This work was supported in part by grants and contracts from the Institute of Education Sciences, U.S. Department of Education. The opinions expressed herein do not necessarily reflect the views of the department.

About the cover

As students progress through this guide, they will understand the features on the cover. In studying Unit I, Lesson 1, they will recognize Professor Quest. Unit II, Lesson 1, will enable them to identify the constellation depicting the Pythagorean Theorem. Lesson 6 in the same unit will provide students with the knowledge to identify Aristarchus’ model of the solar system. In Unit III, Lesson 2, they will learn about Hero’s simple machines and recognize the lever in one constellation. By studying Fibonacci’s numbers in Unit V, Lesson 2, students will understand the significance of the nautilus constellation.

© The Johns Hopkins University, 2005
# Table of Contents

## Unit I

- Using the Teacher's Quest Guide

000 Using the Teacher's Quest Guide

000 **Introduction**

000 **Lesson 1, Preview**

000 **Lesson 2, Chapter 1, “Birthing a Universe,” Chapter 2, “Telling It Like They Thought It Was: Stories of Creation”**

000 **Lesson 3, Chapter 3, “Making Days: Were the Calendar Makers Lunatics or Just Moonstruck?”**

000 **Lesson 4, Chapter 4, “Ionia? What’s Ionia?” Chapter 5, “The ‘A’ Team”**

000 **Lesson 5, Chapter 6, “Elementary Matters: Earth, Air, Fire, and Water, says Empedocles,” Chapter 7, “Being at Sea”**

000 **Lesson 6, Chapter 8, “Worshipping Numbers”**

000 **Lesson 7, Chapter 8 Feature, “Chewing on Pi—or Tasting One of Math’s Mysteries”**

000 **Lesson 8, Preparation for Assessment**

000 **Lesson 9, Assessment**

## Unit II

- Introduction

000 Introduction

000 **Lesson 1, Chapter 9, “Pythagoras Knows It’s Round”**

000 **Lesson 2, Chapter 10, “Getting Atom”**

000 **Lesson 3, Chapter 11, “Aristotle and His Teacher”**

000 **Lesson 4, Chapter 12, “Does It Change? ‘No Way,’ Says A”**

000 **Lesson 5, Chapter 12 Feature, “Why Mars Is a Little Loopy”**

000 **Lesson 6, Chapter 13, “Aristarchus Got it Right—Well, Almost!”**

000 **Lesson 7, Chapter 13 Feature, ”Changing Seasons”**

000 **Lesson 8, Preparation for Assessment**

000 **Lesson 9, Assessment**

## Unit III

- Introduction

000 Introduction

000 **Lesson 1, Chapter 14, “Alexander’s City”**

000 **Lesson 2, Chapter 15, “What’s a Hero?”**
Unit IV

Introduction
Lesson 1, Chapter 19, “Rome Rules”
Lesson 2, Chapter 20, “Longitude and Latitude plus Two Greek Mapmakers,” Feature, “What’s the Point?”
Lesson 3, Chapter 20, “Longitude and Latitude plus Two Greek Mapmakers”
Lesson 4, Chapter 21, “The Greatest”
Lesson 5, Chapter 22, “A Saint Who Was No Scientist”
Lesson 6, Chapter 23, “No Joke—the Earth is Pancake Flat!”
Lesson 7, Chapter 24, “Don’t Worry—the Round Earth is Back!”
Lesson 8, Preparation for Assessment
Lesson 9, Assessment

Unit V

Introduction
Lesson 1, Chapter 25, “Absolute Zero”
Lesson 2, Chapter 25 Feature, “Mr. Fibonacci’s Numbers”
Lesson 3, Chapter 26, “An ‘Ox’ who Bellowed”
Lesson 4, Chapter 27, “Books Will Do It”
Lesson 5, Chapter 28, “The Antipodes: Discovering Down Under”
Lesson 6, Chapter 28, “The Antipodes: Discovering Down Under”
Lesson 7, Chapter 29, “Cosmic Voyagers: Is It Fiction, or Could It Be True?” Chapter 30, “Finally! How Science Works”
Lesson 8, Preparation for Assessment
Lesson 9, Assessment

The Story of Science: Aristotle Leads the Way Assessment
Using the Teachers Quest Guide

STANDARDS

The lessons in this guide meet the National Science Education Standards, grades 5 – 8, and Benchmarks for Science Literacy, grades 6 – 8. Unit introductions list the specific standards and benchmarks met by the lessons in that unit.

LESSON FORMAT

• Sessions contain more activities than a class can accomplish during a typical class period. Select the most important activities according to students’ needs and abilities. For example, as students become grounded in an understanding of the time line and geography of events, de-emphasize these activities to emphasize science activities.

• The curriculum includes forty-five sessions (a term of nine weeks).

• Five units each include an introduction (with background, materials list, and standards) and nine class sessions. Each unit includes one day to prepare for the assessment and one day for the assessment. A final assessment covers the entire book.

• Text-based lessons include reading, discussions, and activities to engage students in learning the material in The Story of Science: Aristotle Leads the Way.

• Science and math sessions include hands-on activities that give students an opportunity to act as scientific investigators. The activities duplicate historic experiments and allow students to observe natural phenomena both inside and outside the classroom.

TEXT-BASED LESSON FORMAT

Theme

Each lesson begins with a quotation from a scientist, great writer, or thinker that states the main idea of the lesson.

Goals

Each lesson has one or more specific goals for students to accomplish. These may include acquiring specific knowledge or building an understanding that will serve as a foundation for knowledge in future lessons.

Who? What? Where? When?

• Who? - scientists and other historic personalities

• What? - important terms

• Where? – geographic locations of events in the lesson

• When? - locations of events in the lesson in history
In some lessons, students find information and definitions during their reading to understand these terms. In other lessons, they draw on already defined terms to assist their reading.

**Groundwork**

A preparation checklist for the teacher appears at the beginning of the lesson. A list of materials for students, teams, the teacher, and the classroom appears in the unit introduction.

**Consider the Quotation**

As a focusing activity, students decipher and paraphrase the theme quotation.

**Directed Reading**

Before assigning reading of a non-fiction passage, students set goals or ask questions so that they have a purpose for reading. What should they look for, note, and learn? To do this, they need prior knowledge on which to base questions.

In preparation for reading, students may be asked to do any of the following:

- Consider the title and/or theme quotation;
- Browse through the passage to look at illustrations, side bars, charts, maps, and headings;
- Predict how a list of names and terms will apply to the passage;
- Speculate and ask questions about the main idea of the passage.

As students read the entire passage, they may pause to take notes on information they encounter that applies to their purpose for reading. When two students pair read, they share a reading assignment by reading portions to one another and stopping between passages to summarize, discuss, and question what they have read. Does the passage give any answers they are seeking? Does it raise new questions? What is interesting?

At the conclusion of the readings, students share and compare their findings in a class discussion.

**Cooperative Team Learning**

Students work in established cooperative teams (four students) to share and discuss ideas and concepts, debate issues, and develop and present projects. As teams work, each student must take equal responsibility to accomplish the task and support team members’ efforts. In some instances the team will produce a group project, but in most lessons each student will complete work individually based on the group activity. To help keep students on task and ensure that all team members participate and contribute, the teacher visits teams as they work.

**Classwide Activity**

The teacher interacts with the entire class to learn a concept or body of knowledge through discussion and demonstration.

**Scientists Speak**

As students study each scientist, they will have the opportunity to put words in that scientist’s mouth. What was the scientist’s most important discovery? What law or principle did he or she state on which future scientists could base their work? The statement formulated by the class is written
Conclusion

Students revisit the lesson’s theme and their paraphrase of the opening quotation to summarize what they have learned and discuss the truth of the quotation. Students use their new knowledge and understanding to interpret the Professor Quest cartoon. The professor knows no boundaries in time, geography, or language. She communicates with the students, with the Greek-speaking philosophers, and with the medieval saints with equal ease. By asking important questions and commenting on significant events, she guides students on their quest through the story of science.

Homework

Students take home a brief independent assignment to reinforce the main points of each lesson, to prepare for a coming lesson, to further a project, or to collect material for a science session.

Curriculum Links

Activities in science, mathematics, geography, social studies, reading, language arts, music, and/or art appear at the end of each lesson. Select from these activities as time permits according to student interest and needs. Students will not have time to complete all of these activities. Some curriculum links may expand into additional lessons; some may provide ideas for presentations and projects.

References

Each lesson concludes with a list of web sites, books, and other sources used in compiling the lesson.

CLASSROOM MATERIALS

The following materials are needed for every lesson.

For each student: The Story of Science: Aristotle Leads the Way by Joy Hakim; Student’s Quest Guide; and a journal/notebook.

For the teacher: The Story of Science: Aristotle Leads the Way by Joy Hakim; Teacher’s Quest Guide.

For the classroom: chart paper; an overhead projector; transparency markers; and a classroom time line.

For individual lessons

Time line

Before beginning the quest through The Story of Science: Aristotle Leads the Way, establish a time line using a long roll of shelf paper or a clothes line stretched around or across the classroom. The time line must be long enough to range from 700 B.C.E. to 2000 C.E., twenty-seven centuries.

Writing directly on the shelf paper or clipping index cards to the line, mark off the time line into twenty-seven even sections, each representing a century. Leave a bit of a tail after 2000 C.E. to mark
the present, the beginning of the twenty-first century. Label the centuries beginning with 700 B.C.E. at one end and ending with 2000 C.E. at the other. The centuries between 700 B.C.E. and 1500 C.E. will become very crowded, but allotting each century equal space on the time line will give students an accurate sense of distance in time between people’s lives and historic events.

As the lessons progress, students maintain the time line by adding people and events using tacks, tape, or clip clothespins. Encourage students to replace the teacher-made time line markers with more creative ways to mark events. For example, students might replace the marker for Pythagoras with an illustration of his theorem. They might illustrate the Roman siege of Syracuse with a drawing of one of Archimedes’ war machines. New markers should still have labels recording the event and the date.

Classroom Maps

The class will need large maps of Europe, the Middle East, Northern Africa, and the world to supplement the maps in The Story of Science: Aristotle Leads the Way.

Keys

Duplicates of Student’s Quest Guide sheets provide the answers.

Transparency Masters

The Teacher’s Quest Guide contains transparency masters to accompany each lesson. They include maps, quest sheets, Scientists Speak, Professor Quest cartoons, and other images specific to a lesson from which to make transparencies for display on an overhead projector.

Student’s Quest Guide

Each student will have a Student’s Quest Guide, which contains the following materials for each lesson.

• Theme
• Professor Quest cartoon
• Who? What? Where? When?
• Quest sheets

Student Sheets

For some science and math sessions, students receive student sheets, copied from masters in the Teacher’s Quest Guide. These are separate from the Student’s Quest Guide because they may go home as part of a homework assignment or may be disposable as part of a science activity.

Journals

Students maintain a journal during their study of The Story of Science in which they reflect on information they have learned; write creatively about people, events, and discoveries; and summarize important material using meaningful sentences.

Writing meaningful sentences using Who? What? Where? When? terms, is a recurring assignment, which provides students with a tool to summarize main ideas. This tool will require modeling when first assigned and frequent reinforcement.

Explain to students that in a meaningful sentence, the writer embeds context clues that indicate a clear understanding of the new word. To test whether or not a sentence is meaningful, try replacing

---

viii
the new word with another word. No other word, other than a close synonym, can replace the new word without changing the meaning of the sentence. In another test for a meaningful sentence, the writer encloses the new word in a box and underlines the words or phrases that serve as context clues.

For example, a meaningful sentence using the word astronomy might read: Julia loves astronomy so much that she watches the heavens every clear night, studying the movements of the planets and the locations of the stars. A not so meaningful sentence might read: My teacher said we will study astronomy this term.

**Assessments**

At the close of each unit, students will demonstrate what they have learned. Assessments may take a number of forms, including

- a creative cooperative team learning project
- an open book web and essay activity
- an objective assessment

Before teaching a unit, the teacher considers the possible assessment activities so that students have an opportunity to prepare as they progress through the lessons.

**Ongoing Study**

Students choose a topic for ongoing study through the nine-week curriculum. The teacher sets class time aside for periodic guidance and progress reports on the ongoing studies. Students may present the results of their ongoing study in a Science Story Fair with exhibits, reports, and presentations. Some possible areas of study include

- Follow art history (choose paintings, sculpture, architecture) from the periods and societies in which the scientists lived. Compare the styles, the attempts at reality, the subject matter, and the influence of scientific knowledge. Art links in at least one lesson per unit suggest an artist to research, and stable museum links offer many color images of art works.

- Trace the progress of medical knowledge through the periods and societies in which the scientists lived. What ailments did the scientists have? How were they treated? What caused their deaths? What contributions to medical science did the scientists whom they study make? What public health problems occurred (the bubonic plague, malnutrition) and how did the societies deal with them?

- Collect an anthology of poetry or prose literature from the periods and societies in which the scientists lived. Compare the styles, moods, the subject matter, and the influence of scientific knowledge. Literature links in at least one lesson per unit suggest authors to research.

- Follow the history of time keeping during the periods and in the societies in which the scientists lived. Build a model clock from one or more of the periods.

- Compile a Who's Who? of people who played major roles in the periods and societies studied in *The Story of Science Book 1* in fields other than science. Write brief biographies and find or create illustrations.

- Keep a sky journal. Find and mark a place on the sidewalk to stand each evening. Watch the sky and draw the night sky exactly as seen, paying careful attention to how high each sky object is in the field of view.
SAFETY IN THE CLASSROOM

Many of the activities in this guide involve exploration by students. In order for such activities to be conducted in an atmosphere of safety and security, teachers should be well-prepared. Whether the activities occur in a classroom, in a laboratory, on the playground, or at home, appropriate equipment and facilities must be available, and adequate supervision must be provided. When safety becomes a state of mind, students not only become more secure but learn habits that extend to other areas of their lives.

There is no way to summarize all of the possible problems that might occur in an active classroom, or to list all of the precautions that should be taken to avoid potential hazards. However, general guidelines prove to be effective:

• Both teachers and students should be well-prepared for each activity. Students must be present when precautions are discussed. Students should demonstrate their understanding of appropriate conduct before they begin.

• When students are active, both supervision ratios and space-per-student are important safety factors. Research shows that groups of over 24, and space per students lower than 45 square feet per student, both contribute to accident rates.

• In order to maintain order and maximize student interest, break exploratory activities into small steps with formative assessments and feedback after each section.

• Science materials must never be tasted or used for food after explorations.

• Encourage cleanliness with soap and hot water, both for hands and desks or tables.

• Eye protection is required for all chemicals, and whenever fire, heat, sharp objects or projectiles might be present in the classroom.

• When chemicals are used, only very small (minimum) quantities should be present in the classroom. These quantities should be provided in labeled containers, with larger stocks of chemicals retained in separate, appropriately secure facilities.

• The only appropriate heat sources for students at the elementary or middle school level are low (tea) candles or (laboratory) hotplates.

A NOTE TO HOMESCHOOLING PARENTS

This curriculum is easily adapted to the home school setting. Each lesson is carefully outlined and explained, eliminating the need for exhaustive lesson planning. All materials needed for experiments and activities are readily available, and no expensive lab equipment is required.

Pair reading, which helps struggling readers in a traditional classroom, can be used to help a younger sibling keep up with challenging material. If only one student is using Aristotle Leads the Way, the home teacher can introduce the lesson and have the student read independently. At times, students work in pairs or teams to accomplish a task. In many instances, a younger sibling can be drawn into these activities, even if he or she is not studying Aristotle Leads the Way.

Home school teachers will appreciate the multidisciplinary elements in this curriculum, which include activities and topics in science, history, math, and language arts. Extension activities at the end of each lesson provide the home teacher with many ideas for further study and independent projects to add to the student’s portfolio.
## Aristotle Leads the Way

### INTRODUCTION – UNIT I

**Schedule**

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Text</th>
<th>Activity/Concept</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Preview – Table of Contents</td>
<td>Studying <em>The Story Of Science</em> time line – B.C.E/ C.E.</td>
</tr>
<tr>
<td>2</td>
<td>Chapter 1, “Birthing a Universe”</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chapter 2, “Telling it Like They Thought It Was: Myths of Creation”</td>
<td>Compare creation stories from several cultures</td>
</tr>
<tr>
<td>3</td>
<td>Chapter 3, “Making Days: Were the Calendar Makers Lunatics or Just Moonstruck?”</td>
<td>Calendars based on the Moon or the Sun</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tidal time activity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Optional math activity</td>
</tr>
<tr>
<td>4</td>
<td>Chapter 4, “Ionia? What’s Ionia?”</td>
<td>Contributions to science and philosophy from Ionians Thales, Anaximanes, Anaximenes, and Anaxagoras</td>
</tr>
<tr>
<td></td>
<td>Chapter 5, “The A Team”</td>
<td>Recreate Thales’ experiment</td>
</tr>
<tr>
<td>5</td>
<td>Chapter 6, “Elementary Matters: Earth, Air, Fire and Water, says Empedocles”</td>
<td>The Greek idea that the four basic elements in the universe are earth, air, fire, and water Elements of air inquiry activity</td>
</tr>
<tr>
<td></td>
<td>Chapter 7, “Being at Sea”</td>
<td>Contributions of Herodotus and the Phoenicians to science</td>
</tr>
<tr>
<td>6</td>
<td>Chapter 8, “Worshipping Numbers”</td>
<td>The importance of mathematics Science Laboratory – B.C.E.</td>
</tr>
<tr>
<td>7</td>
<td>Chapter 8 Feature, “Chewing on Pi—Or Tasting One of Math’s Mysteries”</td>
<td>Understand and calculate pi</td>
</tr>
<tr>
<td>8</td>
<td>Preparation for Assessment</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Assessment</td>
<td></td>
</tr>
</tbody>
</table>
Materials

Lesson 1
For the teacher
transparency masters
  Scientists Speak: Epictetus
  Professor Quest cartoon #1
For each the classroom
time line cards
photocopy of Scientists Speak: Epictetus

Lesson 2
For the teacher
transparency masters
  Myths vs. Science
  Myth of Persephone
  Professor Quest cartoon #2
For the classroom
time line cards

Lesson 3
For the teacher
bright light/lamp
transparency masters
  Scientists Speak: Roger Bacon
  Professor Quest cartoon #3
For each student
  polystyrene ball
  sheet of graph paper

Lesson 4
For the teacher
transparency masters
  Scientists Speak: Thales
  Anaximander
  Anaximenes
  Anaxagoras
  Professor Quest cartoon #4
For the classroom
photocopies of
  Scientists Speak: Thales
  Anaximander
  Anaximenes
  Anaxagoras

Lesson 5
For the teacher
matches
candle
jar
transparency masters
  Scientists Speak: Empedocles
  Herodotus
  Professor Quest cartoon #5
For the classroom
photocopies of
  Scientists Speak: Empedocles
  Herodotus
For each team
tea candle
short, flat dish
water
jar
straw
drops of bromthymol blue
For each student
  safety goggles

Lesson 6
For the teacher
transparency masters
  Who? What? Where?
  The Oracle at Delphi
  Professor Quest cartoon #6
For the classroom
time line cards
Lesson 7

For the teacher
transparency masters
Going in Circles
Professor Quest cartoon #7
You Be the Scientist: Squaring the Circle

thumbtack
string 12cm long
transparent ruler

For each team
long, knotted piece of string
(various lengths)
piece of sidewalk chalk or pencil
meterstick
sidewalk or large piece of paper

For each student
pencil
thumbtack
string 12cm long
ruler
calculator (optional)

Background

When did the universe begin? This question has engaged the human mind from earliest recorded time. Humans found the universe dazzling, vast, capricious, and chaotic. Who could have created such a world? Or was it created? Perhaps the universe had no beginning but had existed forever. Perhaps it would have no end. But then again, maybe it would end. To people in ancient times, an earthquake, the eruption of a volcano, or a comet streaking across the night sky could signal the end of the world.

The movement of heavenly bodies across the sky presented one constant in a world of unpredictable events. Although they had no idea why the Moon and the Sun were so constant, ancient people used celestial movements to measure time and plan important events such as planting and harvest times. The lunar calendar of the Babylonians and Chinese and the solar calendar of the Egyptians were flawed but useful attempts to keep track of time in harmony with nature.

The events of nature and the apparent movement of heavenly bodies across the sky gave ancient people few clues to answer their questions about the universe. Surely such a volatile and awe-inspiring universe must be the work of equally unpredictable, powerful, beautiful gods. For many centuries, myth and superstition served well to explain the unexplainable mysteries of the universe. They also proved very useful to rulers, who represented themselves as gods to hold their subjects in submission.

Every early culture had its own stories to explain the universe and the powers of the natural world. Despite their marked differences, the stories contain common threads: darkness and chaos before the universe began, a creator with great power, the creation of light, and the separation of the heavens from Earth. Human beings came from the tears of the Egyptian creator or from the Brahma of the Hindu Divine Self. According to the Hebrews, God formed humans from mud.

Creation stories prevailed until inevitably someone, somewhere, began to observe the world and question these beliefs. That someone was Thales, the first recorded Greek scientist/philosopher. He lived near the end of the seventh century B.C.E. in Ionia, a city-state bordering the Aegean Sea. Although all that modern readers know about him comes from the writings of others (Plato, Diogensis Laertius, Aristotle, and even Aesop), his philosophy, experiments, and bizarre personality traits remain vivid. Thales was not content with supernatural explanations for natural phenomena. He thought that water was the primary element from which all matter originated. Although incorrect, his theory represented a positive step away from the stories of capricious gods.

Closely following Thales came Anaximander, who contemplated not only the stars, but also the place of the earth among the stars, earning the title “the father of astronomy.” Anaximander
called the origin of all things “the Boundless,” which seemed a peculiar idea for the Greeks, who loved symmetry, harmony, and limits. His pupil, Anaximenes, following the Ionian tradition of observant scientist/philosophers, concluded that air is the source of all things. The concentration of air, Anaximenes asserted, determines what form it takes. In its least dense form it is fire; more dense air is the wind. More concentrated still, air becomes water, and in its densest form it becomes earth.

Anaxagoras completes the amazing quartet of Ionian science/philosophers. Far ahead of his time, he questioned the idea of four basic elements. “How could hair be made of what was not hair?” he asked. Rather, he proposed, everything in the world contains portions of everything else no matter how minutely divided. Anaxagoras also shocked his contemporaries with the assertion that the moon’s glow is the reflected light from a fiery rock. Because he denied that the Moon and Sun were gods, political leaders imprisoned him, setting an unhappy precedent for future scientists who dared to challenge established authority.

A contemporary of Anaxagoras, Empedocles summed up the universe in four elements: earth, fire, air and water. During his lifetime, Empedocles received acclaim for his vast learning and diverse talents. He was a poet, statesman, philosopher, scientist, and physician. While Empedocles did not claim supernatural powers, he did not refuse credit as a miracle worker when he turned plague-carrying winds away from Sicily and restored to life a woman who had not breathed for thirty days. Controversy surrounds Empedocles’ demise on Mount Aetna. Whether he fell into the volcanic crater, or jumped in so that his death would appear mysterious and god-like, or died a natural death is not important. However, Empedocles’ visionary theories of evolution are important: the existence of air, the conservation of energy, and the measurable speed of light. All these he proposed with a correctness nearly two millennia ahead of his time.

In the fifth century B.C.E., Herodotus began to record the knowledge of his times, attempting to sift truth from wild tales. Through his writings, we know the information brought back to the Greek world by the adventurous, sea-faring Phoenicians.

The scientist/philosophers of the ancient world had nothing beyond their observations of the natural world and nothing but their reasoning to interpret those observations. From these beginnings came astronomy, mathematics, and geometry. These infant scientific disciplines took root and began to challenge flourishing superstition and mythical explanations of creation.

Math Session

Unit I, lesson 3, includes a math session in which students draw and identify the parts of circles and use pi to calculate the circumferences and areas of circles.

Assessment

Unit I offers three assessment activities.

• Cooperative Team Learning - Teams compose and perform a science story rap.
• Students use a Venn diagram to organize and write an essay that compares or contrasts two creation stories. (open book)
• Students arrange events on a B.C.E. time line, demonstrate their understanding of B.C.E. dates, and use vocabulary to write meaningful sentences describing main concepts of unit. (closed book)

Standards

National Science Education Standards

Earth and Space Science

Content Standard D

Earth in the solar system

• Most objects in the solar system are in regular and predictable motion. Those motions explain such phenomena as the day, the year, phases of the moon, and eclipses.

History and Nature of Science
Content Standard G

History of Science

- Many individuals have contributed to the traditions of science. Studying some of these individuals provides further understanding of scientific inquiry, science as a human endeavor, the nature of science, and the relationships between science and society.
- In historical perspective, science has been practiced by different individuals in different cultures. In looking at the history of many peoples, one finds that scientists and engineers of high achievement are considered to be among the most valued contributors to their culture.
- Tracing the history of science can show how difficult it was for scientific innovators to break through the accepted ideas of their time to reach the conclusions that we currently take for granted.

Benchmarks for Science Literacy

The Nature of Science

1A The Scientific World View

- Scientific knowledge is subject to modification as new information challenges prevailing theories and as a new theory leads to looking at old observations in a new way.
- Some scientific knowledge is very old and yet is still applicable today.
1C The Scientific Enterprise

- Important contributions to the advancement of science, mathematics, and technology have been made by different kinds of people, in different cultures, at different times.

The Physical Setting

4B The Earth

- Like all planets and stars, the earth is approximately spherical in shape. The rotation of the earth on its axis every 24 hours produces the night-and-day cycle. To people on earth, this turning of the planet makes it seem as though the sun, moon, planets, and stars are orbiting the earth once a day.
4D Structure of Matter

- Scientific ideas about elements were borrowed from some Greek philosophers of 2,000 years earlier, who believed that everything was made from four basic substances: air, earth, fire, and water. It was the combinations of these “elements” in different proportions that gave other substances their observable properties. The Greeks were wrong about those four, but now over 100 different elements have been identified, some rare and some plentiful, out of which everything is made. Because most elements tend to combine with others, few elements are found in their pure form.

Historical Perspectives

10 F Understanding Fire

- From the earliest times until now, people have believed that even though millions of different kinds of material seem to exist in the world, most things must be made up of combinations of just a few basic kinds of things. There has not always been agreement, however, on what those basic kinds of things are. One theory long ago was that the basic substances were earth, water, air, and fire. Scientist now know that these are not the basic substances. But the old theory seemed to explain many observations about the world.

Habits of Mind

12B Computation and Estimation

- Calculate the circumference and areas of rectangles, triangles, and circles, and the volumes of rectangular solids.
Aristotle Leads the Way

Theme

“It is impossible for a man to begin to learn that which he thinks that he knows.”
Epictetus (ca. 55 – ca. 135 C.E.)

Goal

Students will understand that they are about to begin a quest, a journey in search of knowledge. Their journey will deal with astronomy, chemistry, physics, and mathematics, and with the people, places, and important historic events that influenced scientific discovery.

What?

quest – a journey in search of something, knowledge or a prize or treasure

When?

B.C.E. – before the common era
C.E. – the common era

Groundwork

• Read table of contents
• Prepare a classroom timeline as described in the introductory section of the Teacher’s Quest Guide. Have tacks, tapes, or clip clothespins available, depending on the type of timeline you make.
• On index cards, make the following markers for the time line.
  5 B.C.E. – Birth of Jesus of Nazareth
  0 C.E. – Beginning of the Common Era (1 B.C.)

Consider the Quotation

1) Write the theme quotation on chart paper or the chalkboard.
2) Tell students that Epictetus was a freed Roman slave (born in Greece) who lived nineteen centuries ago. Tell students that the ca. before the dates means “circa” or “about” because historians do not know the exact dates of his life.
3) Ask students to paraphrase the quotation to be sure they understand its meaning. Write

“Welcome to the world’s first science laboratory.”
student versions on chart paper or the chalkboard. Ask students

- Do you agree with Epictetus? Why or why not?
- Do people know more now than they knew in Epictetus' time?
- Does modern knowledge make learning more difficult, or, as Epictetus says, impossible? Why or why not?

**Directed Reading**

Read to discover the areas of science covered in *The Story of Science: Aristotle Leads the Way*

1) Distribute *The Story of Science: Aristotle Leads the Way* and allow a few minutes for students to browse through the book.

2) Ask students to turn to the table of contents page to discover what areas of science they will study in this book and the names of some people they will study.

3) Students share their findings in a class discussion, which should include the following points.


4) Tell students that all but the last two names are Greek.

5) Distribute the Student's Quest Guides. Ask students to define the term “quest.” Direct their attention to *What? When?* on page**. Lead them to understand that a quest is an adventure with a goal, a search for something of value. The story of science is a long quest in search of knowledge about our universe, our world, and ourselves. This book, as the title suggests, will guide students on their quest through *The Story of Science: Aristotle Leads the Way*.

6) Allow students a few minutes to browse through the Student's Quest Guide.

7) Tell students that they will begin their science quest in an ancient time period called B.C.E., when early Greek scientists lived. Their quest will end in the Middle Ages.

**Classwide Activity**

Establish a time line, place important markers, understand Common Era and Before the Common Era

1) Direct students’ attention to the classroom time line and the timeline on page 2. Tell students that they will maintain the classroom time line during their quest through *The Story of Science: Aristotle Leads the Way*. In this activity, the class will establish important markers and understand the terms C.E. and B.C.E.

2) Ask students what the letters B.C. and A.D. mean to them. Their discussion should include the following:

   - These initials follow dates noting whether something occurred before the birth of Jesus Christ or after.
   - B.C. stands for before Christ.
   - A.D. stands for Anno Domini, Latin for “in the year of our Lord.”

3) Ask students to speculate what problems might come with this system. Their discussion should include the following points.

   - The birth of Jesus of Nazareth is important only to Christians; many people in the world follow other religions.
   - No one knows for certain when Jesus of Nazareth was born, but scholars now believe his birth occurred four to six years before the year set as 1 A.D. when the B.C.-A.D. system was established.
4) Tell students that the terms Common Era (C.E.) and Before the Common Era (B.C.E.) are replacing A.D. and B.C. This system is both more accurate and more considerate of the non-Christian world. In the Common Era system, B.C. 1 = 0 C.E.; 1A.D. = 1C.E.

5) Direct students’ attention to the marks on the classroom time line. Ask students
   • What is the earliest date? (700 B.C.E.)
   • What is the latest date? (2000 C.E.)
   • How many years pass between each mark? (100 years or one century)
   • How many centuries does the time line show Before the Common Era?
     (seven)
   • How many centuries does the time line show of the Common Era
     (twenty-one)
   • Where is the present on the time line?
     (the small tail after 2000)

6) Help students to visualize, using the time line, why the year 2000 is the beginning of the twenty-first century, not the twentieth century, and why the years 700 to 600 B.C.E. are the seventh century B.C.E., not the sixth century.

7) Show students the prepared time line cards and ask for their help in placing them correctly on the time line.

8) Display the transparency Scientists Speak: Epictetus. Ask students to note when he lived and hang the photocopy in the correct place on the time line.

**Conclusion**

1) On the overhead projector, display Professor Quest Cartoon #1.

2) Introduce Professor Quest, who will appear often to illustrate an important point in a lesson.

3) Ask students to relate the cartoon to the theme of the lesson.

---

**Curriculum Links**

**Math link** — Students write and solve math problems involving both B.C.E. and C.E. dates, using the following information: Epictetus was born around 50 C.E. and died around 125 C.E. How long did he live? (75 years) Plato was born in 427 B.C.E. and died in 347 B.C.E. Aristotle was born in 385 B.C.E. and died in 322 B.C.E. Some example problems include – Which man lived the longest life? (Plato – 80 years) Which men could have seen and talked to one another? (Plato and Aristotle) How many years passed between the death of Aristotle and the birth of Epictetus? (372 years)

**Language Arts link** — Students write an entry in their journal discussing whether they agree or disagree with Epictetus’ statement and supporting their stance.

**References**


"It is impossible for a man to begin to learn that which he thinks that he knows."

Scientists Speak
Epictetus (ca. 55 – ca. 135 C.E.)
“Birthing a Universe” and “Telling It Like They Thought It Was: Myths of Creation”

Theme

“In the beginning, God created the heaven and the earth.”

Genesis

“Some foolish men declare that a Creator made the world....Know that the world is uncreated, as time itself is, without beginning and end.”

The Mahabharata

Goals

Students will learn how mankind has attempted to explain the beginning of the universe.

Students will study and compare creation stories from several civilizations.

What?

millennia — periods of a thousand years each; a millennium is a thousand years

astrology — a false science based on the idea that the stars influence human events

astronomy — the study of the universe and heavenly bodies beyond the Earth’s atmosphere

astronomer — one who studies heavenly bodies

correction: constellation — a recognizable group of stars to which ancient people gave a name

void — empty

geometry — the branch of math that deals with shapes, space, and measuring

observation — something that can be seen with the five senses

hypothesis — a possible and reasonable explanation for a set of observations or facts

theory — a well-tested explanation of observations or facts

fact — information tested and shown to be accurate by competent observers of the same event or phenomenon
**Where?**

Sumer — an ancient Middle Eastern country (present-day Iraq)

Egypt — ancient country in northwest Africa that still exists today

Mesopotamia — ancient land between the Tigris and Euphrates Rivers on the west coast of the Mediterranean Sea (present-day Iraq, Lebanon, and Syria)

**Groundwork**

- Read chapter 1, “Birthing a Universe,” and chapter 2, “Telling It Like They Thought It Was: Myths of Creation.”
- Gather the materials listed for lesson 2 in the unit introduction.

**Consider the Quotation**

1) Direct students’ attention to the theme quotations on page ** in the Student Quest Guide.

2) Tell students that Genesis is the first book of the Hebrew and Christian Bible. The Mahabharata is an ancient epic from India.

3) Ask students to paraphrase these quotations. Write students’ versions on chart paper or the chalkboard.

4) Ask students the following questions.
   - Do these statements agree or disagree?
   - Can you guess the ages of these statements? (both come from sources a thousand years before the Common Era)

5) Have students read the second quotation on the first page of chapter 1 from The Popol Vuh, a translation of creation stories of the ancient Mayan inhabitants of the Americas. How does this quotation agree or disagree with the other two?

6) Ask students whether any human really knows for certain how the universe began.

(Allow for religious convictions in accepting responses.)

**Classwide Activity**

1) Students browse through chapter 1, looking at illustrations, headings, and side bars to form questions about how mankind has attempted to explain the beginning of the universe. Write students’ questions on chart paper or the chalkboard.

2) Direct students to the maps on pages 4 and 5. Students consult the What? Where? list in their Student's Quest Guide to locate areas and define terms.

3) Read aloud chapter 1 as students follow along. At the end of the reading, students identify and discuss information that answers their questions. (Note to the teacher: If students do not have problems with comprehension on this reading level, and have individual copies of The Story of Science: Aristotle Leads the Way, the teacher may choose to assign the reading as homework before the next day’s class.) The class discussion should include the following points.

One of the earliest known great civilizations, Sumer, existed five thousand years ago in the land that is modern Iraq. The Sumerians built city-states with governments, schools, and places of worship. They had a written language and divided labor so that not everyone had to farm. They watched the heavens and devised a calendar based on the moon. The Egyptians also had an early, highly developed society. People’s status rankings varied from slaves to gods. They based their calendar on the sun.
Directed Reading

Read to learn about the Chinese and Greek creation myths

1) Students to turn chapter 2 and browse through illustrations, headings and sidebars to speculate what the stories of creation will contain and from what civilizations they come.

2) Students turn to the quest page “How It All Began” on page ** in the Student’s Quest Guide. Tell students that as they read the chapter, they will use this quest sheet to guide their note taking.

3) Students pair read chapter 2, taking notes individually on their quest sheets. (Note to the teacher: The Hebrew creation story is at the beginning of chapter 1.)

Student Team Learning Activity

1) Ask students what is the difference between science and myths/religious explanations of natural events. Direct students to the quest page, “Myths vs. Science” in their Student’s Quest Guide. Working with a team partner, students discuss the questions and write their answers.

2) Discuss student answers with the class.

3) Read students the following summary of the Greek myth of Persephone.

*Persephone was the beautiful daughter of Zeus, the king of the gods, and Demeter, the goddess of the harvest. Hades, god of the underworld, wanted her for his wife. One day, when Persephone was collecting flowers, the earth split open and Hades seized her and dragged her to the underworld.*

Demeter roamed the earth brokenhearted, searching for her missing daughter. She stopped caring for the earth, and it grew cold and the crops withered and died. When Demeter discovered that her daughter was being held prisoner by Hades, she begged Zeus to make Hades set the girl free. Zeus agreed that Persephone could leave as long as she hadn’t eaten any food in the underworld. But Persephone had eaten several seeds of a pomegranate from Hades’ garden. Because of this, she had to spend one month with Hades for every seed eaten. She could spend the remaining months of the year with her mother on the earth.

Every year, when Persephone returns to the underworld, Demeter lets the plants die. When she returns to the earth, her delighted mother tends the plants so they bloom.

4) Direct students to the quest sheet “Myth of Persephone.” Working with a team partner, students compare the myth of Persephone with modern science’s explanations of natural phenomena. Students share answers in a classroom discussion.

Conclusion

1) On the overhead projector, display Professor Quest cartoon #2

2) Ask students to relate the cartoon to the theme of the lesson.

Curriculum Links

Science link – Students use library and Internet resources to research constellations and their names. In their journals, they draw a diagram of a constellation and write a brief account of its story.
Art link – Students create a mural illustrating the creation stories of different civilizations.

Language Arts link—Students use library and Internet resources to find a translation of the epic poem *Gilgamesh* and read and discuss a portion.

References


How it All Began

Hebrew Creation Story

The creator is called __ God __ __________________________________________________________

The earth is described as

without form _______ void (empty) __________________________________________________________

dark _______ water (the deep) ______________________________________________________________

Two actions that the creator took include

 moved on the face of the waters __________________________________________________________

 said let there be light _________________________________________________________________

_____________________________________________________________________________________

Chinese Creation Story

The creators are called __ Hu and Shu __ ______________________________________________________

Together their names mean __ lightning ______________________________________________________

All that existed at the beginning was __ Chaos called Hundun ______________________________________

What did the creators use to create life? __ thunderbolts _________________________________________

Describe how life began.

_Hu and Shu used thunderbolts to make seven holes in the body of Hundun to correspond to the holes in the human body, and life began._

_____________________________________________________________________________________
Greek Creation Story

What existed at first? ____ darkness  chaos

The creator is called ____ Love

The creator brought ____ light

From where did Earth come? ____ The Earth rose up.

From where did the heavens come? ____ The Earth bore (gave birth to) the heavens.

Describe the children of Mother Earth and Father Heaven.

*Mother Earth, Gaea, and Father Heaven, Ouranous, had children: a one-eyed monster called a ____ Cyclops, giants called Titans, and the gods.*

How did ordinary humans come about?

*After the monsters and the gods fought wars, Mother Earth and Father Heaven created humans.*
<table>
<thead>
<tr>
<th>Myths vs. Science</th>
<th>Myths</th>
<th>Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can it be proved right or wrong?</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>How is it developed?</td>
<td>From imagination and observation</td>
<td>From observation and testing</td>
</tr>
<tr>
<td>Is it tested?</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Is it open to revision?</td>
<td>Not very open</td>
<td>open</td>
</tr>
<tr>
<td>How are numbers used?</td>
<td>Myth-holding societies may make sophisticated use of numbers to explain mathematical relationships (such as the number of days between new moons), but the myths themselves are not mathematically based.</td>
<td>Mathematical relationships are the basis of scientific knowledge.</td>
</tr>
<tr>
<td>Give an example.</td>
<td>Creation stories, Astrology</td>
<td>Predicting eclipses based on patterns</td>
</tr>
</tbody>
</table>
“The calendar is intolerable to all wisdom, the horror of all astronomy and a laughing-stock from a mathematician’s point of view.”

Scientists Speak
Roger Bacon (ca. 1214 – ca. 1292)
“Making Days: Were the Calendar Makers Lunatics or Just Moonstruck?”

Theme

“The calendar is intolerable to all wisdom, the horror of all astronomy and laughing stock from a mathematician's point of view.”

Roger Bacon (ca. 1214 – ca. 1292)

Goal

Students will learn about ancient societies' calendars based on the moon or the sun.

Who?

Roger Bacon — a thirteenth century monk who said that the calendar was wrong and needed to be changed

What?

lunar calendar — a calendar based on the Moon

solar calendar — a calendar based on the Sun

Sirius — the brightest star in the Northern Hemisphere, on which the Egyptians based the beginning of their new year

Where?

Mesopotamia — a civilization in the Middle East that included Babylon (see map page 5)

“Lunar calendar or solar calendar, which is best? I wish someone would shed some light on this subject.”

Groundwork

• Read chapter 3, “Making Days: Were the Calendar Makers Lunatics or Just Moonstruck?”

• Gather the materials listed for lesson 3 in the unit introduction.
Consider the Quotation

1) Direct students' attention to the theme quotation on page ** in the Student's Quest Guide.

2) Ask students to paraphrase this quotation to be sure they understand its meaning. Write student versions on chart paper or the chalkboard.

3) Display the transparency Scientists Speak: Roger Bacon. Note the dates of Roger Bacon's life. Remind students that ca. means "circa" or about.

4) Students look at the classroom timeline and a volunteer hangs the photocopy in the appropriate place.

5) Ask students
   • Why would Bacon make such a statement about the calendar?
   • Would people living before Bacon's time agree with him?
   • Would people living after Bacon's time agree with him?

6) Tell students that Roger Bacon was a monk who thought far ahead of his time. He saw that the calendar in use during his lifetime was so inaccurate that church holidays like Easter and Christmas were slowing slipping into the wrong seasons.

7) Tell students that in this lesson they will learn about the early attempts to develop a calendar and how successful or unsuccessful they were.

Directed Reading/Cooperative Team Learning

Read, record, and share information about calendars based on the Moon and Sun.

1) Students open The Story of Science: Aristotle Leads the Way to page 20 and read the chapter title. Be sure they know the meaning of lunatic and the ancient belief that the Moon could cause madness. Ask students to comment on this title and the question that it asks. What do they think is the answer?

2) Tell students that developing a calendar that works as well as our modern one took centuries of thinking, observing the Moon, stars, and Sun, and changing old ways of keeping track of time.

3) Call students' attention to Who? What? Where? on page ** in the Student's Quest Guide to assist in their reading.

4) Students turn to the Quest Sheet – Read, Record, Share, page ** in the Student's Quest Guide. Each team member becomes the wise person for one of the four societies listed on the quest sheet, but all the students read pages 20-23 at this time.

5) Students read pages 20 through 23 and record information for their identity by completing the statements on the quest sheet.

6) When students have finished reading and recording, the students from each team representing the same society meet to discuss the information about their calendar. Each group appoints a discussion leader to be sure that everyone is prepared to promote the advantages of the calendar and offer solutions for its problems.

7) As students work, visit each group to answer questions and to ensure that the discussion leader is keeping the group on task.

8) Students return to their original cooperative teams to hold a panel discussion in which each member promotes his/her society's calendar and offers solutions to its problems.

Directed Reading/Classroom Activity

Read about and demonstrate phases of the Moon
1) Students finish reading chapter 3, including “Why Does the Moon Dazzle, Then Disappear?” Discuss the picture on page 27 which shows that half the moon is always lit, but that we see changing portions of the illuminated side. This makes it appear that the size and shape of the moon changes each day.

2) Darken the classroom, and put a bright light at the front of the class (or have students sit in a circle around a light which represents the Sun). Each student’s head represents Earth.

3) Students place the Moon (ball) directly between the Earth (head) and Sun (light). Point out that the lit side faces away from the Earth so we cannot see the moon (new Moon).

4) Students move the Moon to the left and turn their faces toward it. Point out that half the moon is still lit by the Sun, but only a small portion facing Earth is lit up so they see a crescent facing away from the Sun.

5) Move the ball further left to 90 degrees. Point out that half remains lit and they see half of that half (first quarter Moon).

6) Move the ball 180 degrees from the starting position. Make sure it’s above the head and the lit half faces Earth (full moon).

7) Move the ball 270 degrees and see the third quarter Moon. As students move the ball back toward the Sun, they will see another crescent, but this time it faces the Sun.

**You Be the Scientist**

1) Direct students to Tidal Time in the *Student’s Quest Guide*. Explain the activity, and answer any questions as students work.

2) Review the activity with students.

**Conclusion**

1) On the overhead projector, display Professor Quest cartoon #3.

2) Ask students to relate the cartoon to the theme of the lesson.

**Homework**

In their own words, students explain why we observe different phases of the Moon.

**Curriculum Links**

**History link** — Students use library and Internet resources to investigate Stonehenge in England or Palenque in Mexico.

**Multicultural link** — Students use library and Internet resources to find and compare calendars of ancient civilizations — Aztec, Sumerian, Egyptian, Mayan, Celtic, and/or Chinese.

**Science/Multicultural link** — Students use library and Internet sources to research the tower built in Henan province, China, by Guo Shou Jing about 1279. What observations might the builders of the Sky Measuring Tower have made?

**Science/Multicultural link** — The ancient city of Cuzco, Peru, was already established when the Inca empire arose about 1400 C.E. Its streets have an unusual alignment based on astronomical observations. Students use library and Internet resources to investigate this design.

**Science/multicultural link** — The Omahas of Nebraska were nomadic and carried a sacred pole for their ceremonies. During sacred rituals, they carefully aimed the pole north at 45 degrees. That was a few degrees higher than the brightest star in their sky, Polaris. Investigate what that might tell us about the history of the Omaha people.

**References**


Read-Record-Share

Directions: You are a wise person in charge of developing a calendar that your society will use to keep track of time. Chose the society to which you belong.

Babylon          Islamic country         China          Egypt

Read chapter 3, pages 20 - 23, to gather information about the kind of calendar you will develop. You will use this information to appear on a panel to promote the advantages of your calendar. Your calendar may have some bad features too. Be ready to suggest remedies for the problems with your calendar.

I am a wise person representing the ancient society of _______________.

My calendar is based on the _______________.

Number of months is ___________. Length of months is _________________.

Length of year is _________________.

Some advantages of my calendar are

The moon calendar allows people to predict what nights will be dark and what nights will be light enough to hunt. The Moon’s repeating pattern gives a reliable way to measure time. The Moon is mystical and romantic, and it may even be a god.

Some problems with my calendar are

Because the Sun, not the Moon, determines the seasons, the lunar calendar is not reliable for planting and harvesting. A Moon year is 11 days shorter than a solar year, so the calendar goes awry very quickly.

I solve the problems by

I add extra days to make my Moon calendar come out right with the seasons.
Read-Record-Share

Directions: You are a wise person in charge of developing a calendar that your society will use to keep track of time. Choose the society to which you belong.

Babylon        Islamic country        China        Egypt

Read chapters 3, pages 20-23, to gather information about the kind of calendar you will develop. You will use this information to appear on a panel to promote the advantages of your calendar. Your calendar may have some bad features too. Be ready to suggest remedies for the problems with your calendar.

I am a wise person representing the ancient society of __________ China ____________________.

My calendar is based on the __ Moon ____________________________________________.

Number of months is __ cannot tell __________. Length of months is __ cannot tell __________.

Length of year is __ cannot tell ____________________________________________.

Some advantages of my calendar are

The Moon calendar allows people to predict what nights will be dark and what nights will be light enough to hunt. The Moon’s repeating pattern gives a reliable way to measure time.

Some problems with my calendar are

Because the Sun, not the Moon, determines the seasons, the lunar calendar is not reliable for planting and harvesting. A Moon year is 11 days shorter than a solar year, so the calendar goes awry very quickly.

I solve the problems by

Every 19 years I add an extra seven months.
Read-Record-Share

Directions: You are a wise person in charge of developing a calendar that your society will use to keep track of time. Chose the society to which you belong.

Babylon  Islamic country  China  Egypt

Read chapter 3, pages 20 - 23, to gather information about the kind of calendar you will develop. You will use this information to appear on a panel to promote the advantages of your calendar. Your calendar may have some bad features too. Be ready to suggest remedies for the problems with your calendar.

I am a wise person representing the ancient society of ___an Islamic country_____________

My calendar is based on the ___Moon_______________________________.

Number of months is ___12_________. Length of months is ___30 days for every other month. The other six months have 29 days.

Length of year is ___354 days_______________________________.

Some advantages of my calendar are

The Moon calendar allows people to predict what nights will be dark and what nights will be light enough to hunt. The Moon's repeating pattern gives a reliable way to measure time.

Some problems with my calendar are

A Moon year is 11 days shorter than a solar year, so the calendar goes awry very quickly. This makes Ramadan, a holy month for Islam, come in different seasons.

I solve the problems by

Doing nothing. I don’t let it bother me.
QUEST SHEET KEY  Student Quest Guide page 8

Read-Record-Share

Directions: You are a wise person in charge of developing a calendar that your society will use to keep track of time. Chose the society to which you belong.

Babylon  Islamic country  China  Egypt

Read chapter 3, pages 20 - 23, to gather information about the kind of calendar you will develop. You will use this information to appear on a panel to promote the advantages of your calendar. Your calendar may have some bad features too. Be ready to suggest remedies for the problems with your calendar.

I am a wise person representing the ancient society of __________ Egypt _________________.

My calendar is based on the __ Sun _____________________________________________.

Number of months is __12____________. Length of months is __30 days ____________.

Length of year is __365.25 days _________________________________.

Some advantages of my calendar are

*The Sun calendar stays in line with the seasons. The first day of the new year is when the brightest star in the sky, Sirius, appears at dawn after its annual disappearance. The Nile River floods at this time every year. By watching the appearance and disappearance of Sirius, I know that the solar year is 365.25 days.*

Some problems with my calendar are

*Because 12x30 = only 360 days, my calendar is five days short. (The solar year is 5.25 days longer than my calendar year.)*

I solve the problems by

*I add five days to every year and use these days to celebrate the birthdays of major gods. Every few years, I add an extra day to use the extra .25 day. Modern calendars use this idea by having a leap year with an extra day every four years.*
You Be the Scientist  Student Quest Guide page 9

Tidal Time

On a voyage with Pytheas and the Phoenicians in 300 BCE, you come across an island in the Atlantic. The people on this island build boats and make their living as fishermen. Because of a reef close to the shore, they can only leave the island or return to it at high tide, when the water is high enough for their boats to pass safely over the reef. There are usually two high tides a day, so they leave the island at first high tide and return at the second high tide. They keep detailed records of when high tide occurs because it is so important to them. Here is their record for the past 31 days.

Your Quest: Do the high tides have a pattern? If so, what is it?

Your Gear: one sheet of graph paper

Your Routine: On the X axis (horizontal) of your graph paper, number the days 1-36. On the Y axis, write hours starting with 12 a.m., 1 a.m., 2 a.m., etc until you have labeled a complete 24-hour day and reach 12 a.m. again. Using the information from the Tidal Time chart, make a dot for each high tide time on each day. Make a square to indicate the days when there is no second high tide.

Reporting Home: Answer the following questions.

1. What pattern do you see in the two high tides for the 31 days?

   There is always a difference of about 12 hours between the first high tide and the second. As the days pass, both tides occur later in the day until there is only one high tide on one day. Then the pattern repeats.

2. Fill in the predicted dots or the high tide for the next five days (days 32-36).

   The dots continue in an upward line.

3. If the island fishermen base their days on high tides, what might their calendar be like?

   Answers may vary. They would spend about twelve hours on the island and twelve hours at sea. They might split their days in half or even call them different days (such as land days and sea days). Their week or month might be arranged between the days when there is only one high tide. They wouldn’t go out to sea on a day when there is only one high tide because they couldn’t come home until the next day.
### Tidal Time Chart

<table>
<thead>
<tr>
<th>Day</th>
<th>Time of First High Tide</th>
<th>Time of Second High Tide</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>11:16 am</td>
<td>11:44 pm</td>
</tr>
<tr>
<td>2</td>
<td>No high tide</td>
<td>12:10 pm</td>
</tr>
<tr>
<td>3</td>
<td>12:44 am</td>
<td>1:20 pm</td>
</tr>
<tr>
<td>4</td>
<td>1:50 am</td>
<td>2:15 pm</td>
</tr>
<tr>
<td>5</td>
<td>3:00 am</td>
<td>3:24 pm</td>
</tr>
<tr>
<td>6</td>
<td>4:12 am</td>
<td>4:34 pm</td>
</tr>
<tr>
<td>7</td>
<td>5:20 am</td>
<td>5:38 pm</td>
</tr>
<tr>
<td>8</td>
<td>6:19 am</td>
<td>6:36 pm</td>
</tr>
<tr>
<td>9</td>
<td>7:12 am</td>
<td>7:27 pm</td>
</tr>
<tr>
<td>10</td>
<td>7:59 am</td>
<td>8:14 pm</td>
</tr>
<tr>
<td>11</td>
<td>8:44 am</td>
<td>9:00 pm</td>
</tr>
<tr>
<td>12</td>
<td>9:28 am</td>
<td>9:44 pm</td>
</tr>
<tr>
<td>13</td>
<td>10:12 am</td>
<td>10:29 pm</td>
</tr>
<tr>
<td>14</td>
<td>10:58 am</td>
<td>11:16 pm</td>
</tr>
<tr>
<td>15</td>
<td>11:46 am</td>
<td>No high tide</td>
</tr>
<tr>
<td>16</td>
<td>12:05 am</td>
<td>12:36 pm</td>
</tr>
<tr>
<td>17</td>
<td>12:56 am</td>
<td>1:29 pm</td>
</tr>
<tr>
<td>18</td>
<td>1:50 am</td>
<td>2:24 pm</td>
</tr>
<tr>
<td>19</td>
<td>2:47 am</td>
<td>3:22 pm</td>
</tr>
<tr>
<td>20</td>
<td>3:46 am</td>
<td>4:21 pm</td>
</tr>
<tr>
<td>21</td>
<td>4:43 am</td>
<td>5:16 pm</td>
</tr>
<tr>
<td>22</td>
<td>5:34 am</td>
<td>6:04 pm</td>
</tr>
<tr>
<td>23</td>
<td>6:19 am</td>
<td>6:45 pm</td>
</tr>
<tr>
<td>24</td>
<td>6:59 am</td>
<td>7:23 pm</td>
</tr>
<tr>
<td>25</td>
<td>7:37 am</td>
<td>7:57 pm</td>
</tr>
<tr>
<td>26</td>
<td>8:12 am</td>
<td>8:31 pm</td>
</tr>
<tr>
<td>27</td>
<td>8:48 am</td>
<td>9:07 pm</td>
</tr>
<tr>
<td>28</td>
<td>9:26 am</td>
<td>9:46 pm</td>
</tr>
<tr>
<td>29</td>
<td>10:09 am</td>
<td>10:33 pm</td>
</tr>
<tr>
<td>30</td>
<td>10:59 am</td>
<td>11:28 pm</td>
</tr>
<tr>
<td>31</td>
<td>11:57 am</td>
<td>No high tide</td>
</tr>
</tbody>
</table>