BY JOHN HUDSON TINER

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 students' reading, writing, and thinking skills.

The study guide shows the relationship of events in *Champions of Mathematics* 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. A B C D — Pythagoras was born on an island in the (A. Aegean Sea B. Atlantic Ocean C. Caribbean Sea D. Pacific Ocean).

2. A B — Tyre is a Phoenician city in the modern-day country of (A. Portugal B. Lebanon).

3. A B — Pythagoras enjoyed playing the (A. flute B. lyre).

4. The word philosophy means love of _____.

5. A B C D — The eclipse predicted by Thales caused the Medes and Lydians to (A. build a solar observatory B. build an altar C. declare Thales the court astronomer D. halt their advance to war against one another).

6. A B C D — Thales measured the height of (A. Mount Everest B. the Colossus of Rhodes C. the Great Pyramid of Giza D. the hanging gardens of Babylon).

7. A B C D — While a prisoner in Babylon, Pythagoras studied (A. astronomy B. chemistry C. metal working D. music).

8. The Greek colony where Pythagoras settled was in southern _____.

9. A B — The two areas in which the work of Pythagoras is still accurate today is mathematics and (A. chemistry B. music).

10. The next square after four is _____.

11. State the Pythagorean theorem:

12. A B C D — The side opposite the right angle in a right triangle is the (A. adjacent side B. hypotenuse C. obtuse angle D. opposite side).

13. A B C D — The Greeks used (A. digits B. knots in ropes C. letters of the Greek alphabet D. marks in sand) to represent numbers.

14. A B C D — The numbers 1/2, 1/3, 2/3, and so on are examples of (A. irrational B. prime C. rational D. whole) numbers.

15. A B — The Greek letter pi, p, represents the (A. first overtone of a musical scale B. circumference of a circle divided by its diameter).

16. T F — The diagonal of a square is a straight line that runs from one corner to the opposite corner.

17. A B — The diagonal of a square is a (A. rational B. irrational) number.

18. T F — An irrational number is one that can be represented as the ratio of two whole numbers.

19. A B C D — Pythagoras based his mathematical discoveries upon (A. ideas that seemed reasonable B. mathematical proofs C. rules of thumb D. vague ideas).

20. T F — Pythagoras noticed the harmony of nature.

CHAPTER 1 ACTIVITIES

Literature: The Greek writer Homer is credited with two of the most enduring epic adventure stories of ancient times — the *Iliad* and the *Odyssey*. The *Iliad* is set in the final year of what historical event? Who are the chief characters? Why is the *Odyssey* considered a sequel to the *Iliad*?

Art and architecture: The pyramids were one of the seven wonders of the ancient world. List and describe the other six. Select one and draw how it might have looked.

Astronomy: Describe the changing understanding of the planet Venus from ancient times until today.

Geography: Locate the following on a map: Aegean Sea, Asia Minor, Egypt, Iraq, Italy, Lebanon, Libya, Syria, and Turkey.

Health and Physical Education: The marathon is one of the events of the Olympic games. What is the standard distance of the marathon in modern Olympic games? What event in Greek history is celebrated by the marathon?

Mathematics: What is the difference between a prime number and a composite number? Between a rational number and an irrational number? List the prime numbers between 1 and 100. The value of pi is sometimes given as 3.14, which can be written as 3 14/100. Why is this value not entirely correct?

Social Studies: Why is Athens considered the first city with a democratic government? Compare life in Athens with life in other Greek cities, especially Sparta.

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

> Thales (625–546 B.C.), Greek philosopher, the first Greek scientist
> Cyrus the Great (600–529 B.C.), king of Persia, conquered Babylon
> Darius I the Great (558–486 B.C), defeated by the Greeks at Marathon
> Hanno (530–470 B.C.), Phoenician explorer
> Hippocrates (460–377 B.C.), greatest physician of ancient world
> Democritus (460–370 B.C.), Greek philosopher

CHAPTER 2 QUESTIONS

1. A B — A textbook more than 100 years old is (A. a classic of proven worth B. hopelessly out of date).

2. T F — *Elements of Geometry* is the most translated, published, and studied book of all time.

3. T F — In 325 B.C., the name Euclid was a common name.

4. A B C D — At Plato's academy, Euclid received a good grounding in (A. agriculture B. biology and plant science C. chemistry and the study of metals D. mathematics and geometry).

5. Alexandria was in _____.

6. A B C D — The greatest library in the world was at (A. Alexandria B. Athens C. Rome D. Sparta).

7. T F — One reason that scientists came to Alexandria was to flee from the fighting in Greece.

8. A B C D — The numbers 2, 3, 5, 7, 11, and 13 are examples of (A. composite B. irrational C. prime D. square) numbers.

9. A B — Euclid proved that there (A. is B. is not) a largest prime number.

10. T F — Prime numbers are used to put banking data into a secret code.

11. A B C D — Optics is the study of (A. electricity B. light C. nuclear power D. ocean life).

12. The ancient Greeks believed everything was made of four basic building blocks: earth, water, air, and _____.

13. T F — Euclid began his *Elements of Geometry* with proofs of his geometric discoveries.

14. T F — Euclid's books on astronomy and music are lost.

15. The city of Alexandria fell to _____ armies in A.D. 640.

16. State the parallel postulate:

17. A B — Euclid listed the parallel postulate as (A. an assumption B. a fact).

18. T F — Science is chiefly concerned with gathering facts.

CHAPTER 2 ACTIVITIES

Composition: When a student asked what he would get from his studies, Euclid said, "Give him a coin, since he must make a gain out of what he learns." When Ptolemy asked for an easier way to study geometry, Euclid said, "There is no royal road to geometry." Write a scene of a play in which Euclid convinces a reluctant student the benefits of studying geometry.

Geography: List the countries of northern Africa that border the Mediterranean Sea. What countries in Europe are directly north across the Mediterranean Sea from Morocco? What regions did the Arabs control during the period A.D. 700 to 1492?

Geometry: What is non-Euclidean geometry? How have mathematicians changed the parallel postulate to develop other geometries?

History: The fall of Alexandria marked the end of the Roman Empire. What are some of the reasons that Rome fell into decline? What contributions did the Arabs make to preserve the scientific discoveries of the Greeks?

Literature: What are the dialogues of Plato?

Mathematics: Research the sieve of Eratosthenes for finding prime numbers. List the prime numbers between 1 and 100. Why is 1 not considered a prime number? Why is 2 considered a prime number? The prime numbers 11 and 13 are called prime pairs. They are two prime numbers separated by the even number 12. The next prime pair is 17 and 19. Are there any other prime pairs?

Social Studies: What role did Ptolemy and his descendents have in making Alexandria the most important city in the ancient world? Who ruled Alexandria between the time of the Greeks and the invasion of the Arabs? What role did the Nile River have in everyday life in Egypt?

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

> Herodotus (484–425 B.C.), Greek historian
> Plato (428–347 B.C.), Greek philosopher
> Alexander the Great (356–323 B.C.), Greek general
> Eratosthenes (276–196 B.C.), Greek mathematician and librarian at Alexandria
> Julius Caesar (100–44 B.C.), Roman general and statesman

CHAPTER 3 QUESTIONS

1. T F — Archimedes' father was a gladiator.

2. A B The story of Archimedes' life is (A. better B. not as well) known as the life of Euclid.

3. T F — Nothing that Archimedes wrote is still in existence.

4. A B C D — Archimedes' hometown, Syracuse, is on the island of (A. Greenland B. Rhodes C. Sicily D. Zanzibar).

5. T F — King Hieron II of Syracuse allowed Archimedes to study science and mathematics full time.

6. T F — Archimedes thought about his mathematical problems by drawing figures.

7. A B C D — A square is an example of a (A. pentagon B. regular polygon C. rhombus D. triangle).

8. A B C D — The number of sides in the regular polygons that Archimedes used to find the value of pi was (A. four B. 22 C. 96 D. 256).

9. Archimedes announced that the value of pi for a circle lay between the two numbers _____ and 223/71.

10. T F — Archimedes solved some difficult mathematical problems by replacing them with a series of easier ones.

11. In the Roman system for representing numbers, the letter V stood for the number _____.

12. A B — The number of sand particles (a. goes on without end B. is not infinite).

13. A B C D — Archimedes told about his own numbering system in a book titled (A. *Book of Calculating* B. *Elements of Geometry* C. *Primer for Gelon* D. *The Sand Reckoner*).

14. A B C D — Plutarch was a Greek (A. general B. historian C. king D. scientist).

15. A B C D — A soldier killed Archimedes as the great scientist (A. defended his city B. drew figures in the sand C. measured the size of the Great Pyramids D. took his bath).

CHAPTER 3 ACTIVITIES

Architecture: Archimedes investigated a number known as the golden section, sometimes called the golden ratio. From the time of Pythagoras until today, this number has been widely accepted as a guide to making buildings that are especially pleasing in their shape and proportion. Research the golden section. What are some of the buildings that are in this shape?

History: What nations were involved in the Punic wars? How many wars were there? How long did they last? What was the final outcome?

Mathematics: Roman numerals are often used on the cornerstones of buildings to show when they were erected. The copyright date of some books and movies are stated in Roman numerals. Write the following dates in Roman numerals: 1066, 1492, 1776, 1969. (What important event took place in each of those years?) Write the year of your birth in Roman numerals.

Science: Archimedes is noted for his invention of the screw of Archimedes for pumping water and his study of levers, pulleys, and other simple machines. Research these discoveries. What are some examples of levers? State the law of simple machines that relates the load to the effort.

Social Studies: The 4,000-mile-long Silk Road connected China with Rome. What role did it have in exchanging goods and ideas between the two parts of the world? At about the same time as Archimedes lived, the Great Wall of China was built. What was the purpose of this wall and did it succeed in that purpose?

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

> Sophocles (496–406 B.C.), Greek dramatist
> Hanno the Great of Carthage (250–201 B.C.), general during the Punic Wars
> Strabo (63 B.C.–A.D. 24), Greek geographer and historian
> Hero of Alexandria (A.D. 20–62), Greek scientist, invented the rotary steam engine
> Plutarch (A.D. 46–120), Greek biographer

CHAPTER 4 QUESTIONS

1. A B — The Romans achievements were in (A. engineering B. scientific research).

2. Rome fell in A.D. 476 and _____ was destroyed by the Arabs in 642.

3. T F — People in Europe owned the small farms where they eked out a living.

4. A B C D — In Europe, the Middle Ages are sometimes called the (A. Age of Enlightenment B. Dark Ages C. Reformation D. Renaissance).

5. A B C D — Venice, Florence, and Pisa are cities in (A. Italy B. Northern Africa C. Protugal D. Spain).

6. Leonard Fibonacci was from the town of _____.

7. T F — The Leaning Tower of Pisa did not begin leaning until 500 years after its construction.

8. A B C D — When Fibonacci began as a trade representative, mathematical calculations were written in (A. the digits 0 through 9 B. Hindu script C. letters of the Greek alphabet D. Roman numerals).

9. A B C D — The Moors lived in (A. Asia B. England C. Italy D. Northern Africa).

10. The new numbering system had been taught to the Moors by Arabs who had visited
    _____.

11. T F — The new numbering system was a place value system.

12. The invention of _____ made place value possible.

13. A B C D — Fibonacci's book was called (A. *Abacus Number Tricks* B. *Book of Calculating* C. *Quick and Easy Math* D. *The Age of Innocence*).

14. The next number in the Fibonacci series 1, 1, 2, 3, 5, 8 is _____.

15. A B — Compared to Roman numbers, the place value system was (A. easier B. harder) to use.

16. A B C D — The only ones who began using the place value numbering system were bankers.

17. A B — With the place value system, calculating mistakes became (A. more B. less) common.

CHAPTER 4 ACTIVITIES

Art: Graphing the Fibonacci numbers produces a beautiful curving Fibonacci spiral. This shape is seen in a number of places, such as the curve of the shell of a snail. The curl of the horns of some animals, the spiral of an orb weaver spider web and the arrangement of the inner ear of humans all have the shape. It extends from the whirl on the surface of a pineapple to the arrangement of stars in distant galaxies. Reproduce the spiral of Fibonacci and draw some of the living organisms that display this shape.

Astronomy: During the Middle Ages, the Mayan culture of Central America developed an accurate calendar. What were the chief features of this calendar, and what were some of the other astronomical achievements of the Mayans?

Health: During the 1300s in Europe, the Black Death sometimes killed as many as one-third of the population. By what name is the Black Death known today? What was its cause? How can outbreaks of the Black Death be prevented?

History: Why do some historians use the term Middle Ages for the period from about A.D. 650 to 1450, while others use the term Dark Ages?

Mathematics: Rather than ten digits, computers use a simple on-off, 0 and 1, system of counting known as the binary system. Research how to write numbers in the binary system. Write the following numbers in the binary system: 2, 5, 17, 31. Write your age in binary numerals

Social Studies: Contrast the life of landowners in Europe during the Dark Ages with the serfs who worked on the land. What changes were brought about by the rise of tradesmen and the middle class in cities such as Genoa, Florence, and Pisa?

Explore: Choose one of the events below and write a summary of its impact on Europe.

    Norman invasion of England, 1066
    The Crusades, started in the year 1095
    Use of the compass for navigation, during the 1100s
    Magna Carta signed, 1215
    Marco Polo travels to China, began travels about 1260
    Invention of the printing press, approximately 1450

CHAPTER 5 QUESTIONS

1. T F — Isaac Newton was born on Christmas Day.

2. A B — Isaac Newton came from a (A. wealthy B. poor) family.

3. A B — After winning the English Civil War, Oliver Cromwell took the title (A. King Cromwell B. Lord Protector).

4. A B C D — Isaac Newton took the 200 books from his stepfather's library about the Bible and (A. sold them B. gave them to charity C. gave them to the Royal Society D. made a bookshelf for them).

5. T F — Although Isaac Newton read many books about the Bible, he never read the Bible all the way through.

6. While attending school at Grantham, Newton lived with Mr. Clark who was a _____.

7. T F — Isaac Newton's models were to scale and they worked.

8. A B C D — At school, Newton made his best grades in (A. Bible B. biology C. chemistry D. mathematics) class.

9. A B — Isaac Newton's grades at Grantham were (A. far better B. no better) than those of other students.

10. A B — On market day, Isaac Newton preferred to (A. learn about business B. read books in the Clark library).

11. A B C D — Isaac Newton paid for his room and meals at Cambridge (A. by making telescopes B. by selling livestock C. doing chores for his professors D. from savings as a successful farmer).

12. T F — When Isaac Newton graduated from Cambridge in 1665, he did so as one of the greatest thinkers of his age.

13. A B C D — University officials closed Cambridge because of (A. Mad Cow Disease B. the Black Death C. the coldest winter on record D. unbearable hot weather).

14. A B C D — While Cambridge was closed, Isaac Newton spent the time (A. at his mother's farm B. at Oxford C. in Europe D. in London).

15. T F — Isaac Newton devoted his forced vacation from school entirely to the study of mathematics.

16. A B C — Professor Barlow said that Isaac's discovery of the binomial theorem was (A. an idea known since ancient times B. an interesting but useless discovery C. worthy of a first-rate mathematician).

17. Isaac Newton's flowing math (fluxions) became known as _____.

18. T F — Most scientists claimed that pure light of the sun became colored as it passed through raindrops.

19. A B C D — Isaac Newton proved that sunlight (A. was a mixture of all the colors B. could not be separated into the colors by a prism C. was mostly yellow with a little red D. was pure white light).

20. A B C D — The scientist who experimented with balls rolling across tables was (A. Copernicus B. Edmund Halley C. Galileo D. Johannes Kepler).

21. A B C D — Johannes Kepler showed that the moon's orbit around the earth was (A. circular B. elliptical C. parabolic D. in the shape of a whirlpool).

22. A B — The one that fell in a straight line but at a constantly changing speed was the (A. apple B. moon).

23. A B — The one that was 240,000 miles from the center of the earth was the (A. apple B. moon).

24. A B C D — Isaac Newton concluded that the force of gravity on the moon decreased by the square of the (A. density B. distance C. mass D. size).

25. A B C D — Isaac Newton called 1666 his (A. lost year B. marvelous year C. year of failures D. year of plagues).

26. A B C D — The person who insisted that Isaac Newton write about his law of gravity was (A. Edmund Halley B. Isaac Barlow C. Robert Boyle D. Sir Christopher Wren).

27. A B C D — Isaac Newton's most famous book is titled (A. *Calculus for Everyone* B. *Principia Mathematica* C. *The Book of Telescope Design* D. *Comets and Their Orbits*).

28. A B C D — Isaac Newton showed that tides were caused primarily by the gravitational attraction of the sun and (A. comets B. Jupiter C. moon D. Venus).

29. A B C D — Edmund Halley used Newton's methods to predict (A. an eruption of the Mount Vesuvius volcano B. the return of a comet C. the rise and fall of the stock market D. the weather in London on Christmas Day).

30. State the law of gravity:

31. T F — Isaac Newton wrote two books about the Bible.

32. A B C D — When Isaac Newton said he had seen farther by standing on the shoulders of giants, he was talking about (A. ancient giants described in the Bible B. friends who let him ride on their shoulders C. his method of thinking long and hard about problems D. people who had assisted him).

CHAPTER 5 ACTIVITIES

Architecture: St. Paul's cathedral is one of the most imposing buildings in London. It is noted for its large dome. Research how the dome of St. Paul's was constructed. What are some other famous domed buildings today? How is mathematics used in designing large, open structures such as the dome of a building?

Health: As people moved from the countryside into cities, the number of deaths because of disease increased. After central London burned in the fire of 1666, several steps were taken to rebuild London as a healthier city. What can be done to improve the health and standard of living in cities?

History: Who were the combatants in the English Civil War? What happened to Charles I? What became of the commonwealth after the death of Cromwell?

Literature: John Milton (1608–1674), the English poet, was also active in the government of Cromwell. His best known work is *Paradise Lost*. John Bunyan (1628–1688) is another writer of this period. He is the author of *The Pilgrim's Progress.* Compare their views on the role of the monarchy. Did either one spend any time in prison?

Science: The three greatest inventions of the 1600s were the telescope, microscope, and air pump. Who invented each one? What discoveries were made with the early instruments?

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

Elizabeth I (1533–1603), queen of England
William Shakespeare (1564–1616), English playwright and poet
Johannes Kepler (1571–1630), German astronomer
William Harvey (1578–1657), English physician
Pocahontas (1595–1617), Native American
Oliver Cromwell (1599–1658), first commoner to rule England
Christopher Wren (1632–1723), English architect
Edmond Halley (1657–1742), English astronomer
Johann Sebastian Bach (1685–1750), German composer

CHAPTER 6 QUESTIONS

1. T F — Matthew's law says that those who have will be given more.

2. A B C D — Socrates, Plato, and Aristotle lived in (A. Athens B. Carthage C. London D. Pisa).

3. T F — Euclid was one of the scientists who made Alexandria famous.

4. Following the Dark Ages in Europe, cities in the country of _____ rose to prominence.

5. A B C D — Leonardo de Vinci lived in (A. Basil, Switzerland B. Dublin, Ireland C. Florence, Italy D. London, England).

6. A B C D — Scientists who lived in London included Robert Boyle, Christopher Wren, and (A. Edmond Halley B. Isaac Newton C. Robert Hooke D. all of the above).

7. A B C D — Nicolaus Bernoulli came to Switzerland because of its (A. greater religious freedom B. higher standard of living C. better government D. richer farmland).

8. T F — It is not possible for a body to have two motions at once.

9. A B C D — For shapes with the same perimeter, the one that encloses the greatest amount of space is a (A. circle B. rectangle C. square D. triangle).

10. A B C D — For a roller coaster to descend faster, its ramp should (A. be a straight line B. drop quickly first C. go up before starting down D. have the shape of a catenary).

11. T F — The shape taken by a rope hanging loosely at each end is the parabola, investigated by the ancient Greeks.

12. A B C D — The Bernoulli's were primarily a family of (A. politicians B. doctors C. lawyers D. mathematicians).

CHAPTER 6 ACTIVITIES

Geography: Locate the cities of Athens, Florence, London, and Basel on a map. In what countries are they located? What are the capitals of those countries?

History: In approximately what order and year did each of these events take place: Invention of the printing press, Scientific Revolution, Renaissance, Reformation, Industrial Revolution, American Revolution, French Revolution.

Mathematics: The Gateway Arch in St. Louis, Missouri, has the shape of an upside-down catenary curve. What were some of the challenges faced in the construction of the Gateway Arch? What does the arch represent? What other objects have the shape of a catenary curve?

Science: The major inventions during the 1700s were the thermometer, the steam engine, the hot air balloon, and the electric battery. Which one do you think had the greatest effect on our daily lives? Describe the principle behind its operation.

Social Studies: What inventions made the industrial revolution possible? With the replacement of human muscle power with machines, what effect did this have on everyday life?

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

> Daniel Defoe (1660–1731), English novelist
> John Wesley (1703–1791), English theologian
> Adam Smith (1723–1790), British economist
> Catherine the Great (1729–1796), empress of Russia
> James Watt (1736–1819), Scottish inventor

CHAPTER 7 QUESTIONS

1. A B C D — The Bernoulli who won the Paris Academy of Science prize ten times was (A. Daniel B. Jacob C. Johann D. Nicolaus).

2. A B C D — Daniel Bernoulli decided to become (A. a businessman B. a doctor C. a mathematician D. an astronomer).

3. A B C D — Water and air are examples of (A. fluids B. gases C. liquids D. solids).

4. T F — Until Daniel's time, Newton's laws of motion were applied to large, solid objects.

5. Newton's first law states that an object keeps its motion unless an outside _____ acts on it.

6. T F — Newton's third law of motion explained why a lightly loaded sled was more easily moved than a heavily loaded one.

7. The third law of motion states that for every action force, there is an _____ reaction force.

8. A B C D — At the University of Pauda in Italy, Daniel Bernoulli studied (A. business B. mathematics C. medicine D. physics).

9. A B C D — The one who discovered that the heart pumped blood around the body was (A. Daniel Bernoulli B. Galileo C. Isaac Newton D. William Harvey).

10. A B C D — Daniel's first book was about (A. mathematics B. measuring time C. medicine D. navigation).

11. T F — Daniel Bernoulli went to Russia after his brother Nicolaus agreed to go with him.

12. A B — After Daniel's brother died, Daniel's father (A. urged him to come home B. sent someone else as a roommate).

13. A B — The one that takes less energy is a (A. smoothly flowing fluid B. fluid with eddies and currents).

14. A B C — Daniel devised a way to measure a patient's (A. blood pressure B. pulse rate C. temperature).

15. A B C D — When Daniel begged to come home to Basel in Switzerland, his father said (A. "All is ready for your return." B. "Nothing is here for you." C. "The only opening is in plant science." D. "The weather is too harsh in Switzerland.")

16. Potential energy is _____ energy.

17. Daniel Bernoulli was the first to understand the importance of the law of conservation of _____.

18. A B — The faster air flows, the greater its (A. active B. potential) energy.

19. A B — The potential energy of air is energy due to its (A. pressure B. motion).

20. A B — Increasing the speed of air causes the pressure to (A. drop B. increase).

21. T F — The law known as Bernoulli's principle is named after Daniel Bernoulli.

22. T F — The one who had blocked Daniel's return from Russia had been Daniel's older brother.

23. A B C D — Daniel gave up mathematics because of (A. a stroke B. better money elsewhere C. lack of recognition in that field D. an argument with his father).

CHAPTER 7 ACTIVITIES

Art: Draw a design for a car or other vehicle that has a streamlined shape to reduce air resistance.

Health and Physical Education: How is blood pressure measured today? What is systolic blood pressure? What is diastolic blood pressure? What are some of the causes of high blood pressure? What can a person do to reduce high blood pressure? Does daily exercise result in higher or lower blood pressure?

Literature: Although G*ulliver's Travels* by Jonathan Swift is often presented as a children's book, it attacked the folly and pretension by the authorities of his day, including scientists. Gulliver visited the flying island of Laputa, which was inhabited entirely by scientists. What predictions did the scientists make about the two moons of Mars? Were these predictions correct?

Science: The forces acting on an airplane are thrust, drag, load, and lift. What is the source of these forces? How is Bernoulli's principle used to explain the lift of an airplane wing?

Social Studies: What are some of the steps that Peter the Great and Catherine the Great took to make Russia more modern? In what ways did they fail?

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

Carolus Linnaeus (1707–1778), Swedish botanist
Frederick II (1712–1786), also known as Frederick the Great, King of Prussia
James Cook (1728–1779), British explorer
Wolfgang Amadeus Mozart (1756–1791), Austrian composer
Henry Cavendish (1731–1810), English physicist and chemist
William Herschel (1738–1822), German-born British astronomer
Alesandro Volta (1746–1827), Italian physicist

CHAPTER 8 QUESTIONS

1. A B C D — About half of the scientific research publications of Leonhard Euler were produced while he was (A. a student B. on expeditions C. totally blind D. under house arrest).

2. A B C D — Leonhard Euler planned to become (A. a doctor B. mathematician C. minister of the Gospel D. ship's captain).

3. T F — Leonard Euler was trained in mathematics by members of the Bernoulli family.

4. T F — Euler received the rank of lieutenant in Catherine I's navy because of his experience as a sailor.

5. T F — Secret police of the Russian government followed Euler because he was a foreigner.

6. A B C D — Euler avoided appearances at the palace by (A. being constantly busy B. going on long mapmaking expeditions C. pretending to be unable to speak Russian D. staying on Lake Geneva in a boat).

7. Mapmaking is a mathematical and _____ art.

8. A B — Euler (A. avoided B. enjoyed) having his children around him as he worked.

9. T F — Euler invited a minister to his home to conduct family devotion each night.

10. At the invitation of Fredrick the Great of Prussia, Euler moved to the city of _____.

11. A B — While working for Fredrick the Great, Euler was paid (A. poorly B. quite well) as a mathematician.

12. A B C D — Euler's book about science for the adults in Prussia was called (A. *Letters to a German Princess* B. *Science for Prussia's Leaders* C. *Science for the Faint of Heart* D. *Science without Tears*).

13. Mathematics can be pure or _____.

14. A B — To walk across all seven of the Königsberg bridges without crossing one a second time was (A. possible B. impossible).

15. A B C D — A procedure that leads to a solution is (A. algebra B. an algorithm C. a fallacy D. a zero sum).

16. T F — When Catherine the Great became the new ruler of Russia, Euler returned to that country.

17. Calculating the moon's obit involves three bodies: sun, moon, and _____.

18. T F — Euler calculated the orbit of Uranus using many observations taken from all around its orbit.

19. T F — Leonhard Euler wrote more research papers than any other mathematician.

CHAPTER 8 ACTIVITIES

Astronomy: How many planets were known in ancient times? What are the events surrounding the discovery of Uranus. Who was Uranus in Greek mythology?

Communication: An algorithm is a step by step procedure. Write a step by step procedure for one of

the following: a recipe for cooking a favorite food; directions to your home from the local library or some other landmark; instructions on how to start a particular program or game on a computer; how to pack for an overnight camping trip.

Geometry: Mapmaking, or cartography, is the science of representing the earth's curved surface. Except for globes that are spherical like the earth, all maps must contain some distortion when converting the spherical shape of the earth's surface to a flat piece of paper. What are some of the choices mapmakers must make in representing the earth's surface? What is a map projection? What is the scale of a map?

Health: Two common causes of vision loss are cataracts and glaucoma. What are the causes of these diseases? How can they be prevented or treated? What inventions have helped blind people lead lives that are more productive?

Science: Hot air balloons were invented in 1783. Who built the first hot air balloons? Why are hot air balloons described as lighter than aircraft? What other gases have been used to give balloons lift?

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

> Gerardus Mercator (1512–1594), Flemish mapmaker
> Immanuel Kant (1724–1804), German philosopher
> James Hutton (1726–1797), Scottish geologist
> Joseph Black (1728–1799), Scottish chemist
> Caroline Herschel (1750–1848), German-born British astronomer

CHAPTER 9 QUESTIONS

1. A B C D — Carl Gauss' father was a (A. gardener B. Lord of the Manor C. professional soldier D. ship builder).

2. A B — The age of Carl Gauss when he corrected his father's figures for paying the gardeners was (A. three B. eight) years old.

3. A B C D — While in school, Carl Gauss instantly gave the correct answer to the math problem because he (A. could work problems in his head B. had already worked the problem   C. knew calculus D. saw a short cut).

4. A B C — The one who agreed to pay for Gauss' education was (A. his father B. his uncle Friedrich C. the Duke of Brunswick).

5. T F — Before computers and pocket calculators, multiplication and division was made easier by using logarithms.

6. A B — A number such as 15 is a (A. composite B. prime) number.

7. A B C D — The first person to prove the fundamental theorem of arithmetic was (A. Euclid B. Gauss C. Newton D. Pythagoras).

8. A B C D — John Bode believed a planet existed between Mars and (A. Earth B. Jupiter C. Pluto D. Venus).

9. A B — The asteroid that Giuseppe Piazzi saw was given the name (A. Ceres B. Neptune.)

10. T F — The word asteroid means planet-like.

11. T F — Carl Gauss' method of least squares became an important mathematical tool.

12. T F — Gauss took great care to publicize his discoveries and inventions.

13. The angles of a triangle sum to _____ degrees.

14. T F — Gauss tested the parallel postulate by measuring the sum of the angles of very large triangles.

15. A B C D — Bernhard Riemann's non-Euclidian geometry was helpful to (A. Columbus in discovering the New World B. Einstein in developing his theory of relativity C. Euclid in proving there is no largest prime number D. Gauss in measuring the strength of the earth's magnetic field).

16. T F — Bernhard Riemann found it difficult to speak before an audience.

17. A B — To exercise his mind, Carl Gauss learned (A. new languages B. to paint).

18. A B — Gauss became known as the (A. General of Arithmetic B. Prince of Mathematicians).

19. The three greatest mathematicians of all time are Archimedes, _____, and Carl Friedrich Gauss.

CHAPTER 9 ACTIVITIES

Art: The first photographs were taken in the 1830s, and by 1860 photography had become a way to record current events as they happened. Mathew Brady took battlefield photographs during the American Civil War. Contrast his work with that of Francisco de Goya's painting *Third of May, 1808*. Draw a dramatic event from your life or some event that took place in the last ten years.

Astronomy: The asteroids are sometimes called planetoids or minor planets. Why? How many minor planets have been found? Do all of them orbit between Mars and Jupiter? What are the names of the four brightest minor planets? Can any of them be seen with the unaided eyes? How do astronomers search for asteroids? How are they named?

Communication: The telegraph was the first invention that used electricity as a method of communication. What were some of the other inventions of the last 150 years that have made communication easier? Choose a conversation you recently had with a friend and write it as if you were sending a telegram in which every word cost money. How briefly can you convey the same information?

Geology: What is the difference between the earth's geographic poles and magnetic poles? Are they both at the same location? Does a compass point toward the north geographic pole or the north magnetic pole?

Mathematics: What is the difference between arithmetic and mathematics? Write each of the following composite numbers as a product of prime numbers: 12, 15, 24, 30, 64, and 100.

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

> Robert Fulton (1765–1815), American inventor and engineer
> Humphry Davy (1778–1829), British chemist
> George Stephenson (1781–1848), British inventor and engineer
> Louis Daguerre (1789–1851), French painter, inventor of photography
> Samuel F.B. Morse (1791–1872), American artist and inventor
> Charles Dickens (1812–1870), English writer
> Ada Byron, Countess Lovelace (1815–1852), British mathematician

ANSWERS TO QUESTIONS

CHAPTER 1

1. A — Aegean Sea
2. B — Lebanon
3. B — lyre
4. knowledge (or learning)
5. D — halt their advance to war against one another
6. C — the Great Pyramid of Giza
7. A — astronomy
8. Italy
9. B — music
10. nine
11. The sum of the squares of the legs of a right triangle is equal to the square of the hypotenuse.

12. B — hypotenuse
13. C — letters of the Greek alphabet
14. C — rational
15. B — circumference of a circle divided by its diameter
16. T
17. B — irrational
18. F — cannot be represented as one whole number divided by another
19. B — mathematical proofs
20. T

CHAPTER 2

1. B — hopelessly out of date
2. F — the Bible is first, *Elements* is second
3. T
4. D — mathematics and geometry
5. Egypt
6. A — Alexandria
7. T
8. C — prime
9. B — is not
10. T

11. B — light
12. fire
13. T
14. T
15. Arab
16. Through a point not on a given line, one and only one line can be drawn parallel to the given line.
17. A — an assumption
18. F — with organizing and summarizing the facts

CHAPTER 3

1. F — astronomer
2. A — better
3. F — even some of his letters have been preserved
4. C — Sicily
5. T
6. T
7. B — regular polygon

8. C — 96
9. 22/7
10. T
11. 5
12. B — is not infinite
13. D — *The Sand Reckoner*
14. B — historian
15. B — drew figures in the sand

CHAPTER 4

1. A — engineering
2. Alexandria
3. F — they worked land they did not own
4. B — Dark Ages
5. A — Italy
6. Pisa
7. F — almost as soon as it was completed
8. D — Roman numerals
9. D — Northern Africa
10. India
11. T
12. zero, 0
13. B — *Book of Calculating*
14. 13 (5 + 8 = 13)
15. A — easier
16. F — businessmen, surveyors, engineers, astronomers, and scientists also used the new numbering system
17. B — less

CHAPTER 5

1. T
2. B — poor
3. B — Lord Protector
4. D — made a bookshelf for them
5. F — he read it through many times
6. druggist
7. T
8. A — Bible
9. B — no better
10. B — read books in the Clark library
11. C — doing chores for his professors
12. F — practically unknown
13. B — the Black Death
14. A — at his mother's farm
15. F — he explored a dozen different subject
16. C — worthy of a first rate mathematician
17. calculus
18. T
19. A — was a mixture of all the colors
20. C — Galileo
21. B — elliptical
22. A — apple
23. B — moon
24. B — distance
25. B — marvelous year
26. A — Edmund Halley
27. B — *Principia Mathematica*
28. C — Moon
29. B — the return of a comet
30. The force of attraction between any two bodies in the universe is directly proportional to the product of their masses and inversely proportional to the square of the distance separating their centers.
31. T
32. D — people who assisted him

CHAPTER 6

1. T
2. A — Athens
3. T
4. Italy
5. C — Florence, Italy
6. D — all of the above
7. A — greater religious freedom
8. F — a point on a wagon wheel moves forward and circles around the wheel
9. A — circle
10. B — drop quickly first
11. F — it is a catenary
12. D — mathematicians

CHAPTER 7

1. A — Daniel
2. B — a doctor
3. A — fluids (air is a gas, water is a liquid, but both air and water are fluids)
4. T
5. force
6. F — second law of motion
7. opposite
8. C — medicine
9. D — William Harvey
10. A — mathematics
11. T
12. B — sent someone else as a roommate
13. A — a smoothly flowing fluid
14. A — blood pressure
15. B — "Nothing is here for you."
16. stored
17. energy
18. A — active
19. A — pressure
20. A — drop
21. T
22. F — his father
23. D — an argument with his father

CHAPTER 8

1. C — totally blind
2. C — minister of the Gospel
3. T
4. F — The only sailing ship Euler had ever seen were boats on the Swiss lakes.
5. T
6. A — being constantly busy
7. geometric
8. B — enjoyed
9. F — he did them himself
10. Berlin
11. B — quite well
12. A — *Letters to a German Princess*
13. applied
14. B — impossible
15. B — an algorithm
16. T
17. earth
18. F — from only a few observations that were close together
19. T

CHAPTER 9

1. A — gardener
2. A — three
3. D — saw a short cut
4. C — the duke of Brunswick
5. T
6. A — composite
7. B — Gauss
8. B — Jupiter
9. A — Ceres
10. F — starlike, planetoid means planetlike
11. T
12. F — He invented a type of telegraph but did not publicize it.
13. 180
14. T
15. B — Einstein in developing the theory of relativity
16. T
17. A — new languages
18. B — Prince of Mathematicians
19. Newton