry: Robert Boyle was the first to give the modern definition of a chemical element. What is that definition? How many chemical elements exist? Robert Boyle also discovered the element phosphorus. What are its properties?

Communication: Write and present to King Charles II a speech describing the advantages of granting a royal charter for scientists to meet regularly as the Royal Society.

Geography: Identify the following regions — England, Scotland, Wales, Isle of Wight, Isle of Mann, Shetland Islands, Orkney Islands, and Ireland.

Health: The Black Death (bubonic plague) was a terrible plague that struck London in 1665. What are the symptoms of this disease and how is it spread?

History: Several countries began East India trading companies. What was the purpose of these companies? What did India have that was desired by people in Europe?

Literature: Robert Boyle and several of his friends, including John Evelyn and Samuel Pepys, kept diaries. What makes a diary different from other forms of literature?

Mathematics: Pressure and volume are said to be inversely related. Explain the meanings of the terms direct, inverse, and independent.

Science: The methods Robert Boyle and other scientists used for exploring nature became known as the scientific method. What is the scientific method?

Explore: Write a short biography of one of the individuals below:

   James Ussher (1581–1656), Irish clergyman
   John Milton (1608–1674), English poet
   Samuel Pepys (1633–1703), naval administrator and observer of London life
   Robert Hooke (1635–1703), English scientist and inventor
   Edmund Halley (1656–1742), English astronomer

Chapter 9 questions

1. A B C D — The science that strives to learn about objects in outer space is (A. astrology B. astronomy C. celestial navigation D. statistics).

2. A B C D — Christiaan Huygens was born in (A. England B. France C. Netherlands D. Switzerland).

3. A B C — Christiaan Huygens was born (A. well before B. well after C. at about the same time) as Robert Boyle and Blaise Pascal.

4. T F — Huygens received very little formal education.

5. A B C D — The subject that interested Huygens the most was (A. astronomy B. biology C. law D. mathematics).

6. A B C D — Mars was surrounded by a series of red, green, and blue images because (A. clouds reflected city lights B. Mars had a series of colored rings like Saturn C. the atmosphere was unstable D. the telescope lens acted as a prism).

7. T F — Christiaan Huygens' telescope was 27 feet long.

8. T F — Saturn has a moon that is about the same size as the four larger moons of Jupiter.

9. Huygens gave the name _____ to the large moon of Saturn.

10. A B C D — The first person to recognize the true nature of the rings of Saturn was (A. Galileo B. Huygens C. Kepler D. Newton).

11. T F — During Huygens' day, only scientists needed accurate clocks.

12. A B C — The first clocks had only (A. an hour B. a minute C. a second) hand because they were so inaccurate.

13. T F — Huygens' first clock was regulated by a pendulum.

14. A B C D — Huygens' clock became known as a (A. Faberge egg B. grandfather clock C. marine chronometer D. pocket watch).

15. A B C — The grandfather clock was (A. larger than B. smaller than C. about the same size as) other clocks of Huygens' day.

16. T F — King Louis XIV of France refused to let foreign scientists come into his country.

17. A B C D — Christiaan Huygens became the first president of the Royal Academy of Science in (A. Paris B. the Hague C. London D. Philadelphia).

18. A B C D — In 1681, Christiaan Huygens returned to the Hague to (A. avoid military service B. begin an optical shop C. build precision clocks D. worship God freely).

Chapter 9 Activities

Astronomy: The stars of the Big Dipper are part of a larger constellation known as the Ursa Major (great bear). Research some of the other names by which Ursa Major and the Big Dipper have been known. Why are the two front stars in the dipper called the Pointers? What is special about Mizar, the star in the crook of the Dipper's handle?

Art: Christiaan Huygens was the first astronomer to detect surface detail on the planet Mars. Draw a scientifically accurate view of the Martian surface as an astronaut on the planet would see it.

History: Christiaan Huygens was a Huguenot. What does the word mean? What religious persecution did the Huguenots face in Paris in the 1600s?

Science: Christiaan Huygens developed a theory of light based on the idea that light is made of waves. What are the chief principles of this theory?

Social Studies: In addition to helping astronomers, Huygens' invention of an improved clock resulted in time playing a greater role in our everyday lives. Why was keeping accurate time important to railroads? What is Greenwich Mean Time? Why are time zones necessary? What is Daylight Savings Time? What does the term "a 24-hour economy" mean?

Explore: Expand on the contributions made by each scientist to the understanding of light.

> Isaac Newton (1642–1727), particle nature of light
> Thomas Young (1773–1829), diffraction and interference of light
> Joseph von Fraunhofer (1787–1826), solar spectrum
> Louis Daguerre (1787–1851), photography
> Albert Michelson (1852–1931), speed of light
> Albert Einstein (1879–1955), photoelectric effect

Chapter 10 questions

1. A B — Royalists supported (A. the king B. Cromwell).

2. A B C D — Kit Wren challenged Robert Hooke and Edmund Halley to develop mathematical equations to (A. describe the force of gravity B. describe the ratio of circumference to diameter of a circle C. describe the relationship between pressure and volume of a gas D. measure the speed of light).

3. A B C D — At his first professional position, Christopher Wren lectured on (A. economics B. astronomy C. chemistry D. law).

4. A B C D — To be a successful architect, Wren had to (A. be an able wood worker B. be an excellent draftsman C. deal with a variety of people D. do all of the above).

5. A B C D — During the English Civil War, Oliver Cromwell used Old St. Paul's (A. as a private exercise gym B. as his private chapel C. as his staff headquarters D. to station men and horses).

6. T F — Wren believed people wanted to see, hear, and join in worship services.

7. A B — Wren wanted to (A. restore B. tear down) Old St. Paul's.

8. A B C D — People suspected the Black Death had spread through London because of (A. a French plot B. filthy conditions C. poor food D. too many stray cats).

9. T F — The Great Fire of London spared all of the churches except Old St. Paul's.

10. T F — Wren improved the safety of pedestrians on the streets of London by installing iron posts near walls.

11. T F — Wren helped control disease by spraying the city with an antiseptic.

12. A B C D — Wren replaced wood and straw buildings with brick and stone to make them (A. less likely to burn B. more expensive C. resist naval bombardment D. soundproof).

13. T F — Wren built 51 identical parish church buildings throughout London.

14. T F — Until Wren's time, no one who had started building a cathedral had lived to see it completed.

15. Christopher Wren made his first sketch of the new St. Paul's when he was _____ years old.

16. The final stone was put in place on St. Paul's when Christopher Wren was _____ years old.

17. T F — Although he succeeded in building St. Paul's, all of the problems he encountered made Christopher Wren an exhausted and bitter man.

18. A B C D — Christopher Wren was buried (A. at St. Martins-in-the-Fields parish church B. at Westminster Abby C. in a garden at the Royal Society D. inside St. Paul's).

Chapter 10 activities

Architecture: The dome of Saint Paul's Cathedral is considered one of the great achievements of architectural design. What are the advantages of a dome? What are some of the other buildings that are noted for their domes? What is a geodesic dome?

Communication: Christopher Wren was president of the Royal Society from 1680 to 1682. One of the goals of the Royal Society was to increase communication among scientists. Which of the following methods of communication were available in the 1680s: telegraph, telephone, television, radio, newspapers, postal service?

Health: Christopher Wren designed and oversaw the construction of one of the first government sponsored hospitals in England (the Royal Hospital at Chelsea for veterans). Religious orders ran the first hospitals (known as Hotels of God). What decree in 1540 by Henry VII put an end to hospital building in England for almost 200 years? After hospitals become common, people still preferred to receive care in their homes rather than at the hospital. Why was this? What discovery made hospitals of today safer places?

History: Christopher Wren was a Royalist during the English Civil War. Who were their adversaries? What role did the Royalists have after the death of Cromwell?

Science: Following a discussion about gravity with Christopher Wren and Robert Hooke, Edmund Halley took the problem to Isaac Newton. Because of Halley's encouragement, Isaac Newton developed the law of universal gravitation. State the law of gravity in both words and as an equation.

Social Studies: What changes had taken place to cause people to want a greater role in worship services?

Explore: Write a short biography that describes the major accomplishment of each individual listed below.

Inigo Jones (1573–1652), British painter and architect
Daniel Defoe (1660–1731), English writer
Jonathan Swift (1667–1745), English writer
Johann Sebastian Bach (1685–1650), German composer
Gabriel Daniel Fahrenheit (1686–1736), German physicist

ANSWERS TO QUESTIONS

CHAPTER 1

1. C — looking them up in ancient Greek books
2. C — Polish
3. T
4. calendar (or almanac)
5. Any five of the following: times of sunrise, sunset, phases of the moon such as full moon, holidays, historical events, pithy sayings, home remedies, when to plant and harvest crops. (Other answers are possible).
6. F — Read Genesis 1:14
7. B — pen and paper
8. earth
9. F — 70 circles
10. the sun
11. B — farther
12. F — he circulated it as a handwritten manuscript
13. B — Copernicus
14. F — he spent several years gathering evidence
15. B — Copernicus
16. C — the earth
17. F — it began a revolution in science

CHAPTER 2

1. C — in Macedonia
2. F — Athens, Greece
3. A — experimentation
4. B — slaves did manual labor
5. T
6. A — animals that lived in the sea
7. T
8. A — Alexander the Great
9. F — he started The Lyceum (a school) in Athens
10. education
11. 33
12. A — Africa
13. D — all of the above
14. B — fewer
15. A — Arabs
16. A — Dark Ages
17. C — to read and write
18. F — 17 years
19. A — before
20. B — flourished
21. C — Johann Gutenberg
22. B — the final authority

CHAPTER 3

1. B — after
2. 17
3. B — doctor
4. T
5. C — the same
6. F — it was not in any of their books
7. C — experimentation
8. A — argued with teachers and students
9. C — at the same speed
10. vacuum
11. F — a force was needed to change its speed or direction
12. T
13. F — he learned of the invention from a student but made his own telescope
14. T
15. F — he could see craters on the moon
16. A — Aristotle
17. C — Galileo
18. B — Copernicus
19. T
20. A — the books of pagan writers
21. F — he spent his last days under house arrest, but not in jail

CHAPTER 4

1. C — Galileo
2. C — Germany
3. D — minister of the Gospel
4. B — the moon would be full
5. dreadful
6. A — astronomy
7. B — Kepler
8. D — Tycho Brahe
9. A — facts
10. B — nose
11. Denmark
12. F — the telescope had not been invented
13. B — Mars
14. Prague
15. D — Tycho's lifetime observations
16. circle
17. C — an ellipse
18. three
19. T
20. ten
21. T

CHAPTER 5

1. B — be stated briefly and concisely
2. B — mathematics
3. B — France
4. B — not very reliable
5. A — law
6. F — to earn a small salary
7. D — all of the above
8. F — he never published it
9. D — to avoid a possible trial
10. B — modern philosophy
11. A — earth
12. B — to measure
13. B — oldest
14. B — Euclid
15. numbers
16. equations
17. A — the same for all circles
18. D — parabola
19. B — while resting comfortably in a soft, warm bed
20. C — Sweden
21. B — God

CHAPTER 6

1. A — Euclid
2. experiment
3. F — not far behind
4. A — Alexandria
5. D — Sicily
6. A — greater
7. A — simple
8. C — soaking in his bath
9. B — lighter
10. B — gold mixed with silver
11. B — I have found it
12. D — Rome
13. A — by being killed by a soldier

CHAPTER 7

1. A — geometry
2. C — Paris
3. B — mechanical calculator
4. A — Galileo
5. B — air pressure pushed water
6. A — 13.5
7. A — air pressure
8. B — less
9. T
10. B — hydraulic press
11. B — 1
12. C — with the help of Pierre de Fermat
13. T
14. F — he had always been interested
15. A — his Christian faith
16. F — he suffered migraine headaches and painful stomach ulcers
17. F — René Descartes visited the ill Pascal
18. B — coat
19. F — he is considered a great scientist

CHAPTER 8

1. C — Ireland
2. F — one of richest men in the world
3. C — in the home of a peasant family
4. F — by the authority of Greek writers
5. T
6. A — be near other scientists
7. A — air pump
8. B — air on the outside pushing them together
9. A — Robert Boyle
10. B — Robert Hooke
11. B — would not
12. C — at the same speed
13. B — decreases
14. A — false
15. D — gold
16. F — they worked in secret
17. B — invisible college
18. B — Royal Society
19. B — a science officer
20. F — most did not know who had helped them
21. B — Mr. Robert Boyle, Christian gentleman

CHAPTER 9

1. B — astronomy
2. C — Netherlands
3. C — at about the same time
4. F — he was tutored and attended the University of Leiden
5. A — astronomy
6. D — the telescope lens acted as a prism
7. T
8. T
9. Titan
10. B — Huygens
11. F — so did ordinary citizens
12. A — an hour
13. T
14. B — grandfather clock
15. B — smaller
16. F — he invited Christiaan Huygens to come into the country from the Netherlands
17. A — Paris
18. D — worship God freely

CHAPTER 10

1. A — the king
2. A — describe the force of gravity
3. B — astronomy
4. D — all of the above
5. D — to station men and horses
6. T
7. B — tear down
8. B — filthy conditions
9. F — 87 parish churches burned
10. F — he made the streets wider
11. F — he put in better drainage and a healthier water supply
12. A — less likely to burn
13. F — each parish church building was distinctive and could be identified by its steeple alone
14. T
15. 33
16. 79
17. F — he kept his sunny disposition
18. D — inside St. Paul's