Pass the TExES
Core Subjects
4-8

FOR TEXAS TEACHERS
A test prep program for the TExES Core Subjects exam #211 for grades 4-8.

First Edition

by Joe Kortz, Ed.D., Vickie Hester, Ph.D., Judy Mattair, Ph.D., & Paola Docemascolo, M.S.
with Mark Mentze, M.Ed., M.A.

Also available from
Ed Publishing:
Pass the TExES Core Subjects EC-6
4. Reading Comprehension and Assessment

Key Descriptors

- Understands reading comprehension as an active process of constructing meaning.
- Understands the continuum of reading comprehension skills.
- Understands factors affecting students’ reading comprehension.
- Knows characteristics of informal and formal reading comprehension assessments.
- Selects and uses appropriate informal and formal assessments to monitor and evaluate students’ reading comprehension.
- Analyzes student errors and provides focused instruction in reading comprehension.
- Knows how to use ongoing assessment to determine when a student needs additional help or intervention.
- Understands and teaches metacognitive skills.
- Determine students’ independent, instructional and frustration reading levels to help select reading material for students.

Key Words:
Levels of Comprehension:
Literal, Inferential and Evaluative
Indirect and Direct Informal and Formal Assessments
Reading to Learn
Metacognitive
KWL Chart
Literary Analysis

NOTE: Refer to the lettered descriptors under each Competency in the ETS/SBEC study material (in the back of this manual). Analyze each descriptor, and synthesize it down to a paraphrase that is meaningful to you, using no more than 5 words. List those phrases in order on the lines above. It will help to letter the lines above. When complete, record them again on Worksheet 4 in Appendix I.

<table>
<thead>
<tr>
<th>Descriptor Highlights</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understands reading comprehension as an active process of constructing meaning.</td>
</tr>
<tr>
<td>Uses various instructional strategies to enhance students’ reading comprehension.</td>
</tr>
<tr>
<td>Knows how to provide students with direct, explicit instruction in the use of strategies to improve their reading comprehension.</td>
</tr>
<tr>
<td>Uses various communication modes to promote students’ reading comprehension.</td>
</tr>
<tr>
<td>Understands how to model and teach literal, inferential and evaluative comprehension skills.</td>
</tr>
<tr>
<td>Knows how to provide instruction to help students increase their reading vocabulary.</td>
</tr>
<tr>
<td>Understands reading comprehension issues for students with different needs and knows effective reading strategies.</td>
</tr>
<tr>
<td>Knows difference between guided and independent practice.</td>
</tr>
<tr>
<td>Knows how to promote students’ development of an extensive reading and writing vocabulary.</td>
</tr>
</tbody>
</table>
Competency 4:
The teacher understands the importance of reading for understanding, knows components and processes of reading comprehension, and teaches students strategies for improving their comprehension.

A. READING COMPREHENSION
The understanding of what has been read aloud, and what has been read by the student. Factors include oral background, prior reading experience, language background, characteristics of text (i.e. narrative, informational, persuasive, non-standard text, inferential, etc.).

Comprehension Defined
Reading comprehension is the process of constructing meaning from written texts, based on a complex coordination of a number of interrelated sources of information.

Reading comprehension has many components, all of which work together to build understanding of what is read.

• The ability to understand and demonstrate a concept in a variety of ways: visual, oral, and written.
• The process of assimilating information either visually, auditorially, or kinesthetically, by relating to one’s prior knowledge and schemata.
• Getting meaning from what is said, in print, or visualized, and being able to impart that meaning to others in a manner in which they understand.

Building Vocabulary
Vocabulary can be developed
• Indirectly, when students engage daily in oral language, listen to adults read to them, and read extensively on their own.
• Directly, when students are explicitly taught both individual words and word-learning strategies.

Example:
Main Idea and Supporting Details Pyramid

Graphic organizers support direct instruction of vocabulary. They allow students to build deep and lasting connections to a new word. Graphic organizers for vocabulary include semantic maps, the Frayer Model, and a variety of others.

B. LEVELS OF COMPREHENSION
Students must have individual abilities in a variety of comprehension levels (i.e. main idea, recalling details, inference, predictions, charac-
ter development, faulty reasoning, main idea/summary, cause and effect, etc.). Prompting students to read purposefully for any comprehension level engages the student to pay close attention and apply reflective, metacognitive skills which are essential for high order thinking and skills in the statewide curriculum or TEKS.

C. LEVELS OF READING COMPREHENSION

Words to Know:

- Literal Comprehension – Type of comprehension that asks students to answer questions and identify facts that are directly stated in the text (“on the lines”)
  - Identifying main idea
  - Identifying supporting details

- Inferential Comprehension - Type of comprehension that asks students to respond to questions based on ideas and information that are directly stated in the text along with the use of their intuition, background, and experiences to reach a conclusion and to make inferences and predictions (“between the lines”)
  - Identifying cause-and-effect relationships
  - Making predictions

- Evaluative Comprehension - Type of comprehension that asks students to compare information from the text with their own experiences, background, and values (“behind the lines”)
  - Analyzing characters
  - Analyzing use of language
  - Determining author’s point of view and bias
  - Detecting own faulty reasoning

D. STRATEGIES FOR ENHANCING COMPREHENSION

Text comprehension, the true goal of reading, is an active and purposeful process. Good readers think about what they are reading, and they are aware when they don’t understand something. They work for understanding, using their experiences and knowledge of the world, their knowledge of vocabulary and language structure, and their knowledge of reading strategies (or plans), persevering until they have a real understanding of the content read. Text comprehension is not magic and it does not “just happen.” The ability to comprehend text can be both taught and learned. Specific comprehension strategies assist readers in understanding text.

Strategies for Improvement:
The following specific strategies have proven helpful for increasing comprehension skills.

1. Monitoring comprehension

Students who monitor their comprehension recognize when they do not understand what they have read. They know specific strategies for gaining understanding and utilize them to increase their reading comprehension. These students identify what they do not understand, define their specific difficulty, and look back or forward in the text for information that may help them resolve their difficulty.
2. Using graphic and semantic organizers
Graphic organizers are visual devices that illustrate concepts and interrelationships among concepts in a text. Regardless of the label, graphic organizers can help readers focus on concepts and how they are related to other concepts. Graphic organizers help students read to learn from informational text in the content areas, such as science and social studies textbooks and trade books. Used with informational text, graphic organizers can help students see how concepts fit common text structures. Graphic organizers provide students with tools for writing well-organized text summaries. Graphic organizers are also used with narrative text, or stories, as story maps.

3. Answering questions
Teacher questioning strongly supports and advances students’ learning from reading. Questions give students a purpose for reading and focus attention on key concepts within the text. They help students to become active thinkers while they read, and encourage students to monitor their comprehension. Questions help students review content and relate it to their prior knowledge. Questions help readers understand text that is explicitly stated, inferential text, and text that draws upon a student’s prior knowledge and experiences.

4. Generating questions
Teaching students to ask their own questions improves their active processing of text and their comprehension. By generating questions, students become aware of whether they can answer the questions and if they understand what they are reading. Students learn to ask themselves questions that require them to integrate information from different segments of text. For example, students can be taught to ask main idea questions that relate to important information in a text.

5. Recognizing story structure
Teaching students to recognize the way the content and events of a story are organized assists them in having greater appreciation, understanding, and memory for stories. In story structure instruction, students learn to identify the categories of content (setting, initiating events, internal reactions, goals, attempts, and outcomes) and how this content is organized into a plot. Often, students learn to recognize story structure through the use of story maps. Story maps, a type of graphic organizer, show the sequence of events in simple stories.
6. Summarizing
Teaching students to summarize gives them the tools to determine the key concepts in a passage. To summarize, students must condense the key concepts and put it into their own words. Instruction in summarizing helps students to identify and connect key concepts and central ideas, to eliminate unneeded information, and to remember what they have read.

7. Making use of prior knowledge
Good readers draw on prior knowledge and experience to help them understand what they are reading. Teaching students to make use of their prior knowledge improves their comprehension. Previewing text, diagrams and pictures prepares students for what they will read. Previewing important vocabulary assists students in understanding what they are reading. This strategy lends itself to graphic organizer use.

8. Using mental imagery
Good readers often form mental pictures, or images, as they read. Readers (especially younger readers) who visualize during reading understand and remember what they read better than readers who do not visualize. Students can visualize characters, settings and story events.

E. FACTORS AFFECTING READING COMPREHENSION
This includes oral language development, word analysis skills, prior knowledge, language background, previous reading experiences, fluency, vocabulary development, and ability to monitor understanding, and characteristics of specific texts.

Comprehension is impacted by many things, including:
- Delays or gaps in oral language development
- Weak decoding skills
- Weak word analysis skills
- Weak fluency skills
- Lack of vocabulary or weak vocabulary development
- Access to literature and educated adult readers
- Poverty and other economic deficits
- Lack of experiences and prior knowledge (schemata)
- Second language or language learning
- Previous experiences with reading
- Ability to self-monitor comprehension
- Emotional or motivational factors

Teachers must identify factors that produce comprehension delays and craft methods to overcome these factors. Have a “whatever it takes” mentality. Find solutions for each and every child, so all can succeed.

F. INFORMAL AND FORMAL READING COMPREHENSION ASSESSMENTS
This includes criterion-referenced state tests, curriculum-based reading assessments, informal reading inventories, norm-referenced tests, and authentic assessments. Analyze errors in comprehension to focus instruction.

Ongoing assessments determine additional intervention based on TEKS.

The TEKS are aligned vertically, so that with each progressive grade level, the students build new skills that add to previously mastered skills. It is very important to preview the TEKS for reading prior to taking this test as skills are progressive and the TEKS are the basis for the TExES examination.
Subject Test II (807):
Math

Competencies 1-19

21% of the test

*NOTE: The numbering of these Competencies is based upon how we number them for the comprehensive Core Subjects 4-8 test prep program, and also how the SBEC numbers them for the separate Subject Tests. They are noted as such due to the design of our worksheets in the Appendices.
3 (12). Number Theory

Key Descriptors:

- Demonstrates an understanding of ideas from number theory as they apply to whole numbers, integers and rational numbers.
- Uses integers, rational numbers and real numbers to describe and quantify phenomena such as money, length, area, volume and density.
- Applies knowledge of place value and other number properties to develop techniques of mental mathematics and computational estimation.

Key Words:
Factors
Prime Numbers
Composite Numbers
Even and Odd Numbers
Prime Factorization
Greatest Common Factor
Length, Area, Volume, Density
Permutation

NOTE: Refer to the lettered descriptors under each Competency in the ETS/SBEC study material (in the back of this manual). Analyze each descriptor, and synthesize it down to a paraphrase that is meaningful to you, using no more than 5 words. List those phrases in order on the lines above. It will help to letter the lines above. When complete, record them again on Worksheet 4 in Appendix I.
3 (12). Number Theory

Competency 3 (12):
The teacher understands ideas of number theory and uses numbers to model and solve problems within and outside mathematics.

A. FACTORS, PRIME NUMBERS, COMPOSITE NUMBERS, EVEN AND ODD NUMBERS

1. Key Concepts

• Prime Number: Two factors: 1 and itself
  The prime numbers begin with 2.
  Zero and one are not prime numbers.
  Example: 11 is prime: has exactly two factors: 1 and 11

• Composite Number: More than two factors
  Example: 24 is composite, has multiple factors: 1,2,3,4,6,8,12,24

• Even Numbers: Integers divisible by 2
  If \( n \) = any integer, then \( 2n \) is an even number.

• Odd Numbers: Integers not evenly divisible by 2.
  If \( n \) = any integer, then \( 2n + 1 \) is an odd number.

2. Prime Factorization, Greatest Common Factorization or Factoring

Process used to rewrite a composite number as the product of two or more whole number factors.

Examples: All of these are ways the number 24 can be factored.
24 = 1(24) or 2(12) or 3(8) or 4(6)

• Prime Factorization: All the factors in a product are prime.
  Examples: All these factors are prime numbers.
  This number can be written using exponents.
  \( 24 = (2)(2)(2)(3) \) or \( 2^3(3) \)

• Greatest Common Factor:
  Largest factor by which two different numbers are divisible.
  Example: What is the GCF of 24 and 32?
  Compare the two trees. Eight is the greatest common factor.
  The correct answer is 8.

3. Mental Arithmetic

• Divisibility Rules
  Divisible by 2: number is even
  Divisible by 3: Sum of digits divisible by 3
  Divisible by 5: number ends in 0 or 5
  Divisible by 6: Even number divisible by 3
  Divisible by 9: Sum of digits divisible by 9
  Divisible by 10: number ends in 0

• Patterns of 10

  Multiplication:
  Examples:
  \[ 17 \times 20 = (17 \times 2) \times 10 = 34 \times 10 = 340 \]
  \[ 17 \times 25 = (17 \times 4) \times 100 = 4.25 \times 100 = 425 \]
  \[ 17 \times 50 = (17 \times 2) \times 100 = 8.5 \times 100 = 850 \]

  Division:
  Examples:
  \[ 1780 \div 20 = (1780 \div 2) \div 10 = 890 \div 10 = 89 \]
  \[ 1780 \div 25 = (1780 \times 4) \div 100 = 7120 \div 100 = 71.2 \]
  \[ 1780 \div 50 = (1780 \times 2) \div 100 = 3560 \div 100 = 35.6 \]

Unit Percent | Unit Fraction
--- | ---
1% | 1/100
2% | 1/50
4% | 1/25
5% | 1/20
10% | 1/10
20% | 1/5
25% | 1/4
33.33% | 1/3
50% | 1/2
100% | 1

Percents and Fractions:
Learn the unit percents and their fractional equivalents and then just use multiples.

continued
Enter the appropriate fractions and decimals in the chart above.

**B. LENGTH, AREA, VOLUME, AND DENSITY**

**Length:** measure of one dimension such as feet, inches, meters, kilometers, miles

**Area:** measure of two dimensions or covering of a flat surface such as square inches, sq. meters.

\(\text{ft}^2, \text{m}^2, \text{in}^2, \text{cm}^2\)

**Volume:** measure of three dimensions or capacity, such as cubic feet, cubic meters

\(\text{ft}^3, \text{m}^3, \text{in}^3, \text{cm}^3\)

**Capacity:** a measure based on three dimensions or how much something will hold, such as gallons, liters, pints, quarts, ounces

**Density:** physical property of matter related to mass and volume—Density = \(\frac{\text{Mass}}{\text{Volume}}\)

**NOTE:** During testing you are provided with a chart that has the following formulas.

Circumference: circle
Area: circle, triangle, rhombus, trapezoid
Surface Area: sphere
Lateral Area: cylinder
Volume: cylinder, cone, sphere, prism

*See page 107 of this book for formulas.*
Examples:

**Example 1:** The Pick 3 Lottery in Texas has the player select 3 numbers from the digits 0-9. To win the “big prize”, you must select your numbers in the exact order given when the numbers are drawn and no digits can be repeated. How many sets of 3 digit numbers are possible?

- a. 84  
- b. 504  
- c. 120  
- d. 720

**Solution:** The correct answer is 720 (10)(9)(8) possible sets of 3 digit numbers can be made from the 10 digits.

Option a is from finding the combination using 9 digits.

Option b is from finding the permutation using 9 digits.

Option d is from finding the combination using 10 digits.

**Example 2:** A fourth grade teacher wanted to build a sandbox for her room that she could use to teach students about artifacts. The box was to be filled to a depth of 15 inches and had dimensions of 5 feet by 4 feet by 2 feet. If a cubic foot weighs about 10 pounds, how many pounds of sand are needed to fill the sandbox?

- A. 1000 pounds  
- B. 6400 pounds  
- C. 160 pounds  
- D. 25 pounds

**Solution:**

First convert the 15 inches to feet, \( \frac{15}{12} = \frac{5}{4} \) foot.

\[ V = BH \cdot 5(\frac{5}{4}) = 25 \text{ ft}^3 \]

\[ \frac{1}{4} \text{ ft}^3 = 10 \text{ pounds so } 1\text{ft}^3 = 40 \text{ pounds} \]

So the amount of sand needed is 25(40) or 1000 pounds of sand.
Geometric Formulas

<table>
<thead>
<tr>
<th>Example</th>
<th>Meaning</th>
<th>Example</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\angle A$</td>
<td>angle $A$</td>
<td>$\overrightarrow{AB}$</td>
<td>vector $AB$</td>
</tr>
<tr>
<td>m $\angle A$</td>
<td>measure of angle $A$</td>
<td>$\overrightarrow{AB} \parallel \overrightarrow{CD}$</td>
<td>Line $AB$ is parallel to line $CD$.</td>
</tr>
<tr>
<td>$\overrightarrow{AB}$</td>
<td>line segment $AB$</td>
<td>$\overrightarrow{AB} \perp \overrightarrow{CD}$</td>
<td>Line $AB$ is perpendicular to line $CD$.</td>
</tr>
<tr>
<td>$AB$</td>
<td>measure of line segment $AB$</td>
<td>$\angle A \cong \angle B$</td>
<td>Angle $A$ is congruent to angle $B$.</td>
</tr>
<tr>
<td>$\triangle ABC$</td>
<td>triangle $ABC$</td>
<td>$\triangle A \sim \triangle B$</td>
<td>Triangle $A$ is similar to triangle $B$.</td>
</tr>
<tr>
<td>$\square ABCD$</td>
<td>rectangle $ABCD$</td>
<td></td>
<td>Similarly marked segments are congruent.</td>
</tr>
<tr>
<td>$\Box ABCD$</td>
<td>parallelogram $ABCD$</td>
<td></td>
<td>Similarly marked angles are congruent.</td>
</tr>
</tbody>
</table>

Geometric Symbols

<table>
<thead>
<tr>
<th>Abbreviations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume $V$</td>
</tr>
<tr>
<td>Lateral Area $L.A.$</td>
</tr>
<tr>
<td>Total Surface Area $S.A.$</td>
</tr>
<tr>
<td>Area of Base $B$</td>
</tr>
</tbody>
</table>

Pi

$\pi \approx 3.14$

$\pi \approx \frac{22}{7}$
Subject Test III (808):
Social Studies

Competencies 1-7 (29-35)

21% of the test

*NOTE: The numbering of these Competencies is based upon how we number them for the comprehensive Core Subjects EC-6 test prep program, and also how the SBEC numbers them for the separate Subject Tests. They are noted as such due to the design of our worksheets in the Appendices.
1(29). History

Key Descriptors

Key Words:

Native Americans
European Colonization
The American Revolution
Civil War
Reconstruction
Reform Movements

D E S C R I P T O R  H I G H L I G H T S

- Knows traditional points of historical reference
- Knows how important events, people, and issues shaped Texas, U.S., and world history
- Understands how various factors influenced the development of societies
- Knows common characteristics of societies past and present
- Understands chronology and how it applies to history
- Uses different methods to interpret past events in context and from several points of view
- Understands similarities and differences between Native American groups in Texas and the West before the arrival of European settlers
- Understands the causes for and effects of European Colonization
- Understands the issues America faced in its early years
- Understands westward expansion and its effects on U.S. development
- Knows the social, political, and economic factors that led to the Civil War
- Has in-depth knowledge of the events of the Civil War and Reconstruction
- Understands 19th century reform movements
- Understands important events and issues of the 20th century
- Understands the contributions of various cultural and religious groups
- Analyzes ways contemporary societies reflect historical events

NOTE: Refer to the lettered descriptors under each Competency in the ETS/SBEC study material (in the back of this manual). Analyze each descriptor, and synthesize it down to a paraphrase that is meaningful to you, using no more than 5 words. List those phrases in order on the lines above. It will help to letter the lines above. When complete, record them again on Worksheet 4 in Appendix I.
I(29). History

Competency 1(29):
The teacher understands and applies knowledge of significant historical events and developments, multiple historical interpretations and ideas, and relationships between the past, the present, and the future, as defined by the Texas Essential Knowledge and Skills (TEKS).

I. HISTORY
Texas teachers must be familiar with “historical points of reference,” which are briefly outlined below. Familiarize yourself with these points, paying careful attention to how each shaped our state and our government.

A. NATIVE AMERICANS
Texas teachers should be able to compare and contrast various Native American tribes throughout Texas and the Western Hemisphere. Below is a list of the prime attributes of each group.

1. Natives of the Western Hemisphere
The major Native American groups of the Western Hemisphere were the Incas, the Mayas, and the Aztecs. The Incan empire stretched from Ecuador to northern Chile. The Aztecs dominated northern Mexico, while the Mayans flourished in the rain forests of Guatemala. Their influence continues today; their positive achievements included the following:
• advanced agricultural methods
• tribute systems
• advanced communication systems
• skilled artisans
• highly specialized and stratified societies
• imperial administration
• schools

Many historians count the cooperative governing systems many nations had in place to be among their greatest contributions to modern society. In many parts of America, Native American tribes met on a regular basis to share news, methods, and culture, as well as to make cooperative governmental decisions. None had a system of writing, nor did they have many scientific advances.

2. Natives of the United States
When the Europeans came to America, about 10 million Native Americans lived in all parts of the United States. All lived off the land and were
• hunters
• gatherers
• farmers

They were resourceful in making tools and had advanced skills in:
• horsemanship
• farming
• buffalo hunting
• building homes

Scientists believe that the earliest Texans arrived about 11,000 years ago, following herds of mammoth and mastodon. The earliest groups lived in the Gulf Coastal Plains (Caddo, Coahuiltecs, Karankawas) and were hunters, fishers, and farmers. The Plains nations (Tonkawa, Lipan Apache, Comanche, Kiowa) were mostly nomadic, skilled buffalo hunters. The most sedentary tribes (Pueblo, Jumano, Concho, Tigua) occupied the Mountains and Basins region. Contributions from these groups included:
• Caddo – built the first buildings in Texas (beehive shaped huts made from wooden frames covered with grass or reeds); also known for advanced farming methods

continued
• Karankawas - created dugout canoes, small ships carved from the trunks of trees to facilitate their nomadic lifestyle (dependent on fishing)
• Coahuiltecs - nomadic hunters and trappers, enslaved Cabeza de Vaca and other Spanish explorers
• Lipan Apaches and Comanche – buffalo hunters who tamed wild mustangs, becoming skilled horsemen
• Pueblo – built elaborate homes and cities using adobe (sun-dried mud) bricks

B. EUROPEAN EXPLORATION AND COLONIZATION
During the 15th and 16th centuries, Europe engaged in a strong push for exploration. England, Spain, and France sent explorers to establish colonies in the Americas.
• The French claimed lands in Canada, around the Great Lakes, and all along the Mississippi River.
• Spain claimed territory that is now Texas, New Mexico, Arizona, California, Mexico, and Central and South America.
• England established colonies in the Caribbean, and thirteen colonies along the east coast of America.

Colonization had some clearly positive effects, creating communities and trade routes that facilitated cultural exchange. However, these were forged at the expense of the indigenous peoples of the area; their populations were ravaged by displacement, disease, warfare with the Europeans, and enslavement.

1. Reasons for European Exploration
• To locate a new passage to the Far East (for trade)
• To map uncharted areas
• To find treasure (gold, silver, gems, artifacts)
• To claim new lands and set up colonies
• To convert people to Christianity

2. Significant Explorers
Columbus (1492, 1493, 1498)
• led expeditions to South America for Spain.
• landed in South America.
• opened cultural exchange and the west (Columbian exchange)
De Pineda (1519).
• led first expedition into Texas
• explored Gulf Coasts for Spain (Florida, Alabama, Louisiana, Texas, and Mexico)
De Vaca (1527 -1535).
• Part of a Spanish mission to claim land along the Gulf, he became stranded in Florida when his ships did not return from a supply run to Cuba.
• Built rafts and skirted the coast, eventually wrecking near East Island, Louisiana; continued on foot with a slave called Esteban, eventually coming to Texas.
• Encountered Caddo Indians near Houston; impressed with their sophistication and tales of wealth inland, he mapped and wrote about the area in detail, creating our first written record of America.
• His tales of Cibola, a fabled city of gold, greatly influenced subsequent explorers including Coronado and De Soto.
Coronado (1540-1542).
• Sent by Spain to find fabled city of gold, reported by De Vaca.
• Traveled much of the Texas Panhandle.
• First Europeans to see Palo Duro Canyon.
• Went home empty handed La Salle (1682-1685) a French explorer.
• Led expedition in 1682 from a French colony in Canada down the Mississippi River to the Gulf of Mexico, claiming land for France on both sides of the river.
• In 1684, led another expedition from France to start a colony at the mouth of
1(29). History, cont’d.

the Mississippi River; sailed past the river and mistakenly landed in Texas.
• Built the first French colony in Texas, Ft. St. Louis, near Galveston.

3. The Thirteen English Colonies
• In 1607 the first permanent English colony was established in Jamestown, Virginia. In less than six months, more than half of the settlers had died from disease, starvation, and attacks from Native Americans.
• In 1620, Pilgrims (religious dissidents) set up a strict, parochial colony of Puritans in Massachusetts, Plymouth colony.
• Roger Williams set up a colony in Rhode Island that advocated religious freedom for all, including Native Americans.
• William Penn established a colony for Quakers in Pennsylvania. The Quakers opposed violence, slavery, and war, and advocated religious tolerance for all people.

4. Important People
• William Bradford – Second governor of Plymouth colony; in 1621 he ordered the first Thanksgiving, sharing harvest with the Wampanoag Indians.
• Roger Williams – banished from Plymouth colony, advocated religious freedom, established Rhode Island colony.
• John Smith – Established trade relations with the Powhatan Indians; bargained for food for the starving Plymouth settlers.
• Pocahontas – Daughter of the Chief of the Powhatan Indians; convinced her father to spare John Smith and help the settlers.
• John Rolfe – member of Jamestown, began tobacco industry in America; married Pocahontas and brought her to England ensuring peace with the Powhatan Indians.
• Squanto – A Pawtuxet Indian who taught the Plymouth Pilgrims how to hunt, fish, and grow crops, thereby saving the lives of many.

5. The Mayflower Compact
• An agreement written on the Mayflower, a ship which carried the Pilgrims to America.
• This agreement established the governing laws of the new colonies.

6. Missions, Presidios, and Early Towns
After La Salle built a French colony in Texas, Spain became worried about protecting their claims in Texas. They brought Franciscan monks to build missions – religious settlements in Texas. By 1740, there were more than 20 missions in Texas. Later they added forts called Presidios to protect the missions (and Spain’s territorial claims). Missions were built to:
• Solidify Spain’s territorial claims (primary purpose).
• Open and protect trade routes.
• Spread the Christian faith to the Native Americans.
• Provide a safe center for working and learning.

C. THE FRENCH AND INDIAN WAR (1754-1763)
This conflict, between British and French colonies, instigated issues between the colonists and England, which eventually led to the American Revolution. During the war, most Native American tribes sided with the French, fearing the British would take their ancestral homelands. The British won.

Causes of the War
• Britain and France were at war, causing conflict between their colonies in America.
• The British colonies wanted land owned continued
by the French colonists for fur trading.

Results of the War
• France lost the majority of its territory and power in North America.
• England’s land expanded to include all of the French lands east of the Mississippi River, except New Orleans, which became Spanish territory.
• Spain’s holdings expanded to include all of the French territory west of the Mississippi River, and New Orleans.
• England tightened its hold on the colonies, restricting freedom and levying large taxes to help offset the costs of the war.

D. THE AMERICAN REVOLUTION (1776-1785)
By 1775, tensions were high between England and their American colonists. England had passed laws that prevented colonists from being elected to Parliament; at the same time, Parliament passed many laws that levied taxes on the colonists. Angry colonists called this “taxation without representation,” which became an instigation and a battle-cry for the revolt. For nine years, colonists fought the British with the aid of France. In 1781, British general Cornwallis surrendered to Washington after the Battle of Yorktown. The war officially ended with the Treaty of Paris in 1783.

Causes of the Revolution
• Progressively direct, internal taxes were levied against the colonists in order to provide support to mother England. In order to keep peace with the Native Americans, Parliament passed The Proclamation of 1763, a bill that said colonists could not settle west of the Appalachian Mountains. Settlers felt this was a local decision and the government should not interfere.
• In 1765, the Stamp Act was passed, which levied taxes against the colonists on almost everything printed on paper – legal documents, almanacs, diplomas, and playing cards. This law united the colonists against British rule, and resulted in many bloody demonstrations and riots.
• Parliament passed the Townshend Acts in 1767, which taxed glass, lead, paper, paint, and tea. The colonists refused to buy these items, so the tax was finally repealed on everything except tea.
• In 1768, 4,000 British soldiers were moved into Boston, and the colonists were required to provide room and board to the soldiers. On March 5, 1770, several townsmen got into an argument and threw snowballs at a group of soldiers. The soldiers opened fire on the unarmed crowd, killing five colonists. This became a highly publicized story known as the Boston Massacre; it fueled the fires for colonial independence.
• Parliament passed the Tea Act of 1773 which forbade the colonists from buying non-English tea, which was still taxed as a way of demonstrating England’s right to tax the colonies. The colonists strongly opposed the tax, and when the British East India Company brought three ships loaded with tea into Boston harbor, merchants refused to sell the tea, and local authorities refused to allow the ships to off-load their cargo. On December 16, colonists dressed as Mohawk Indians boarded the ships and tossed 342 chests of tea into the bay. This is known as the Boston Tea Party. Similar incidents occurred throughout the colonies until British tea was boycotted completely.
• To punish the colonists, England passed laws that were more rigid than ever, igniting a revolt. The colonists dubbed these new laws “Intolerable Acts,” and held the First and Second Continental
Congress, meetings of representatives from each colony. In these meetings, colonial leaders began discussing revolution and agreed to form an American Continental Army, led by George Washington.

Results of the Revolution
- The colonies became an independent nation, the United States of America.
- Britain recognized the new country and gave up rights to the land east of the Mississippi River, to Canada in the north, and Florida in the south.
- A new government was elected.

E. DEMOCRATIC GOVERNMENT
Below is a listing of important documents and terms related to the newly formed Democratic government of America.

1. The Declaration of Independence
- stated that governments must recognize civil rights.
- governments are formed to protect their citizens’ rights.
- spelled out the insults, abuse, taxation issues, and other problems colonists had under British rule.
- stated colonies' intent to form a new government.

2. The Articles of the Confederation
- first American Constitution.
- provided for a government with no monarch.
- a weak central government, and stronger state governments.
- each state decided for itself, and issues that affected all were decided by majority vote.

3. The Constitution
- the highest law in the United States.
- provides for citizens to elect their representing officials.
- provides for the sharing of power between state and national government.
- designates branches of government – legislative (Congress), executive (President), and Judicial (the Supreme Court).
- delineates a system of checks and balances, whereby each branch can be controlled by the other two branches.

4. The Bill of Rights
- safeguards the rights of the people.
- guarantees basic rights – freedom of speech, freedom of the press, freedom of religion, etc.

F. The War of 1812
The War of 1812 was fought between Britain and the newly formed U.S. During the war, the British captured and burned Washington, D.C., though the U.S. eventually won the conflict. This battle was important because it set the stage for other nations to recognize the United States as a viable, independent country.

Causes of the War
- England and France were capturing U.S. ships and interfering with trade.
- The U.S. believed England was still interfering with the colonies, as well as providing weapons to the natives (so they could attack the colonies).
- The U.S. wanted to take new territories – Canada (Britain) and Florida (Spain).

Results of the War
- England recognized U.S. boundaries.
- American industry flourished because, Americans had to make their own goods as opposed to relying on imports from England.
- The United States became recognized by other countries.

continued
G. WESTWARD EXPANSION

• After the Revolution, American territory increased due to an American belief known as “Manifest Destiny.” This belief encompassed the idea that America was destined by God to encompass the land from the east coast to the Pacific Ocean.
• Louisiana Purchase (1803) – Jefferson purchased French lands west of the Mississippi
• Lewis and Clark Expedition (1804-1806) – Explorers sent to find a water route from the source of the Missouri River to the Pacific Ocean, mapped much of the Continental U.S., made trade relations with the Native Americans living there, and paved the way for westward expansion.
• Sacajawea – (1805) A Shoshone Indian woman who served as a guide and translator for Lewis and Clark
• Florida Purchase (1819) – Florida was purchased from Spain
• The Trail of Tears and Resettlement of Native Americans (1830-1832) – removed Native Americans from their ancestral homes onto government reservations. Due to harsh traveling conditions and lack of supplies, many died during the journey.
• Texas joined the Union (1845) - including parts of New Mexico, Colorado, and Wyoming
• Oregon Territory (1846) – Washington, Oregon, Idaho and most of Montana
• Transportation during westward expansion
  - Wagon trains – Settlers moving to new lands traveled by covered wagon
  - Stagecoach
  - The Pony Express
  - Canals
  - Railroads
• Mexican land acquisition from Mexican-American War (1848) – California, Arizona, Utah, Nevada
• Mexico land purchase (1853) – the southern parts of New Mexico and Arizona
• Homestead Act of 1862 – gave land to any settler who lived and farmed it for five years; instrumental in the settlement of central and western regions of the U.S.
• Alaska (1867) – purchased from Russia
• Hawaii (1898) – annexed by the U.S.

1. Immigration Patterns and Diffusion
People came to Texas for many reasons:
• to make a better life
• inexpensive land
• democracy
• religious freedom

Major cultural groups in Texas:
• Old-stock Anglo-Americans
• Upper South/Southerners
• Lower South/Southerners
• Direct European (groups)
• Hispanic / Mexican-Americans
• African-Americans
• Native-Americans

2. Culture, Settlement, and Diffusion
Diffusion is the process by which an idea or innovation is transmitted from one individual or group to another across space – the way innovations and ideas travel through society. Texas is composed of distinct culture groups, each with its own way of life. The exchanges of cultural ideas and practices, as well as the physical properties of the land, have greatly influenced Texas, both in the past and the present.
H. TEXAS REVOLUTION (1820-1840)

1. Important Events
   • 1821 – Stephen F. Austin, the “Father of Texas,” brought white, American settlers to Texas.
   • 1830 – Mexico refused to allow any more U.S. settlers into the territory, creating tension and a cry for independence.
   • 1835 – The Texas Revolution began with the Battle of Gonzalez.
   • 1836 – The Texas Declaration of Independence was created and issued.
   • 1836 – The Battle of the Alamo; 5,000 Mexican soldiers attacked and killed 186 Texans (almost everyone there), including William B. Travis, David Crockett, and Jim Bowie.
   • 1836 – The Massacre at Goliad; 300-400 Texas soldiers were taken prisoner by the Mexican army. Later, the prisoners were paraded through the streets and killed.
   • 1836 – General Sam Houston defeated Mexican General Santa Anna at the Battle of San Jacinto.
   • 1836 – The Republic of Texas, an independent country, was formed, and the Texas Constitution was written.
   • 1839 – Texas joined the United States.
   • 1845 – The new Texas Constitution was written.

2. Important People
   • Stephen F. Austin, “The Father of Texas” (because he brought settlers to Texas)
   • Sam Houston, first general of the Texas army, first President of the Republic of Texas
   • Antonio Lopez de Santa Anna, arrogant Mexican general who led the assault against the Texas army, and later President of Mexico (1833)
   • William B. Travis, commander of the Alamo
   • James Bowie and David Crockett, important statesmen who fought and died at the Alamo

I. THE MEXICAN WAR (1846-1848)

After Texas joined the Union, conflicts continued with Mexico and Santa Anna. President Polk pushed to buy more Mexican lands (because of his strong belief in the Manifest Destiny). The U.S. won the war after taking over Mexico City, Mexico’s capital.

Causes of the War
   • Mexico was against Texas joining the Union
   • Disputes regarding the southern border of Texas (U.S. claimed it was the Rio Grande, Mexico claimed it was the Nueces River, farther to the north)
   • The U.S. wanted to own more land, which Mexico refused to sell

Results of the War
   • Mexico agreed that the southern border was the Rio Grande.
   • Mexico sold the U.S. California, Nevada, Utah, and parts of Arizona, New Mexico, Colorado, and Wyoming
   • U.S. size and power increased

J. CIVIL WAR (1861-1865)

1. The Issue of Slavery
   • Abolitionists - those who wanted to abolish slavery.
   • The Underground Railroad - a secret movement that helped slaves escape (safe houses, hiding places, etc.).
   • The Compromise of 1820 and The Compromise of 1860 - decided if new states joining the union would be free states or slave states; attempted to balance continued
those for and against the issue in Congress

• The Dred Scott Decision - Dred Scott, a slave who had moved with his master to the free state of Illinois, sued for his freedom. The Supreme Court decided that because Scott was “property,” he could not sue for his freedom. This enraged Abolitionists and fueled the fires for Civil War.
• The Lincoln-Douglas Debates - Public political debates between Abraham Lincoln and Stephen A. Douglas (during the 1858 senate election). Slavery was hotly debated, drawing large crowds and national attention to the issue.

2. *A Nation Divided*

• 1860 Secession begins (South Carolina is the first to secede).
• 1861 South fires on Fort Sumter, Civil War begins.
• 1861 Battle of Bull Run - first major land battle of the Civil War.
• 1862 Battle of Antietam - first major land battle to take place on Northern soil.
• 1863 Emancipation Proclamation - Lincoln declared all slaves freed.
• 1863 Battle of Gettysburg - bloodiest battle of the war, a turning point for Northern victory.
• 1864 Sherman’s army burns Atlanta
• 1864 Lee surrenders to Grant at Appomattox.
• 1865 Lincoln assassinated.

*Causes of the War*

• Slavery - the issue at the heart of the war.
• Northern (industrial) vs. Southern (agricultural) Ways of Life.
• Free labor vs. paid labor - Southern economy was based on the free labor provided by slaves.
• States’ rights - The north held that no state could secede (leave the nation), while the south felt that individual states could vote to do so.

*Results of the War*

• Slavery ended, though blacks were not given equal rights. They could not vote, join their state army, serve on a jury, or testify against whites in court.
• Secession was no longer allowed
• The U.S. government was reconstructed to change civil rights and citizenship laws.

3. *Texas in the Civil War*

Only a small percentage of Texas families owned slaves, though most Texans felt that states should make their own decisions regarding this and most issues. Texas joined the Confederacy and was a formidable force in many battles. During the Battle of Vicksburg, a small band of Texans held a pass against an entire platoon of northern soldiers, took the entire platoon hostage, and took their weapons. Few Civil War battles were fought on Texas soil.

K. *RECONSTRUCTION*

• After the Civil War and Lincoln’s assassination, there was a period of intense restructuring in the United States. These are the key aspects of Reconstruction:
  • The 13th Amendment was passed, outlawing slavery.
  • Freedmen’s Bureau was created to help the newly freed slaves with food, housing, and employment.
  • The Civil Rights Act of 1866 gave citizenship to all persons born in the U.S.
  • Men from the former Confederacy were required to take an oath of loyalty to the Union.
  • The 14th Amendment was passed,
giving citizenship rights to freed slaves.

- The 15th Amendment was passed, giving voting rights to all male citizens over the age of 21, including freed slaves.
- Jim Crow laws passed by southern states legalized segregation (separate waiting areas in public places).
- Ku Klux Klan, a secret society of white supremacists, was formed and engaged in acts against African Americans and those that supported them.
- The Compromise of 1877 ended Reconstruction and called for federal troops that were stationed in southern states to be removed.

L. INDUSTRIAL REVOLUTION, TECHNOLOGICAL ADVANCES, AND INDUSTRIALIZATION

In the 1800s, many significant technological advances increased the flow of goods and services throughout the U.S. In the 1900s, manufacturing capabilities of the U.S. grew significantly. Products changed from hand-made to machine-made, increasing output and wealth. Below is a list of significant technological advances that impacted trade and industry in the U.S. and Texas. In addition, around the turn of the century, cities began to grow, and Americans became increasingly urban. Before 1870, less than 25% of Americans lived in cities (most lived on farms or in small, rural towns). By the mid-1900s, more than half of all Americans lived in cities.

<table>
<thead>
<tr>
<th>Year</th>
<th>Invention</th>
<th>Inventor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1793</td>
<td>Cotton Gin</td>
<td>Eli Whitney</td>
</tr>
<tr>
<td>1700s-1870s</td>
<td>Cattle Drives and Cattle Industry</td>
<td>n/a</td>
</tr>
<tr>
<td>1814</td>
<td>Steam Engine</td>
<td>George Stephenson</td>
</tr>
<tr>
<td>1830</td>
<td>Sewing Machine</td>
<td>B. Thimonnier</td>
</tr>
<tr>
<td>1831</td>
<td>Refrigerator</td>
<td>Jacob Perkins</td>
</tr>
<tr>
<td>1836</td>
<td>Revolver</td>
<td>Samuel Colt</td>
</tr>
<tr>
<td>1838</td>
<td>Telegraph</td>
<td>Samuel Morse</td>
</tr>
<tr>
<td>1856</td>
<td>Pasteurization</td>
<td>Louis Pasteur</td>
</tr>
<tr>
<td>1862</td>
<td>Plastic</td>
<td>Alexander Parkes</td>
</tr>
<tr>
<td>1869</td>
<td>The Transcontinental Railroad (1869) – first railroad line to cross the continent</td>
<td>Union and Central Pacific Railroad Companies</td>
</tr>
<tr>
<td>1865-1945</td>
<td>Oil Industry – Spindletop</td>
<td>Anthony Lucas</td>
</tr>
<tr>
<td>1876</td>
<td>Telephone</td>
<td>Alexander Graham Bell</td>
</tr>
<tr>
<td>1903</td>
<td>Gas Powered and Manned Airplane</td>
<td>William and Orville Wright</td>
</tr>
<tr>
<td>1908</td>
<td>Mass Automobile Production (via Assembly Line)</td>
<td>Henry Ford</td>
</tr>
<tr>
<td>1920</td>
<td>First Commercial Radio Station</td>
<td>n/a</td>
</tr>
<tr>
<td>1927</td>
<td>First Television Transmission</td>
<td>n/a</td>
</tr>
<tr>
<td>1928</td>
<td>Penicillin</td>
<td>Alexander Fleming</td>
</tr>
<tr>
<td>1947</td>
<td>Transistor</td>
<td>Bell Labs</td>
</tr>
</tbody>
</table>
M. SPANISH-AMERICAN WAR OF 1898
Spain and the United States fought in the Philippines and Cuba.

Causes of the War
- The Maine, a U.S. battleship was mysteriously sunk (killing 260 people) while serving as a peace-keeping force near Cuba while Cuba was engaged in a battle for independence from France.
- Many Americans felt we should support the Cuban freedom efforts; others felt the U.S. should take over Cuba as many American businesses had holdings there.
- Two major newspapers in New York were in a heated competition for readers. They sensationalized the sinking of the Maine, which stirred Americans for war.

Results of the War
- Cuba gained limited independence from Spain.
- The U.S. gained territory, including Guam, Puerto Rico, and the Philippines.
- The U.S. became a recognized leader in international affairs.

N. WORLD WAR I (1914-1918)
World War I, the “war to end all wars,” began in 1914 and involved several countries from all over the world. The U.S. joined the conflict in 1917.

Causes of the War
- European industrial countries had large world empires, were very competitive, and wanted to increase their holdings.
- Countries formed alliances - agreements to defend each other in case of attack.
- Archduke Franz Ferdinand, heir apparent for the Austrian-Hungarian throne, was assassinated in Sarajevo. Austria declared war on Serbia, which triggered WWI, as alliances brought other countries into the war.

<table>
<thead>
<tr>
<th>Allies</th>
<th>Central Powers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>Austria</td>
</tr>
<tr>
<td>Great Britain</td>
<td>Bulgaria</td>
</tr>
<tr>
<td>France</td>
<td>Germany</td>
</tr>
<tr>
<td>Italy</td>
<td>Hungary</td>
</tr>
<tr>
<td>Japan</td>
<td>The Ottoman (Turkish) Empire</td>
</tr>
<tr>
<td>United States</td>
<td></td>
</tr>
</tbody>
</table>

- The U.S., neutral at the beginning of the war, turned against Germany when German U-boats sank the Lusitania, an unarmed passenger ship. Twelve hundred people were killed, including 100 Americans. That, and the sinking of other, unarmed American merchant ships, led to the U.S. declaring war on Germany in 1917.
- Despite the early war in Serbia, Germany was held responsible for starting the war. Between August 1-4, Germany declared war on Russia and France, and invaded Belgium.

Results of the War
- World War I ended with the Treaty of Versailles, a harsh agreement that punished the Germans severely.
- Germany lost territory to Belgium, Denmark, France, and Poland.
- The size of Germany’s army was reduced.
- Germany was forbidden to have submarines and aircraft.
- Germany was fined $33 million in damages to other nations (which they never paid).
- The League of Nations was formed.

O. THE LEAGUE OF NATIONS
After World War I, President Woodrow Wilson founded the League of Nations to foster peace among the nations of the world.
Subject Test IV (809):
Science
Competencies 1-23 (36-58)

21% of the test

*NOTE: The numbering of these Competencies is based upon how we number them for the comprehensive Core Subjects 4-8 test prep program, and also how the SBEC numbers them for the separate Subject Tests. They are noted as such due to the design of our worksheets in the Appendices.
1 (36). Safety Precautions

Key Descriptors

Key Words:
Responsible Behavior
Guidelines
Safety

NOTE: Refer to the lettered descriptors under each Competency in the ETS/SBEC study material (in the back of this manual). Analyze each descriptor, and synthesize it down to a paraphrase that is meaningful to you, using no more than 5 words. List those phrases in order on the lines above. It will help to letter the lines above. When complete, record them again on Worksheet 4 in Appendix I.
1 (36). Safety Precautions

Competency 1 (36):
The teacher understands how to manage learning activities to ensure the safety of all students.

A. GUIDELINES
• Students must never be left unsupervised with laboratory equipment
• There should be no eating or drinking in the laboratory
• The teacher must demand responsible behavior from all students
• Very clear instructions must be given explaining any assignment using laboratory equipment or chemicals before students proceed with the assignment
• Work areas should be clean and students should keep only what is necessary for the assignment on the bench top
• Students must be told to inform the teacher if any problem arises during the assignment
• Suitable clothing must be worn when completing a laboratory assignment.

B. PROPER HANDLING OF MATERIAL
• Know the locations and operating procedures of all safety equipment; know where the fire alarm and the exits are located.
• Chemical waste must be disposed of properly. The teacher must be consulted before pouring any liquid down the drain. Insoluble materials are to be disposed of in the proper waste containers, not in the sink. Cracked or broken glass should be placed in the special container for “Broken Glass.”
• Students should never use broken glassware
• The teacher should be in possession of MSDSs for chemicals used in the laboratory.
• Chemical containers should be carefully labeled and students instructed to read all labels carefully before handling material

C. PROPER HANDLING OF ORGANISMS AND SPECIMENS
• The teacher should be familiar with safety guidelines such as NABT Guidelines for the Use of Live Animals, Working with DNA & Bacteria in Precollege Science Classrooms or other safety guidelines from organizations such as NIH, the American Chemical Society, Flinn Scientific, etc.
• The teacher should discuss safety procedures with students before the beginning of each laboratory assignment.

Rules and regulations for the proper handling of material should be posted throughout the laboratory.

 Teachers need a basic understanding of proper laboratory etiquette. Before beginning each laboratory assignment, instructors must discuss safety procedures with students; teachers must always be alert that students are following all safety rules and regulations.
2 (37). Tools and Technology

Key Descriptors

Key Words:

- Precision
- Accuracy
- Error
- International System of Units
- Tools
- Pictorial Representations of Information

NOTE: Refer to the lettered descriptors under each Competency in the ETS/SBEC study material (in the back of this manual). Analyze each descriptor, and synthesize it down to a paraphrase that is meaningful to you, using no more than 5 words. List those phrases in order on the lines above. It will help to letter the lines above. When complete, record them again on Worksheet 4 in Appendix I.

- Selects and safely uses appropriate tools, technologies, materials and equipment needed for instructional activities.
- Understands concepts of precision, accuracy and error with regard to reading and recording numerical data from a scientific instrument.
- Understands how to gather, organize, display and communicate data in a variety of ways (e.g., charts, tables, graphs, diagrams, written reports, oral presentations, maps, satellite views).
- Understands various units of measure such as the International System of Units (SI or metric system), light years and degrees Celsius, and performs unit conversions within measurement systems.
Competency 2 (37):
The teacher understands the correct use of tools, materials, equipment and technologies.

A. TOOLS
Science is the study of the natural world, not by anyone in particular. It is important to realize that anyone can be a scientist, as long as there are questions that are being asked and a desire to learn about the world around you. Professional scientists can only make comments on what their senses can tell them about the world, but oftentimes human senses are limited. Therefore, scientists use tools to aid them in their research. There are some basic tools that all scientists should know about.

- **Graduated Cylinder** - This is a long container for measuring volume. Remember to always read the number which the bottom-most part of the meniscus is touching, while keeping your eye level with the meniscus.
- **Balance or scale** - This is used for measuring weight and determining mass. There are many different types of balances, such as mechanical balances, digital balances, and spring scales.
- **Pipette** - This is used to transfer a certain volume of liquid; again, there are different types of pipette.
- **Microscope** - A cornerstone of scientific laboratories. Used to view small objects; again, there are different types of microscopes, such as a compound light microscope, and a dissecting microscope.
- **Bunsen burner** - Creates a flame that is used for heating and sterilization.
- **Test Tubes** - Containers which hold liquid and in which chemicals can be mixed.
- **Rulers**
- **Hot plates** - Used to heat objects.
- **Beakers and Flasks** - Used to contain liquids.
- **Computers**
- **Dissecting tools**

B. MEASUREMENTS

- **Precision** - The ability to produce the same value or result; also can be thought of as the number of digits used to record a measurement or which a measuring device is capable of providing
- **Accuracy** - A measure of how close a measured value is to the true value.
- **The Bulls eye analogy** - To distinguish between precision and accuracy. Imagine a target in which the bulls eye is our true value. If you shoot a few arrows and they land relatively close to the bulls eye, but far apart from each other, then this is an illustration of accuracy (your arrows, or measurements, were close to the true value); if instead, your arrows land far from the bulls eye, but all in a bunch, where they are all close to one another, then this is an illustration of precision (you produced relatively the same result with all your throws). A good scientific measurement is both precise and accurate.
- **Error** - The difference between a computed, estimated, or measured value and the true value that is caused by random, and inherently unpredictable fluctuations in the measurement instruments. The deviation can be small and inherent in the structure and functioning of the measurement.
2 (37). Tools and Technology, cont’d.

Common Water Measurement Conversion Chart

<table>
<thead>
<tr>
<th>Fraction</th>
<th>Decimal</th>
<th>Millimeter</th>
<th>Fraction</th>
<th>Decimal</th>
<th>Millimeter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/64</td>
<td>0.015625</td>
<td>0.3969</td>
<td>33/64</td>
<td>0.515625</td>
<td>13.969</td>
</tr>
<tr>
<td>1/32</td>
<td>0.03125</td>
<td>0.7938</td>
<td>17/32</td>
<td>0.52125</td>
<td>13.4938</td>
</tr>
<tr>
<td>1/16</td>
<td>0.0625</td>
<td>1.5875</td>
<td>9/16</td>
<td>0.5625</td>
<td>14.2875</td>
</tr>
<tr>
<td>5/64</td>
<td>0.078125</td>
<td>1.9844</td>
<td>37/64</td>
<td>0.578125</td>
<td>14.8844</td>
</tr>
<tr>
<td>3/32</td>
<td>0.09375</td>
<td>2.3813</td>
<td>19/32</td>
<td>0.59375</td>
<td>15.0813</td>
</tr>
<tr>
<td>7/64</td>
<td>0.109375</td>
<td>2.7781</td>
<td>39/64</td>
<td>0.609375</td>
<td>15.4781</td>
</tr>
<tr>
<td>1/8</td>
<td>0.125</td>
<td>3.175</td>
<td>5/8</td>
<td>0.625</td>
<td>15.875</td>
</tr>
<tr>
<td>9/64</td>
<td>0.140625</td>
<td>3.5719</td>
<td>41/64</td>
<td>0.640625</td>
<td>16.2719</td>
</tr>
<tr>
<td>5/32</td>
<td>0.15625</td>
<td>3.9688</td>
<td>21/32</td>
<td>0.65625</td>
<td>16.6688</td>
</tr>
<tr>
<td>11/64</td>
<td>0.171875</td>
<td>4.3655</td>
<td>43/64</td>
<td>0.671875</td>
<td>17.0656</td>
</tr>
<tr>
<td>3/16</td>
<td>0.1875</td>
<td>4.7625</td>
<td>11/16</td>
<td>0.6875</td>
<td>17.4625</td>
</tr>
<tr>
<td>13/64</td>
<td>0.203125</td>
<td>5.1594</td>
<td>45/64</td>
<td>0.703125</td>
<td>17.8594</td>
</tr>
<tr>
<td>7/32</td>
<td>0.21875</td>
<td>5.5553</td>
<td>23/32</td>
<td>0.71875</td>
<td>18.2563</td>
</tr>
<tr>
<td>15/64</td>
<td>0.234375</td>
<td>5.9531</td>
<td>47/64</td>
<td>0.734375</td>
<td>18.6531</td>
</tr>
<tr>
<td>1/4</td>
<td>0.25</td>
<td>6.3500</td>
<td>3/4</td>
<td>0.75</td>
<td>19.0500</td>
</tr>
<tr>
<td>1/2</td>
<td>0.5</td>
<td>12.7000</td>
<td>1</td>
<td>1.00</td>
<td>25.4000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fraction</th>
<th>Decimal</th>
<th>Millimeter</th>
<th>Fraction</th>
<th>Decimal</th>
<th>Millimeter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/8</td>
<td>0.125</td>
<td>3.175</td>
<td>5/8</td>
<td>0.625</td>
<td>15.875</td>
</tr>
<tr>
<td>1/4</td>
<td>0.25</td>
<td>6.3500</td>
<td>3/4</td>
<td>0.75</td>
<td>19.0500</td>
</tr>
<tr>
<td>1/2</td>
<td>0.5</td>
<td>12.7000</td>
<td>1</td>
<td>1.00</td>
<td>25.4000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fraction</th>
<th>Decimal</th>
<th>Millimeter</th>
<th>Fraction</th>
<th>Decimal</th>
<th>Millimeter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/8</td>
<td>0.125</td>
<td>3.175</td>
<td>5/8</td>
<td>0.625</td>
<td>15.875</td>
</tr>
<tr>
<td>1/4</td>
<td>0.25</td>
<td>6.3500</td>
<td>3/4</td>
<td>0.75</td>
<td>19.0500</td>
</tr>
<tr>
<td>1/2</td>
<td>0.5</td>
<td>12.7000</td>
<td>1</td>
<td>1.00</td>
<td>25.4000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit</th>
<th>Gallon</th>
<th>Quart</th>
<th>Pint</th>
<th>Pound</th>
<th>Avoirdupois ounce</th>
<th>Fluid ounce</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 gallon</td>
<td>1.0</td>
<td>4.0</td>
<td>8.0</td>
<td>8.345</td>
<td>133.52</td>
<td>128.0</td>
</tr>
<tr>
<td>1 quart</td>
<td>0.25</td>
<td>1.0</td>
<td>2.0</td>
<td>2.086</td>
<td>33.38</td>
<td>32.0</td>
</tr>
<tr>
<td>1 pint</td>
<td>0.125</td>
<td>0.5</td>
<td>1.0</td>
<td>1.043</td>
<td>16.09</td>
<td>16.0</td>
</tr>
<tr>
<td>1 pound</td>
<td>0.0625</td>
<td>0.25</td>
<td>0.5</td>
<td>0.52125</td>
<td>10.0</td>
<td>10.0</td>
</tr>
<tr>
<td>1 ounces</td>
<td>0.0075</td>
<td>0.03</td>
<td>0.06</td>
<td>0.035</td>
<td>0.75</td>
<td>0.75</td>
</tr>
<tr>
<td>1 fluid ounce</td>
<td>0.001</td>
<td>0.0005</td>
<td>0.0125</td>
<td>0.00625</td>
<td>0.125</td>
<td>0.125</td>
</tr>
<tr>
<td>1 cubic inch</td>
<td>0.0017</td>
<td>0.00067</td>
<td>0.0035</td>
<td>0.00175</td>
<td>0.357</td>
<td>0.357</td>
</tr>
<tr>
<td>1 cubic foot</td>
<td>0.292</td>
<td>1.0</td>
<td>8.0</td>
<td>8.345</td>
<td>133.52</td>
<td>128.0</td>
</tr>
<tr>
<td>1 cubic centimeter</td>
<td>1.0</td>
<td>0.035</td>
<td>0.001</td>
<td>0.00035</td>
<td>0.035</td>
<td>0.035</td>
</tr>
<tr>
<td>1 liter</td>
<td>0.264</td>
<td>1.097</td>
<td>2.1154</td>
<td>2.203</td>
<td>35.28</td>
<td>33.815</td>
</tr>
<tr>
<td>1 gram</td>
<td>0.001</td>
<td>0.000035</td>
<td>0.0002</td>
<td>0.0002</td>
<td>0.00035</td>
<td>0.00035</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit</th>
<th>Cubic inch</th>
<th>Cubic foot</th>
<th>Milliliter</th>
<th>Liter</th>
<th>Gram</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 gallon</td>
<td>231.0</td>
<td>1.0</td>
<td>3,785.4</td>
<td>3.785</td>
<td>3,785.4</td>
</tr>
<tr>
<td>1 quart</td>
<td>57.749</td>
<td>0.25</td>
<td>946.96</td>
<td>0.946</td>
<td>946.96</td>
</tr>
<tr>
<td>1 pint</td>
<td>28.875</td>
<td>0.125</td>
<td>473.18</td>
<td>0.473</td>
<td>473.18</td>
</tr>
<tr>
<td>1 ounce</td>
<td>27.67</td>
<td>0.016</td>
<td>433.50</td>
<td>0.434</td>
<td>433.50</td>
</tr>
<tr>
<td>1 fluid ounce</td>
<td>1.0</td>
<td>0.001</td>
<td>28.3</td>
<td>0.0283</td>
<td>28.3</td>
</tr>
<tr>
<td>1 cubic inch</td>
<td>1.0</td>
<td>0.00066</td>
<td>1.0</td>
<td>0.0010</td>
<td>1.0</td>
</tr>
<tr>
<td>1 cubic foot</td>
<td>1,728.0</td>
<td>1.0</td>
<td>28,322.0</td>
<td>28.322</td>
<td>28,322.0</td>
</tr>
<tr>
<td>1 cubic centimeter</td>
<td>61.0</td>
<td>0.0025</td>
<td>1.0</td>
<td>0.0010</td>
<td>1.0</td>
</tr>
<tr>
<td>1 liter</td>
<td>61.025</td>
<td>0.0353</td>
<td>1.0000</td>
<td>1.0</td>
<td>1.0000</td>
</tr>
</tbody>
</table>

Fractions/Decimals
Inches/Millimeters
of the system and be within acceptable limits or can be due to lack of care or mistakes made by the investigator. A related term is **standard deviation**, which is a measure of the dispersion of random errors about the mean value.

- **Bias** - A prejudice, usually of the investigator, that can inhibit impartial judgment and cause certain results to be more likely to happen than should be the case; bias can therefore invalidate an experiment.

**C. COMMUNICATION OF RESULTS**

Historically, science has never really been an introverted discipline. Those who explore the natural world communicate their observations and conclusions to keep the world informed and further the understanding of mankind in order to apply new scientific knowledge and technology. Scientists have found convenient ways to communicate scientific results.

- **Chart** - A way of representing information pictorially.
- **Table** - Organizes numbers and information into tables and rows.
- **Graph** - A type of chart which has an x and y axis used to represent the relationship between variables; there are different types of graphs, such as line graphs and bar graphs
- **Diagram** - A pictorial representation, such as a drawing.
- **Written and Oral reports**

**D. INTERNATIONAL SYSTEM OF MEASUREMENT**

Most of us in America are familiar with inches, yards, etc. But the scientific community has declared the existence of an international system of measurement that is unwavering no matter what country you go to. This is to make sure scientists of different countries can understand each other. This system is called **The Metric System**, also known as **The International System of Units (SI)**.

- Length is measured in **meters**
- Time is measured in **seconds**
- Mass is measured in **grams**
- Electric current is measured in **amperes**
- Thermodynamic temperature is measured in **Kelvin**
- Amount of substance is measured in **moles**
- Luminous intensity is measured in **candela**

Teachers must be able to handle with ease all the tools likely to be encountered in a school laboratory, being familiar with the measurement taking procedure and being able to convey this knowledge to students. Teacher must be capable of stimulating students to use different methods of presenting their data.

---

**Metric Conversion Chart**

- **Kilo - 1000 units**
- **Hecto - 100 units**
- **Deka - 10 units**
- **Basic Unit**
- **Deci - 0.1 units**
- **Centi - 0.01 units**
- **Milli - 0.001 units**

To convert to a smaller unit, move decimal point to the right or multiply.

To convert to a larger unit, move decimal point to the left or divide.
3 (38). Scientific Inquiry and the History of Science

Key Descriptors

________________________________________________________

________________________________________________________

________________________________________________________

________________________________________________________

________________________________________________________

________________________________________________________

________________________________________________________

________________________________________________________

Key Words:

Scientific Method

Experiment

Controlled Experiment

Control Group

Experimental Group

Data

Independent Variable

Dependent Variable

Serendipity

Ethics

NOTE: Refer to the lettered descriptors under each Competency in the ETSSBE study material (in the back of this manual). Analyze each descriptor, and synthesize it down to a paraphrase that is meaningful to you, using no more than 5 words. List those phrases in order on the lines above. It will help to letter the lines above. When complete, record them again on Worksheet 4 in Appendix I.
A. THE SCIENTIFIC METHOD
Science is essentially a process used to understand natural phenomenon, and the domain of this process is not restricted to men in white lab coats; indeed, all individuals can use the scientific process to understand the world they live in. Over the years, however, professional scientists have somewhat formalized this process, breaking it down into steps, to maintain a certain "code of conduct" in the scientific community.

- **Observation.** A good scientist, whether wearing a white lab coat or not, is constantly observing the world around himself or herself. One characteristic that is fundamental to science is curiosity; not only does a scientist observe, or notice, things, but he or she must be curious enough to ask questions such as "Why does this happen?" or "What is the reason behind that?" Observing the world also includes reading what has been observed and concluded by others, for another characteristic fundamental to science is that it is cumulative; the scientific knowledge of today would not be here had it not been able to benefit from what was learned yesterday.

**Example:** Before the invention of refrigerators, meat was hung out at butcher shops and people needed to make daily trips to their local butcher if they wanted to eat meat. After the meat was hung out for a while, flies appeared where there were no flies. Obviously, a great many people observed the flies buzzing around their heads.

- **Question.** The scientist then asks the question that he or she is curious to answer. The question must be relatively simple, in that a well-thought out experiment may give some insight into the answer to the question.

**Example:** Many astute minds of the pre-refrigerator era thought it logical to assume that the newly buzzing flies were created from the decaying meat. Indeed, it was a common belief at the time that life could spring from dead or decaying matter; this was the idea of *spontaneous generation.* To approach this problem, scientists asked themselves the question, "Where do the flies come from?"

- **Hypothesis.** In formulating a hypothesis, you are essentially putting forth a tentative explanation for what you have observed. What you have observed is the effect, and your hypothesis is a potential cause. Hypotheses rely heavily on past experience, facts, and general principles. This potential cause gives the scientist a starting point on which to base further study of the initial observation.

**Example:** A scientist by the name of Francesco Redi was not convinced by the idea of spontaneous generation (as was the case for other scientists) and so came up with his own hypothesis. He hypothesized that "flies are not created by the decaying meat; flies can only hatch from eggs laid by other flies."

continued
• **Experimentation.** A scientist then makes a prediction based on his or her hypothesis and tests this prediction. An experiment is an artificial situation created by a scientist in order to verify whether his or her hypothesis/prediction is supported or not. The experimental design refers to all the subjects, tools, and specific procedures found in a particular experiment.

*Example:* Francesco Redi’s hypothesis that flies can only hatch from eggs laid by other flies led him to predict that if he somehow protected meat from contact with flies, no new flies would be found on the meat, no matter how rotten it was. Redi placed wide-mouthed jars in which were contained pieces of meat in a butcher shop; the ONLY thing that differed among them was how “open” they were to the outside environment. One jar was completely open, another was completely sealed with a lid, and a third was covered with gauze.

• **Data Collection.** A scientist must observe what happens in the experiment and collect data, the results of the experimental procedure. Data should be quantitative and objectively measurable. It is not enough to say “Oh, I’m going to see how this person reacts to this drug;” rather, a scientist must have a list of behaviors or conditions which he or she is looking to test as an indication of reaction to the drug.

*Example:* Redi recorded the presence or absence of flies, and most importantly maggots, in each jar. Flies were seen entering the open jar. Later, maggots, then more flies were seen on the meat. In the gauze-covered jar, no flies were seen in the jar, but were observed around and on the gauze, and later a few maggots were seen on the meat. In the sealed jar, no maggots or flies were ever seen on the meat.

• **Conclusions.** At this point, the scientist analyzes the data and comes up with a statement as to whether his or her hypothesis is supported or rejected. Conclusions of experiments, along with the experimental design and the results, are communicated to other scientists usually in the form of articles published in scientific journals. This communication ensures that all scientists are aware of breaking news and that all scientific work is constantly subject to peer review and critique.

*Example:* What Redi observed was that flies entered the completely open jar and laid eggs on the meat; a while later, maggots hatched and then grew into other flies. The jar that was completely sealed had no flies whatsoever growing on the meat because no flies got in to lay eggs; instead flies would land on the lid, lay eggs, maggots would hatch, and these would mature into flies. The jar covered with gauze presented an intermediate situation in which there were a few flies on the meat in the jar; indeed, only some of the eggs that were laid on the gauze were able to fall through openings in the gauze onto the meat. Therefore, flies were found on meat only in situations where other flies had access to the meat and laid their eggs. It seems that the hypothesis “flies only come from other flies” is supported. Indeed, historically this experiment was but one of many nails in the coffin of spontaneous generation.
B. THE NATURE OF SCIENTIFIC INVESTIGATIONS

• Controlled experiments
  In a sense, all scientific experiments are controlled, because the scientist is the one creating the experiment, manipulating the situation and comparing the results to some standard. More precisely, though, a controlled experiment is one in which a variable, called the independent variable, is manipulated to reveal the effect on another variable, called the dependent variable, while all other variables in the situation are held fixed. The scientist has control over the independent variable, while he or she can only measure the dependent variable. Two classes of groups are present in this type of experiment: the control group and the experimental group, which differ only with respect to the independent variable. In our example of the Redi experiment, the independent variable was the degree of “openness” of the jars, while the dependent variable was the presence of flies. The control group was the open jar, while there existed two experimental groups, slightly different in their degrees of openness, gauze-sealed, and lid-sealed. An important note to be made is that in these types of experiments, more than one subject should always be included in the group to prevent individual variations, errors, or statistical phenomena to influence the outcome; indeed, Redi actually used several of each type of jar. Furthermore, the experimental design should be such that another researcher can perform the experiment and achieve the same results. In the case that this is not so, the original experiment would be invalid because the results are most likely due to some kind of personal bias.

• Descriptive studies. Estimation rather than testing is emphasized in these types of studies. They tend to be simpler and easier to conduct the experimental studies, but can provide background from which experimental studies emerge. Descriptive studies help to generate hypotheses, rather than test them.

• Serendipity. Luck rather than estimation or testing is emphasized in this situation. Actually, serendipity is not just “discovery by accident,” but involves the notion that the scientist possesses some kind of knowledge that allows him or her to take advantage of unexpected results. One example of serendipity is the discovery of aspartame, while another is the discovery of penicillin.

• Do-it-yourself. Sometimes scientists are desperate and do not follow any of the above-mentioned paths of scientific inquiry. Take the scientist who was desperate to convince the medical community that bacteria play an important role in the cause of stress. Instead of retiring to a psychiatric hospital because he was called crazy (see below), he drank a beaker of bacteria to cause himself to get an ulcer and prove the bacteria were the cause of it!

C. SCIENCE AS A HISTORICAL AND CULTURAL PROCESS

Modern-day scientific knowledge would not
exist were it not for past scientists who performed many of the basic experiments that today we take for granted. Indeed, science is a historical process, with each new scientist building on the knowledge of others that came before him or her. Science is also a cultural process, benefiting from the input of many different cultures and cultural perspectives.

- **Ignaz Semmelweis. 1800s.** One of the first investigators to propose aseptic techniques after running some rudimentary experiments to figure out why women were dying during childbirth. Pasteur’s germ theory was not accepted yet so Semmelweis was deemed crazy and eventually ended up in a psychiatric hospital where he died.

- **Louis Pasteur. 1800s.** Germ theory. “Life is a germ, and a germ is Life.”

- **Rosalind Franklin. 1950s.** Often unsung heroine in the search for the structure of the DNA double helix. Without her X-ray crystallographic studies, Watson and Crick might not have arrived at their groundbreaking discovery. Did not share the noble prize for this because she died of ovarian cancer (possibly work-related).

- **George Washington Carver. 1900s.** Born into slavery, he eventually became a famous botanist; advocated crop rotation practices and agricultural extension programs.

- **Ellen Ochoa. 1900s-present day.** First Hispanic woman to become an astronaut.

**D. ETHICS**

Human beings are creatures with values and these values cannot, and should not, be separated from science. These values, however, must not interfere with an ethical approach to scientific inquiry. Generally, ethics deals with what is right and wrong: science has powerful implications for society and so it is necessary to establish a code of ethics for scientific inquiry. For example, a scientist cannot invent whatever hypothesis he or she likes; hypotheses must agree with observations, or they are not acceptable. Results obtained from scientific inquiries, furthermore, must be subject to peer review, or critiqued by other scientists, in order to apply different perspectives and therefore validate an experimental design and its consequences.

- **Error.** Since no scientist can test his or hypothesis under every condition possible in the universe, no hypothesis can be conclusively proved as true or false in absolute. In this sense, all scientific results are susceptible to error. Putting the inherent nature of scientific study aside, though, errors also result from the direct action of humans. Sometimes a scientist does not have enough time to allow a phenomenon to properly unfold or he or she does not have the proper tools to observe some phenomenon; mistakes happen and scientists who acknowledge these mistakes immediately are not usually condemned. Mistakes caused by carelessness or deliberately falsifying data, however, are criticized very harshly in the scientific community and could cost a scientist his or her reputation.