ATTACHMENT 4

Texas College and Career Readiness Standards

College and career readiness standards

NEWS Texas Education Agency
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Texas College and Career Readiness Standards more comprehensive than national standards

AUSTIN - Texas' English and mathematics college and career readiness standards meet and, in many cases, exceed national standards, a new analysis released today found.

Teams of higher education and public school educators and content specialists conducted a comparison of the Texas College and Career Readiness Standards, adopted in January 2008, and the national Common Core College Readiness Standards created by the Council of Chief State School Officers (CCSSO) and the National Governors Association (NGA). President Barack Obama has proposed conditioning a state's eligibility for federal education funding on either its adoption of these national standards or certification that a state's standards are college and career ready.

Texas was the first state to adopt college readiness standards, concepts that are to be taught in the public schools that help prepare students for success in the workplace or in college or university courses. The standards were jointly created through a process that included Texas public education, higher education and business community stakeholders.

The comparison of the Texas and national standards, known as a "gap analysis" or crosswalk, found that the Texas standards contained everything that is included in the national standards. But the Texas standards are more comprehensive, covering additional areas of college readiness that are missing from the national standards.

"Today's report confirms that Texas' college readiness standards in English language arts and mathematics are superior to the national standards being created in Washington," said Commissioner of Education Robert Scott. "I am confident that our students are well served by standards created by Texans."

Some examples of material found in the Texas standards but missing from the national standards are:

- Analyze works of literature for what they suggest about the historical period and cultural context in which they were written;
- Use effective reading strategies to determine a written work's purpose and intended audience;
- Identify and analyze the audience, purpose, and message of an informative or persuasive text;
- Geometric reasoning that makes connections between geometry, statistics and probabilities;
- Connecting mathematics to the study of other disciplines by using appropriate mathematical models in the natural, physical and social sciences.

A team of analysts for each subject area compared the Texas standards to the national standards to determine how much they were alike. To ensure an accurate and thorough comparison, another team reversed the process and compared the national standards to the Texas standards. An external evaluator then reviewed the teams' methodology and work product.

The review focused only on English language arts and mathematics standards because those are the only subjects for which national Common Core standards have been prepared. Texas also has college and career readiness standards in social studies and science.

The findings from the gap analysis are available at: http://www.tea.state.tx.us/index2.aspx?id=8019.

The two documents that the teams based their findings on are available at: www.thecb.state.tx.us/collegereadiness/TCRS.cfm and http://www.corestandards.org/ .

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Texas College and Career Readiness Standards and Common Core College and Career Readiness Standards Crosswalk / Review Analysis

Teams of higher education and public school educators and content specialists conducted a comparison of the Texas College and Career Readiness Standards, adopted in January 2008, and the Common Core College and Career Readiness Standards created by the Council of State School Officers (CSSO) and the National Governor's Association (NGA).

Texas Education Agency College and Career Readiness Standards Press Release

Phase I - Using the Texas College and Career Readiness Standards as the benchmark

Phase I - ELA Narrative

Phase I - ELA Gap Analysis

Phase I - Mathematics Narrative

Phase I - Mathematics Gap Analysis

Phase II - Using the Common Core College and Career Readiness Standards as the benchmark

Phase II - ELA Narrative

Phase II - ELA Gap Analysis

Phase II - Mathematics Narrative

Phase II - Mathematics Gap Analysis

Phase II - Media Application of the Core

Texas College and Career Readiness Standards / Common Core College and Career Readiness Standards Crosswalks Validation Statement

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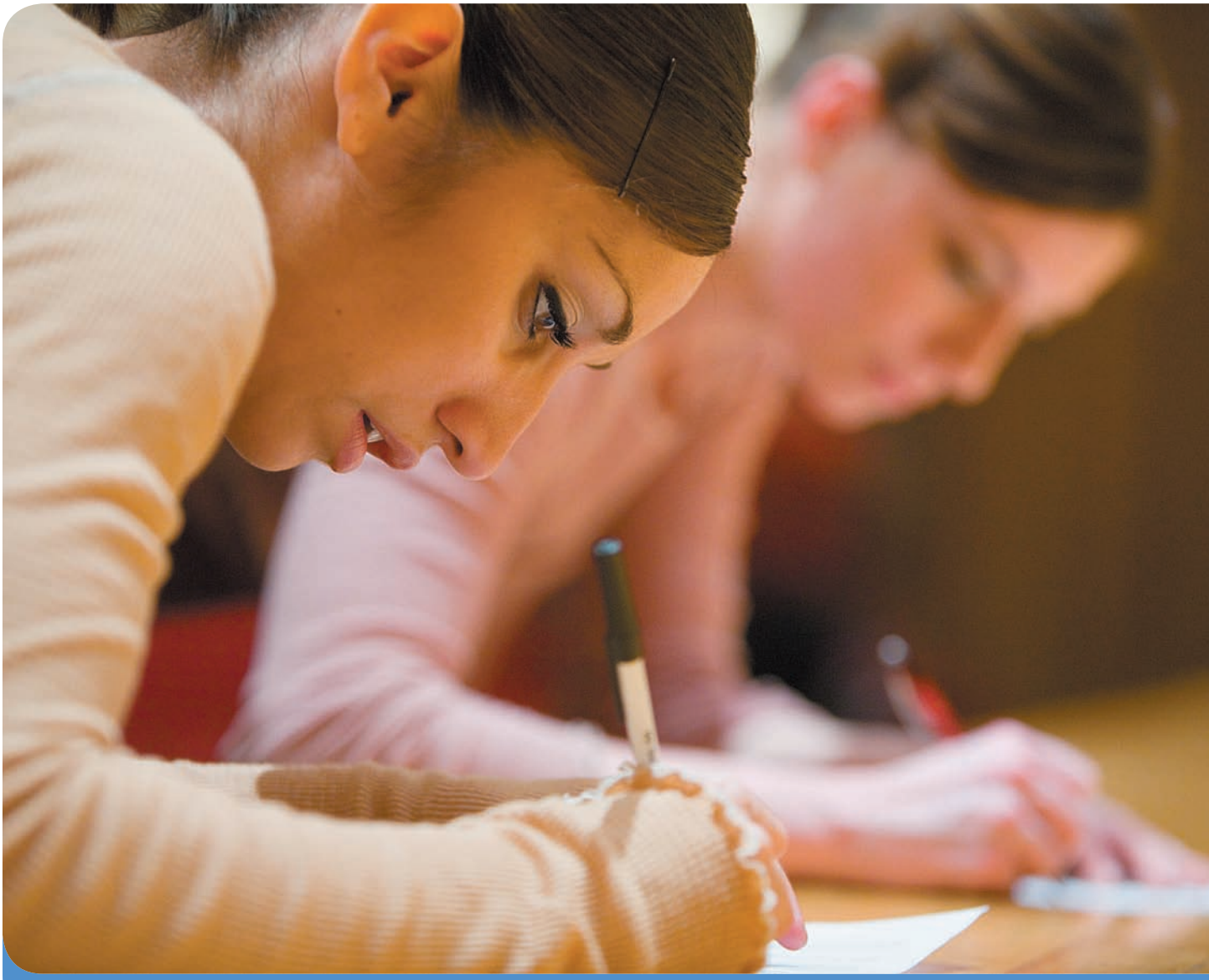
Texas College and Career Readiness Standards



Texas College and Career Readiness Standards

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Introduction

Over the past decade, Texas has focused on ensuring that its students are prepared for a changing and increasingly complex future. In elementary and middle schools, test results have improved, especially among students of color, and more students of all backgrounds are entering and completing postsecondary education programs. However, despite these substantial gains, Texas trails other states in preparing and sending students to postsecondary education. It is also clear that K-12 students, along with their parents, are uncertain about what students must know and what intellectual skills they must possess to be successful beyond high school.

Recognizing the importance of a world class education, the 79th Texas Legislature, Third Called Special Session, passed House Bill 1, the "Advancement of College Readiness in Curriculum." Section 28.008 of the Texas Education Code, seeks to increase the number of students who are college and career ready when they graduate high school. The legislation required the Texas Education Agency (TEA) and the Texas Higher Education Coordinating Board (THECB) to establish Vertical Teams (VTs) to develop College and Career Readiness Standards (CCRS) in the areas of English/language arts, mathematics, science, and social studies. These standards specify what students must know and be able to do to succeed in entry-level courses at postsecondary institutions in Texas.

Vertical Teams were composed of secondary and postsecondary faculty. In 2007, the VTs met in February, March, June, and August and developed draft standards to present to the THECB. At its October 2007 meeting, Board members approved posting of the draft standards for public comment. Over 1500 comments were received and were reviewed by the VTs as they prepared their final drafts. The final drafts were submitted to the Commissioner of Higher Education who presented them to the THECB for adoption at its January 2008 meeting. The CCRS were approved unanimously and sent to the Commissioner of Education and the State Board of Education for incorporation into the Texas Essential Knowledge and Skills (TEKS).

The Nature of College and Career Readiness Standards

In developing the CCRS, the VTs set out to specify the knowledge and skills necessary to succeed in entry-level community college and university courses. The CCRS serve a different purpose than high school graduation standards, which typically emphasize mastery of basic skills and knowledge, and not necessarily college and career readiness. High school courses are designed to provide a broad set of core knowledge and skills and a foundation in literacy and basic mathematics. College courses typically require students to use content knowledge to weigh and analyze important issues and questions in a field of study. Even a high-quality college-preparatory curriculum is unlikely to prepare students to pursue a specific major in college. It can, however, help students develop a foundation of skills that they can employ to successfully pursue a variety of college majors. Therefore, the CCRS distinguish themselves from high school standards by emphasizing content knowledge as a means to an end: the content stimulates students to engage in deeper levels of thinking.

The CCRS are designed to represent a full range of knowledge and skills that students need to succeed in entry-level college courses, as well as in a wide range of majors and careers. According to research, over 80 percent of 21st century jobs require some postsecondary education. By implementing these standards, secondary school and postsecondary faculty in all academic disciplines will advance the mission of Texas: college and career ready students.

Organization of the College and Career Readiness Standards Framework

The CCRS consist of a multi-level framework that focuses not only on subject matter, but also on the way it is organized and presented in the classroom. This is crucial because at the postsecondary level, students need to understand the structure of the discipline and how knowledge expands from initial study of a topic. This pedagogical understanding sets a threshold for the kinds of deeper investigation and learning that occur as students pursue in-depth courses in their chosen majors.

Without an adequate understanding of the structure of their discipline, students will have difficulty succeeding in or will get less out of the upper-division courses that they will eventually take. The CCRS, therefore, introduce these disciplinary structures at the entry-level in order to familiarize students with key concepts and content in each of the four subject areas previously specified and in a set of cross-disciplinary standards.

Roman numerals mark the key content within each subject area. Capital letters specify the organizing components for introducing key knowledge and skills. Numbered headings delineate specific performance expectations regarding expected knowledge and skills and also suggest the challenge level of the standard. Lower-case letters present indicators of ways in which students would demonstrate performance in each area. These performance indicators, which are included as part of the appendix, serve as examples only and have not been adopted as policy by the THECB.

The CCRS should not be construed as a checklist. Generally, however, the more standards a student can demonstrate successfully, the more likely it is that he or she will be college and career ready. More importantly, that student will be prepared to succeed in most subject areas offered in college. Therefore, rather than superficially glossing over each standard, students will benefit from mastering them. The reader should keep an important distinction in mind when reviewing the CCRS: they avoid restating in detail all the prerequisite knowledge and skills that students must master to be college and career ready. The CCRS focus on "keystone" knowledge and skills. They depend on students achieving facility and fluency in foundation knowledge in the disciplines. They assume that students have achieved mastery of the knowledge and skills delineated in the TEKS. Establishing a clear connection between the TEKS and the CCRS is a crucial component of system alignment that will result in more students being ready for college.

The final section of the CCRS contains cross-disciplinary, foundational cognitive skills that may be as important as any particular content knowledge. Some of these skills, such as problem solving, are also contained within specific subject areas, but they are given additional emphasis by their inclusion in the separate cross-disciplinary standards section. Research on entry-level college courses conducted with thousands of college instructors has confirmed both the importance of these skills in entry-level courses as well as the significant shortcomings entering students demonstrate in these areas.

"Generally, the more standards a student can demonstrate successfully, the more likely it is that he or she will be college and career ready."

One additional point should be made. In delineating the knowledge and skills necessary for college and career readiness, the CCRS do not specify the performance levels necessary to demonstrate competence. Without examples of course syllabi, assignments, and student work to illustrate when or how a standard is met, some standards could conceivably be interpreted to be at a level that would challenge graduate students. Obviously, this is not the intent of the CCRS. The expectations inherent in each standard are keyed to what high school students can be expected to accomplish by the time they complete high school. Examples of course material that illustrate the necessary performance level for each standard will be made available as the CCRS are implemented.

In developing these standards, members of the VTs and staff at the TEA and the THECB were fully aware that not all high school graduates plan to go to college. However, a survey of the research on readiness for entry into the skilled workforce makes it clear that employers want their employees to be able

to read and communicate well, to perform relatively complex mathematical calculations accurately, to possess a strong knowledge of basic science, to have a fundamental knowledge of American culture and the world beyond, and to be able to think critically and adjust to rapidly changing work environments. Because these college and career readiness standards focus precisely on a strong foundation of knowledge and intellectual skills, including intellectual nimbleness and adaptability, they will serve equally well those students heading to college and to the workforce.

Organization of the College and Career Readiness Standards

The goal of the Texas CCRS is to establish what students must know and be able to do to succeed in entry-level courses offered at institutions of higher education. These CCRS are organized into four levels of specificity. The levels are defined and will appear as follows:

I. Key Content

A. Organizing Components

1. Performance Expectations

a. Examples of Performance Indicators

I. Key Content:
Keystone ideas of a discipline that reverberate as themes throughout the curriculum. (Designated by Roman numerals.)

A. Organizing Components:
Knowledge and subject areas that organize a discipline around what students should retain, be able to transfer, and apply to new knowledge and skills. (Designated by capital letters.)

1. Performance Expectations:
Knowledge and skills that represent important ideas of the current understanding of each organizing concept as well as the multiple contexts in which each organizing concept can be manifest. (Designated by numbers.)

EXAMPLE

a. Examples of Performance Indicators: Examples of how to assess and measure performance expectations. This list of indicators is not meant to be either EXHAUSTIVE or PRESCRIPTIVE. The operating premise is that the more of these or other similar indicators a student is successfully able to demonstrate, the greater the probability that the student will be prepared to succeed in college. (Designated by lowercase letters and shading in the appendix of this document.)

English/Language Arts Standards

ENGLISH/LANGUAGE ARTS STANDARDS

English as a Way of Knowing

Listening, speaking, writing, and reading are vehicles for communication. They enable people to express their thoughts and demonstrate what they have learned. In the past, students were taught specific lessons under the rubric of language, and the skills were practiced, reinforced, and analyzed throughout the day in subjects such as geography, history, and science. Today the teaching of language arts is often considered the exclusive responsibility of English teachers. However, the complex role of language in education makes it clear that the language arts cannot be left entirely to the English class. Improvement in the language arts requires students to read and write frequently in all disciplines and to receive ample feedback. Following these standards, the language arts should be viewed as being fundamental to pedagogy in any subject.

English teachers have the expertise to ask, explore, and help students answer fundamental questions about language, among them:

- How does one convey a message in writing?
- What genres are most suitable in a given context, and what are the textual features of those genres?
- What is Standard American English?
- How might one become a more skillful reader who can understand both the text's surface and deeper meanings?
- What shared and unique features characterize specific literary genres?
- What are significant texts in American, British, and world literature, and what might they reveal about their cultural and historical contexts?
- What are the characteristics of effective listening and speaking, and how might one acquire and improve them?

English is mastered in the context of challenging content that requires students to think deeply and to exercise discipline in order to demonstrate understanding, raise questions, and present ideas.

Understanding and Using These Standards

Vertical Team (VT) members reviewed research on the skills and content knowledge students need to succeed in college; they also examined exemplary College and Career Readiness Standards (CCRS) and state and national standards in English. As members of the Commission for a College and Career Ready Texas (CCRT), the VT co-chairs studied reports and heard expert testimony. The VT's first draft was posted for public comment in October 2007 by the Texas Higher Education Coordinating Board (THECB). Concurrently, the VTs revised the standards in response to feedback from the CCRT, and this second draft was incorporated into the Report of the CCRT. The standards adopted by the THECB incorporate revisions based on the feedback to both public documents.

These standards are designed to be straightforward and easy to read. The VT members sought to avoid redundancy, wordiness, or specialized terminology. The danger with this approach is that even though each statement may be simple, the underlying meaning may not. The mastery level necessary on any particular standard depends on the specific task faced by the student. In other words, the standards can be fully understood only in the context of the learning materials or assignments with which the student is presented.

In this document, the rules of Standard American English are embedded into the writing process because a student must use language correctly in order to be college and career ready. For example, it would be highly unusual for a student to be given a multiple-choice test on parts of speech in a first-year English class in college. These rules are also contained in the cross-disciplinary standards to indicate the need for students to be able to use grammar and punctuation correctly in all subject areas. Another reason that mechanics and usage are not separated from the writing process is that the context of communication—what educators and scholars call the rhetorical situation—determines what is appropriate and what is effective. Because language is employed in a wide range of situations, skillful users of language must know how to

interpret and express themselves in a variety of forms and formats. Therefore, the standards address the full range of American English, allowing for the possibility that language can be used appropriately in many different formats and that students must have mastery of the rules associated with those formats and know when and how to apply those rules.

Because the language arts are present throughout the core curriculum, standards for the language arts appear in two places in this document—as elements of the cross-disciplinary standards fundamental to all subjects and as a stand-alone subject.

I. Writing

A. Compose a variety of texts that demonstrate clear focus, the logical development of ideas in well-organized paragraphs, and the use of appropriate language that advances the author's purpose.

1. Determine effective approaches, forms, and rhetorical techniques that demonstrate understanding of the writer's purpose and audience.

2. Generate ideas and gather information relevant to the topic and purpose, keeping careful records of outside sources.
3. Evaluate relevance, quality, sufficiency, and depth of preliminary ideas and information, organize material generated, and formulate a thesis.
4. Recognize the importance of revision as the key to effective writing. Each draft should refine key ideas and organize them more logically and fluidly, use language more precisely and effectively, and draw the reader to the author's purpose.
5. Edit writing for proper voice, tense, and syntax, assuring that it conforms to standard English, when appropriate.

II. Reading

A. Locate explicit textual information, draw complex inferences, and analyze and evaluate the information within and across texts of varying lengths.

1. Use effective reading strategies to determine a written work's purpose and intended audience.
2. Use text features and graphics to form an overview of informational texts and to determine where to locate information.
3. Identify explicit and implicit textual information including main ideas and author's purpose.
4. Draw and support complex inferences from text to summarize, draw conclusions, and distinguish facts from simple assertions and opinions.
5. Analyze the presentation of information and the strength and quality of evidence used by the author, and judge the coherence and logic of the presentation and the credibility of an argument.
6. Analyze imagery in literary texts.
7. Evaluate the use of both literal and figurative language to inform and shape the perceptions of readers.
8. Compare and analyze how generic features are used across texts.

9. Identify and analyze the audience, purpose, and message of an informational or persuasive text.
10. Identify and analyze how an author's use of language appeals to the senses, creates imagery, and suggests mood.
11. Identify, analyze, and evaluate similarities and differences in how multiple texts present information, argue a position, or relate a theme.

B. Understand new vocabulary and concepts and use them accurately in reading, speaking, and writing.

1. Identify new words and concepts acquired through study of their relationships to other words and concepts.
2. Apply knowledge of roots and affixes to infer the meanings of new words.
3. Use reference guides to confirm the meanings of new words or concepts.

C. Describe, analyze, and evaluate information within and across literary and other texts from a variety of cultures and historical periods.

1. Read a wide variety of texts from American, European, and world literatures.
2. Analyze themes, structures, and elements of myths, traditional narratives, and classical and contemporary literature.
3. Analyze works of literature for what they suggest about the historical period and cultural contexts in which they were written.
4. Analyze and compare the use of language in literary works from a variety of world cultures.

D. Explain how literary and other texts evoke personal experience and reveal character in particular historical circumstances.

1. Describe insights gained about oneself, others, or the world from reading specific texts.
2. Analyze the influence of myths, folktales, fables, and classical literature from a variety of world cultures on later literature and film.

III. Speaking

A. Understand the elements of communication both in informal group discussions and formal presentations (e.g., accuracy, relevance, rhetorical features, organization of information).

1. Understand how style and content of spoken language varies in different contexts and influences the listener's understanding.
2. Adjust presentation (delivery, vocabulary, length) to particular audiences and purposes.

B. Develop effective speaking styles for both group and one-on-one situations.

1. Participate actively and effectively in one-on-one oral communication situations.
2. Participate actively and effectively in group discussions.
3. Plan and deliver focused and coherent presentations that convey clear and distinct perspectives and demonstrate solid reasoning.

IV. Listening

A. Apply listening skills as an individual and as a member of a group in a variety of settings (e.g., lectures, discussions, conversations, team projects, presentations, interviews).

1. Analyze and evaluate the effectiveness of a public presentation.
2. Interpret a speaker's message; identify the position taken and the evidence in support of that position.
3. Use a variety of strategies to enhance listening comprehension (e.g., focus attention on message, monitor message for clarity and understanding, provide verbal and nonverbal feedback, note cues such as change of pace or particular words that indicate a new point is about to be made, select and organize key information).

B. Listen effectively in informal and formal situations.

1. Listen critically and respond appropriately to presentations.
2. Listen actively and effectively in one-on-one communication situations.
3. Listen actively and effectively in group discussions.

V. Research

A. Formulate topic and questions.

1. Formulate research questions.
2. Explore a research topic.
3. Refine research topic and devise a timeline for completing work.

B. Select information from a variety of sources.

1. Gather relevant sources.
2. Evaluate the validity and reliability of sources.
3. Synthesize and organize information effectively.

C. Produce and design a document.

1. Design and present an effective product.
2. Use source material ethically.

Mathematics Standards

MATHEMATICS STANDARDS

Mathematics as a Way of Knowing

Mathematics knowledge is essential to becoming a productive citizen in today's society. Many factors have increased the level of understanding of mathematics needed by the average adult. Our ever-changing world has become increasingly quantitative in nature. For example, in the physical sciences, social studies, and the business world, a widening array of phenomena is explained with numeric data presented visually in the form of charts and graphs that require interpretation. Mathematical reasoning is key to solving problems, formulating logical arguments, understanding quantitative features of various disciplines, critically analyzing media sources, and searching for patterns. Through mathematics, people become more able to make well-informed decisions by formulating conjectures and testing hypotheses. Mathematics cannot be viewed solely as a series of stand-alone courses or a set of specific skills. It must also be considered as a source of cross-disciplinary knowledge that is essential for success in numerous areas of study.

Understanding and Using These Standards

The College and Career Readiness Standards (CCRS) were developed as a result of a collaborative effort between secondary and postsecondary faculty. The standards are not intended to prescribe specific high school mathematics course titles or to endorse particular sequences. Students may encounter some of the content included in these standards at lower levels and should aim to meet these standards in high school.

These CCRS are designed to help students, parents, teachers, and counselors understand the specific content knowledge and academic skills necessary for college and career readiness. This knowledge enables all stakeholders to determine if the challenge level of any given mathematics course is appropriate to prepare students for college and careers. The CCRS are broad in nature, equipping students for general education college mathematics courses, but are not intended to encompass all skills necessary for students entering majors that require specific mathematical knowledge.

"Students who enter college having mastered these standards are likely to be successful in entry-level college mathematics courses and to be prepared for courses in related disciplines that require mathematical proficiency."

Students who enter college having mastered these standards are likely to be successful in entry-level college mathematics courses and to be prepared for courses in related disciplines that require mathematical proficiency. For science, technology, engineering, and mathematics majors in particular, additional mathematical knowledge and skills will be necessary, although adequate foundation for these future studies would be established.

Some standards identify specific mathematical skills and knowledge. Some are specific to subject area topics, while others address global topics. All are viewed as equally important to achieving the level of mathematical proficiency necessary for college and career readiness. In addition, students must develop ways of thinking about mathematics. These key cognitive skills elevate mathematics from an exercise in rote memorization to a process of analysis and interpretation that enables the learner to work with a range of complex questions, topics, and issues. The standards contain frequent reference to these key cognitive skills, but always in the context of challenging and appropriate content knowledge. Mathematical thinking never occurs in a vacuum; it is always embedded in appropriate content.

The use of technology is an instructional decision that facilitates the learning of mathematical concepts and processes. The Vertical Team decided to allow instructors to determine when and how to use technology based on their students' needs, the instructional resources, and the learning expectation. The growing technological world we live in requires students to embrace technology and the constant changes it brings to daily life.

I. Numeric Reasoning

A. Number representation

1. Compare real numbers.
2. Define and give examples of complex numbers.

B. Number operations

1. Perform computations with real and complex numbers.

C. Number sense and number concepts

1. Use estimation to check for errors and reasonableness of solutions.

II. Algebraic Reasoning

A. Expressions and equations

1. Explain and differentiate between expressions and equations using words such as "solve," "evaluate," and "simplify."

B. Manipulating expressions

1. Recognize and use algebraic (field) properties, concepts, procedures, and algorithms to combine, transform, and evaluate expressions (e.g., polynomials, radicals, rational expressions).

C. Solving equations, inequalities, and systems of equations

1. Recognize and use algebraic (field) properties, concepts, procedures, and algorithms to solve equations, inequalities, and systems of linear equations.
2. Explain the difference between the solution set of an equation and the solution set of an inequality.

D. Representations

1. Interpret multiple representations of equations and relationships.
2. Translate among multiple representations of equations and relationships.

III. Geometric Reasoning

A. Figures and their properties

1. Identify and represent the features of plane and space figures.
2. Make, test, and use conjectures about one-, two-, and three-dimensional figures and their properties.
3. Recognize and apply right triangle relationships including basic trigonometry.

B. Transformations and symmetry

1. Identify and apply transformations to figures.
2. Identify the symmetries of a plane figure.
3. Use congruence transformations and dilations to investigate congruence, similarity, and symmetries of plane figures.

C. Connections between geometry and other mathematical content strands

1. Make connections between geometry and algebra.
2. Make connections between geometry, statistics, and probability.
3. Make connections between geometry and measurement.

D. Logic and reasoning in geometry

1. Make and validate geometric conjectures.
2. Understand that Euclidean geometry is an axiomatic system.

IV. Measurement Reasoning

A. Measurement involving physical and natural attributes

1. Select or use the appropriate type of unit for the attribute being measured.

B. Systems of measurement

1. Convert from one measurement system to another.
2. Convert within a single measurement system.

C. Measurement involving geometry and algebra

1. Find the perimeter and area of two-dimensional figures.
2. Determine the surface area and volume of three-dimensional figures.
3. Determine indirect measurements of figures using scale drawings, similar figures, the Pythagorean Theorem, and basic trigonometry.

D. Measurement involving statistics and probability

1. Compute and use measures of center and spread to describe data.
2. Apply probabilistic measures to practical situations to make an informed decision.

V. Probabilistic Reasoning

A. Counting principles

1. Determine the nature and the number of elements in a finite sample space.

B. Computation and interpretation of probabilities

1. Compute and interpret the probability of an event and its complement.
2. Compute and interpret the probability of conditional and compound events.

VI. Statistical Reasoning

A. Data collection

1. Plan a study.

B. Describe data

1. Determine types of data.
2. Select and apply appropriate visual representations of data.
3. Compute and describe summary statistics of data.
4. Describe patterns and departure from patterns in a set of data.

C. Read, analyze, interpret, and draw conclusions from data

1. Make predictions and draw inferences using summary statistics.
2. Analyze data sets using graphs and summary statistics.
3. Analyze relationships between paired data using spreadsheets, graphing calculators, or statistical software.
4. Recognize reliability of statistical results.

VII. Functions

A. Recognition and representation of functions

1. Recognize whether a relation is a function.
2. Recognize and distinguish between different types of functions.

B. Analysis of functions

1. Understand and analyze features of a function.
2. Algebraically construct and analyze new functions.

C. Model real world situations with functions

1. Apply known function models.
2. Develop a function to model a situation.

VIII. Problem Solving and Reasoning

A. Mathematical problem solving

1. Analyze given information.
2. Formulate a plan or strategy.
3. Determine a solution.
4. Justify the solution.
5. Evaluate the problem-solving process.

B. Logical reasoning

1. Develop and evaluate convincing arguments.
2. Use various types of reasoning.

C. Real world problem solving

1. Formulate a solution to a real world situation based on the solution to a mathematical problem.
2. Use a function to model a real world situation.
3. Evaluate the problem-solving process.

IX. Communication and Representation

A. Language, terms, and symbols of mathematics

1. Use mathematical symbols, terminology, and notation to represent given and unknown information in a problem.
2. Use mathematical language to represent and communicate the mathematical concepts in a problem.
3. Use mathematics as a language for reasoning, problem solving, making connections, and generalizing.

B. Interpretation of mathematical work

1. Model and interpret mathematical ideas and concepts using multiple representations.
2. Summarize and interpret mathematical information provided orally, visually, or in written form within the given context.

C. Presentation and representation of mathematical work

1. Communicate mathematical ideas, reasoning, and their implications using symbols, diagrams, graphs, and words.
2. Create and use representations to organize, record, and communicate mathematical ideas.
3. Explain, display, or justify mathematical ideas and arguments using precise mathematical language in written or oral communications.

X. Connections

A. Connections among the strands of mathematics

1. Connect and use multiple strands of mathematics in situations and problems.
2. Connect mathematics to the study of other disciplines.

B. Connections of mathematics to nature, real world situations, and everyday life

1. Use multiple representations to demonstrate links between mathematical and real world situations.
2. Understand and use appropriate mathematical models in the natural, physical, and social sciences.
3. Know and understand the use of mathematics in a variety of careers and professions.

Science Standards

Science as a Way of Knowing

As with mathematics, proficiency in science needs to improve before and during the secondary school years in order to meet the test of college and career readiness. The process of science rests on information and descriptions about the natural world, collected by observation. When an observation has been made repeatedly and independently by several observers under controlled and reproducible conditions, the findings are regarded with increasing confidence. Findings that are repeatedly confirmed across a range of situations yield insights that can lead to explanatory models, also called theories. Throughout this process, certain analytical procedures and practices are used in all scientific disciplines. These include specific mathematical procedures and techniques, standardized measurement methods, and several applications of formal logic.

These logical procedures are extremely important components of scientific methods but are not usually spontaneous, intuitive modes of thought. Scientific methods emphasize the practice of testing hypotheses (i.e., theories, explanatory models) by comparing their predictions to observations of the natural world. To judge the quality of a hypothesis, scientists ask whether it leads to accurate predictions about future events or observations. This pattern of logical thought and this particular method of analyzing and improving our understanding of the natural world is a fundamental element of all studies of science.

The field of science is typically divided into disciplines such as biology, chemistry, physics, environmental science, and Earth science. Although each discipline focuses on different features of the natural world, all areas of science share a common set of principles and procedures for collecting, analyzing, evaluating, and synthesizing information.

Science is distinguished from other fields of study by the way students learn skills for appropriately applying a variety of apparatuses, equipment, techniques, and procedures for collecting, interpreting, and using data. While engaged in scientific inquiry, students utilize other foundational skills such as mathematics, communication, and social ethics, as well as personal skills such as time management, self-discipline, and organization.

"The standards are focused on ensuring that students are ready to explore and appreciate the richness and complexity of the natural world..."

Understanding and Using These Standards

The science Vertical Team (VT) consulted a range of resource materials that contained standards for science developed by national subject matter organizations, and considered carefully other the college readiness standards in science that have been previously developed. In addition, the process drew from various VT member experiences and backgrounds in order to respond to the needs and situations of Texas schools.

The standards are focused on ensuring that students are ready to explore and appreciate the richness and complexity of the natural world, to grapple with new ideas and divergent interpretations, and to master the powerful techniques of collecting, organizing, and analyzing information that scientists use in their investigations. The standards go beyond the three "traditional" high school science courses of biology, chemistry, and physics. They are less

concerned with course titles and more focused on ensuring that students are ready to explore and appreciate the richness and complexity of the natural world.

Although the standards are quite extensive and specific in their identification of important prerequisite knowledge, they emphasize in equal measure the importance of the key cognitive skills necessary to succeed in the kinds of tasks that students will almost certainly encounter in entry-level college science courses.

Student success in college-level introductory science courses depends on the development of certain skills in high school classes. Although applications of these skills vary from one discipline and one grade level to the next, all high school science courses should encourage students to master in an age-appropriate manner the concepts and vocabulary outlined in the standards, and to do so while acquiring and developing the key cognitive skills necessary to think like a scientist.

Within the context of these standards, scientific vocabulary should be viewed as a tool, not as an end in itself. Technical words and phrases allow concise and precise communication. Accurate use of technical language is critical for interaction among those who are actively engaged in science. But to focus on vocabulary alone is not sufficient. Students should be encouraged to maintain a judicious balance between learning vocabulary and applying that vocabulary as they formulate good questions, plan investigations, gather and evaluate data, and draw conclusions.

I. Nature of Science: Scientific Ways of Learning and Thinking

A. Cognitive skills in science

1. Utilize skepticism, logic, and professional ethics in science.
2. Use creativity and insight to recognize and describe patterns in natural phenomena.
3. Formulate appropriate questions to test understanding of natural phenomena.
4. Rely on reproducible observations of empirical evidence when constructing, analyzing, and evaluating explanations of natural events and processes.

B. Scientific inquiry

1. Design and conduct scientific investigations in which hypotheses are formulated and tested.

C. Collaborative and safe working practices

1. Collaborate on joint projects.
2. Understand and apply safe procedures in the laboratory and field, including chemical, electrical, and fire safety and safe handling of live or preserved organisms.
3. Demonstrate skill in the safe use of a wide variety of apparatuses, equipment, techniques, and procedures.

D. Current scientific technology

1. Demonstrate literacy in computer use.
2. Use computer models, applications, and simulations.
3. Demonstrate appropriate use of a wide variety of apparatuses, equipment, techniques, and procedures for collecting quantitative and qualitative data.

E. Effective communication of scientific information

1. Use several modes of expression to describe or characterize natural patterns and phenomena. These modes of expression include narrative, numerical, graphical, pictorial, symbolic, and kinesthetic.
2. Use essential vocabulary of the discipline being studied.

II. Foundation Skills: Scientific Applications of Mathematics

A. Basic mathematics conventions

1. Understand the real number system and its properties.
2. Use exponents and scientific notation.
3. Understand ratios, proportions, percentages, and decimal fractions, and translate from any form to any other.
4. Use proportional reasoning to solve problems.
5. Simplify algebraic expressions.
6. Estimate results to evaluate whether a calculated result is reasonable.
7. Use calculators, spreadsheets, computers, etc., in data analysis.

B. Mathematics as a symbolic language

1. Carry out formal operations using standard algebraic symbols and formulae.
2. Represent natural events, processes, and relationships with algebraic expressions and algorithms.

C. Understand relationships among geometry, algebra, and trigonometry

1. Understand simple vectors, vector notations, and vector diagrams, and carry out simple calculations involving vectors.
2. Understand that a curve drawn on a defined set of axes is fully equivalent to a set of algebraic equations.
3. Understand basic trigonometric principles, including definitions of terms such as sine, cosine, tangent, cotangent, and their relationship to triangles.
4. Understand basic geometric principles.

D. Scientific problem solving

1. Use dimensional analysis in problem solving.

E. Scientific application of probability and statistics

1. Understand descriptive statistics.

F. Scientific measurement

1. Select and use appropriate Standard International (SI) units and prefixes to express measurements for real world problems.
2. Use appropriate significant digits.
3. Understand and use logarithmic notation (base 10).

III. Foundation Skills: Scientific Applications of Communication

A. Scientific writing

1. Use correct applications of writing practices in scientific communication.

B. Scientific reading

1. Read technical and scientific articles to gain understanding of interpretations, apparatuses, techniques or procedures, and data.
2. Set up apparatuses, carry out procedures, and collect specified data from a given set of appropriate instructions.
3. Recognize scientific and technical vocabulary in the field of study and use this vocabulary to enhance clarity of communication.
4. List, use, and give examples of specific strategies before, during, and after reading to improve comprehension.

C. Presentation of scientific/technical information

1. Prepare and present scientific/technical information in appropriate formats for various audiences.

D. Research skills/information literacy

1. Use search engines, databases, and other digital electronic tools effectively to locate information.
2. Evaluate quality, accuracy, completeness, reliability, and currency of information from any source.

IV. Science, Technology, and Society

A. Interactions between innovations and science

1. Recognize how scientific discoveries are connected to technological innovations.

B. Social ethics

1. Understand how scientific research and technology have an impact on ethical and legal practices.
2. Understand how commonly held ethical beliefs impact scientific research.

C. History of science

1. Understand the historical development of major theories in science.
2. Recognize the role of people in important contributions to scientific knowledge.

V. Cross-Disciplinary Themes

A. Matter/states of matter

1. Know modern theories of atomic structure.
2. Understand the typical states of matter (solid, liquid, gas) and phase changes among these.

B. Energy (thermodynamics, kinetic, potential, energy transfers)

1. Understand the Laws of Thermodynamics.
2. Know the processes of energy transfer.

C. Change over time/equilibrium

1. Recognize patterns of change.

D. Classification

1. Understand that scientists categorize things according to similarities and differences.

E. Measurements and models

1. Use models to make predictions.
2. Use scale to relate models and structures.
3. Demonstrate familiarity with length scales from sub-atomic particles through macroscopic objects.

VI. Biology

A. Structure and function of cells

1. Know that although all cells share basic features, cells differentiate to carry out specialized functions.
2. Explain how cells can be categorized into two major types: prokaryotic and eukaryotic, and describe major features that distinguish one from the other.
3. Describe the structure and function of major sub-cellular organelles.
4. Describe the major features of mitosis and relate this process to growth and asexual reproduction.
5. Understand the process of cytokinesis in plant and animal cells and how this process is related to growth.
6. Know the structure of membranes and how this relates to permeability.

B. Biochemistry

1. Understand the major categories of biological molecules: lipids, carbohydrates, proteins, and nucleic acids.
2. Describe the structure and function of enzymes.
3. Describe the major features and chemical events of photosynthesis.
4. Describe the major features and chemical events of cellular respiration.
5. Know how organisms respond to presence or absence of oxygen, including mechanisms of fermentation.

6. Understand coupled reaction processes and describe the role of ATP in energy coupling and transfer.

C. Evolution and populations

1. Know multiple categories of evidence for evolutionary change and how this evidence is used to infer evolutionary relationships among organisms.
2. Recognize variations in population sizes, including extinction, and describe mechanisms and conditions that produce these variations.

D. Molecular genetics and heredity

1. Understand Mendel's laws of inheritance.
2. Know modifications to Mendel's laws.
3. Understand the molecular structures and functions of nucleic acids.
4. Understand simple principles of population genetics and describe characteristics of a Hardy-Weinberg population.
5. Describe the major features of meiosis and relate this process to Mendel's laws of inheritance.

E. Classification and taxonomy

1. Know ways in which living things can be classified based on each organism's internal and external structure, development, and relatedness of DNA sequences.

F. Systems and homeostasis

1. Know that organisms possess various structures and processes (feedback loops) that maintain steady internal conditions.
2. Describe, compare, and contrast structures and processes that allow gas exchange, nutrient uptake and processing, waste excretion, nervous and hormonal regulation, and reproduction in plants, animals, and fungi; give examples of each.

G. Ecology

1. Identify Earth's major biomes, giving their locations, typical climate conditions, and characteristic organisms.
2. Know patterns of energy flow and material cycling in Earth's ecosystems.
3. Understand typical forms of organismal behavior.
4. Know the process of succession.

VII. Chemistry

A. Matter and its properties

1. Know that physical and chemical properties can be used to describe and classify matter.
2. Recognize and classify pure substances (elements, compounds) and mixtures.

B. Atomic structure

1. Summarize the development of atomic theory. Understand that models of the atom are used to help understand the properties of elements and compounds.

C. Periodic table

1. Know the organization of the periodic table.
2. Recognize the trends in physical and chemical properties as one moves across a period or vertically through a group.

D. Chemical bonding

1. Characterize ionic bonds, metallic bonds, and covalent bonds. Describe the properties of metals and ionic and covalent compounds.

E. Chemical reactions

1. Classify chemical reactions by type. Describe the evidence that a chemical reaction has occurred.
2. Describe the properties of acids and bases, and identify the products of a neutralization reaction.
3. Understand oxidation-reduction reactions.
4. Understand chemical equilibrium.
5. Understand energy changes in chemical reactions.
6. Understand chemical kinetics.

F. Chemical nomenclature

1. Know formulas for ionic compounds.
2. Know formulas for molecular compounds.

G. The mole and stoichiometry

1. Understand the mole concept.
2. Understand molar relationships in reactions, stoichiometric calculations, and percent yield.

H. Thermochemistry

1. Understand the Law of Conservation of Energy and processes of heat transfer.
2. Understand energy changes and chemical reactions.

I. Properties and behavior of gases, liquids, and solids

1. Understand the behavior of matter in its various states: solid, liquid, and gas.
2. Understand properties of solutions.
3. Understand principles of ideal gas behavior and kinetic molecular theory.
4. Apply the concept of partial pressures in a mixture of gases.
5. Know properties of liquids and solids.
6. Understand the effect of vapor pressure on changes in state; explain heating curves and phase diagrams.
7. Describe intermolecular forces.

J. Basic structure and function of biological molecules: proteins, carbohydrates, lipids, and nucleic acids

1. Understand the major categories of biological molecules: proteins, carbohydrates, lipids, and nucleic acids.

K. Nuclear chemistry

1. Understand radioactive decay.

VIII. Physics

A. Matter

1. Demonstrate familiarity with length scales from sub-atomic particles through macroscopic objects.
2. Understand states of matter and their characteristics.
3. Understand the concepts of mass and inertia.
4. Understand the concept of density.
5. Understand the concepts of gravitational force and weight.

B. Vectors

1. Understand how vectors are used to represent physical quantities.
2. Demonstrate knowledge of vector mathematics using a graphical representation.
3. Demonstrate knowledge of vector mathematics using a numerical representation.

C. Forces and motion

1. Understand the fundamental concepts of kinematics.
2. Understand forces and Newton's Laws.
3. Understand the concept of momentum.

D. Mechanical energy

1. Understand potential and kinetic energy.
2. Understand conservation of energy.
3. Understand the relationship of work and mechanical energy.

E. Rotating systems

1. Understand rotational kinematics.
2. Understand the concept of torque.
3. Apply the concept of static equilibrium.
4. Understand angular momentum.

F. Fluids

1. Understand pressure in a fluid and its applications.
2. Understand Pascal's Principle.
3. Understand buoyancy.
4. Understand Bernoulli's principle.

G. Oscillations and waves

1. Understand basic oscillatory motion and simple harmonic motion.
2. Understand the difference between transverse and longitudinal waves.
3. Understand wave terminology: wavelength, period, frequency, and amplitude.

4. Understand the properties and behavior of sound waves.

H. Thermodynamics

1. Understand the gain and loss of heat energy in matter.
2. Understand the basic laws of thermodynamics.

I. Electromagnetism

1. Discuss electric charge and electric force.
2. Gain qualitative and quantitative understandings of voltage, current, and resistance.
3. Understand Ohm's Law.
4. Apply the concept of power to electricity.
5. Discuss basic DC circuits that include voltage sources and combinations of resistors.
6. Discuss basic DC circuits that include voltage sources and combinations of capacitors.
7. Understand magnetic fields and their relationship to electricity.
8. Relate electricity and magnetism to everyday life.

J. Optics

1. Know the electromagnetic spectrum.
2. Understand the wave/particle duality of light.
3. Understand concepts of geometric optics.

IX. Earth and Space Sciences

A. Earth systems

1. Know the major features and characteristics of atmosphere, geosphere, hydrosphere, and biosphere.
2. Understand relationships and interactions among atmosphere, geosphere, hydrosphere, and biosphere.
3. Possess a scientific understanding of the history of Earth's systems.
4. Utilize the tools scientists use to study and understand the Earth's systems.

B. Sun, Earth, and moon system

1. Understand interactions among the sun, Earth, and moon.
2. Possess a scientific understanding of the formation of the Earth and moon.

C. Solar system

1. Describe the structure and motions of the solar system and its components.
2. Possess a scientific understanding of the formation of the solar system.

D. Origin and structure of the universe

1. Understand scientific theories for the formation of the universe.
2. Know the current scientific descriptions of the components of the universe.

E. Plate tectonics

1. Describe the evidence that supports the current theory of plate tectonics.
2. Identify the major tectonic plates.
3. Describe the motions and interactions of tectonic plates.
4. Describe the rock cycle and its products.

F. Energy transfer within and among systems

1. Describe matter and energy transfer in the Earth's systems.
2. Give examples of effects of energy transfer within and among systems.

X. Environmental Science

A. Earth systems

1. Recognize the Earth's systems.
2. Know the major features of the geosphere and the factors that modify them.
3. Know the major features of the atmosphere.
4. Know the major features of the hydrosphere.
5. Be familiar with Earth's major biomes.
6. Describe the Earth's major biogeochemical cycles.

B. Energy

1. Understand energy transformations.

2. Know the various sources of energy for humans and other biological systems.

C. Populations

1. Recognize variations in population sizes, including human population and extinction, and describe mechanisms and conditions that produce these variations.

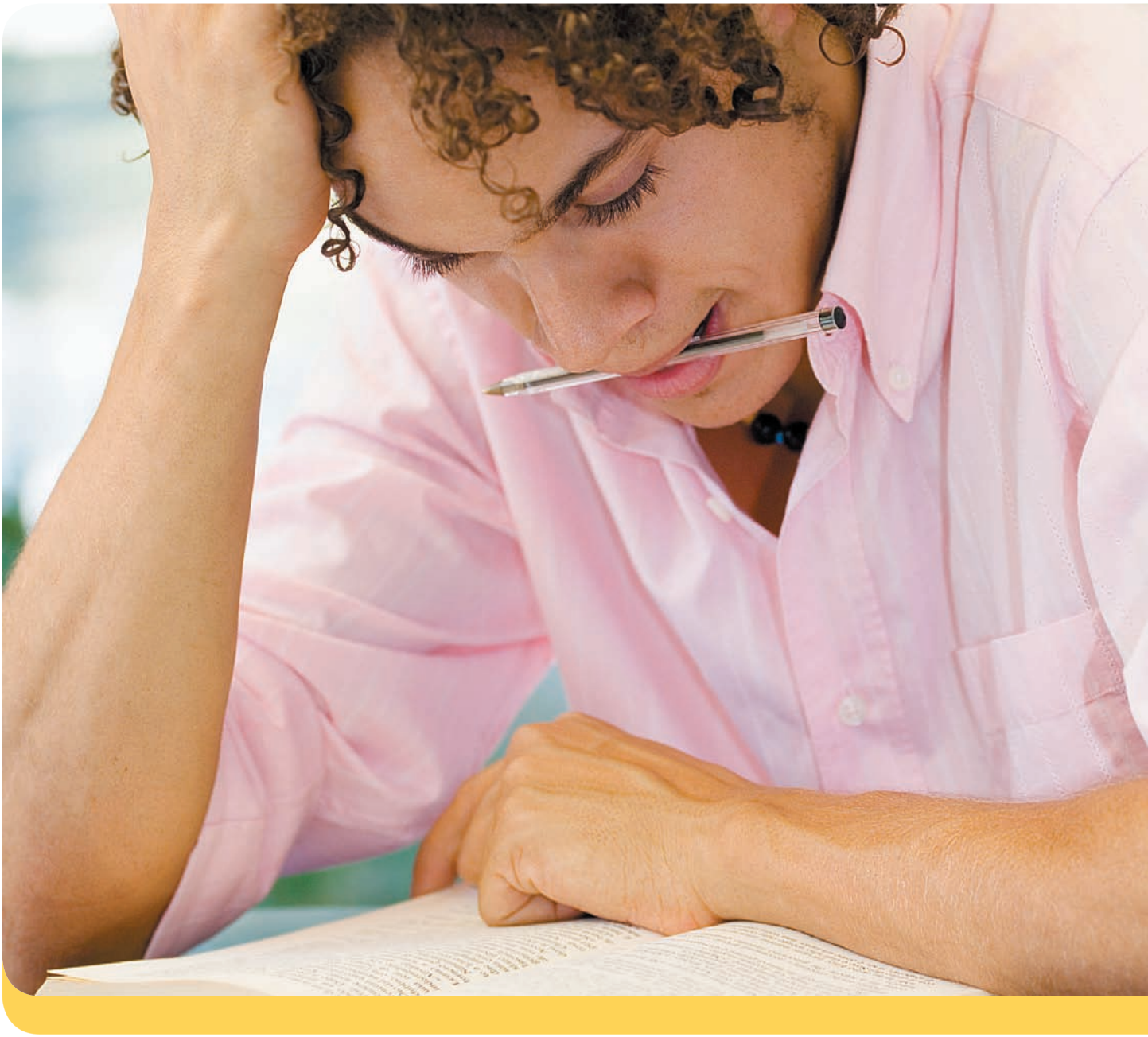
D. Economics and politics

1. Name and describe major environmental policies and legislation.
2. Understand the types, uses, and regulations of the various natural resources.

E. Human practices and their impacts

1. Describe the different uses for land (land management).
2. Understand the use and consequences of pest management.
3. Know the different methods used to increase food production.
4. Understand land and water usage and management practices.
5. Understand how human practices affect air, water, and soil quality.

Social Studies Standards



SOCIAL STUDIES STANDARDS

Social Studies as a Way of Knowing

Social studies encompass a wide variety of disciplines including history, geography, political science, sociology, psychology, anthropology, economics, philosophy, and archeology as well as several fields of specialization within these broad categories. Each discipline focuses on specific aspects of the human experience and employs a variety of methodological approaches to study these phenomena. Within each field, social scientists incorporate research, statistical methods, and conclusions from other disciplines to strengthen their own mode of inquiry. All social scientists employ a variety of key cognitive skills from the sciences, mathematics, and language arts. They use an interdisciplinary approach to understanding human behavior, organizations, institutions, beliefs, and attitudes across time and space.

The goal and the focus of social studies is to promote a deeper and richer understanding of the human experience. Together, social studies disciplines impart particular knowledge and skills that equip students to engage actively, thoughtfully, and responsibly with their local, national, and international communities.

A primary goal of social studies is to promote greater civic awareness and responsibility. Effective citizenship requires knowledge of political and economic structures and institutions, methods of participation, and tools for problem solving. Social studies encourage rational and logic-based analysis of complex social problems using a variety of approaches, while recognizing and appreciating diverse human perspectives. They encourage individuals to understand social and environmental influences on their behavior and to connect their lives and decisions to the world around them, taking into consideration both past and present.

Understanding and Using These Standards

Social studies as taught at the college level require mastery of key cognitive skills that utilize a broad body of factual information and concepts. Simply memorizing facts and data is not sufficient to succeed in a college-level social studies course. These thinking processes are the method by which students develop a greater understanding of the historical, political, economical, geographical, social, and psychological forces that have shaped their lives and the world they live in. Students need to know how to read and examine information critically, to communicate conclusions effectively, and to gather cogent information that will help them understand problems they will encounter in a wide variety of disciplines and careers.

"The ability to be a thoughtful analyst and interpreter of social and human behavior and events is at the heart of what it takes to succeed in college social studies courses."

To succeed at the college level, students in social studies must possess a body of knowledge and skills that enable them to engage actively with complex material. They must understand and be able to apply in a systematic manner the fundamental concepts, approaches, and terminologies common to a range of social studies disciplines including history, geography, political science, economics, and sociology. While it is not necessary for high school students to take courses in all of these subject areas, they do need to understand something about the tools that scholars in these subject areas use to formulate ideas and

investigate major problems in their fields. The ability to be a thoughtful analyst and interpreter of social and human behavior and events is at the heart of what it takes to succeed in college social studies courses. Training to develop these sophisticated skills needs to begin early and be nurtured over many years, and students need to be ready to demonstrate them with some level of fluency in college courses. The standards are designed to provide insight into the knowledge and skills students should be mastering in high school to be better prepared for the challenge of college social studies courses.

The Vertical Teams (VTs) chose deliberately not to identify lists of facts that students must master to be ready for college. Of course, students should master a range of specific information about social systems and phenomena. The VTs created standards that assume students will use their understanding of events, social systems, and human behavior to develop greater insight into how the various parts fit together into a more unified whole and how seemingly contradictory explanations or points-of-view can be analyzed for greater understanding instead of simply taking sides. This perspective is supported by and consistent with the approach taken in many exemplary social studies standards from other states and national organizations that were reviewed in the process of developing these standards.

I. Interrelated Disciplines and Skills

A. Spatial analysis of physical and cultural processes that shape the human experience

1. Use the tools and concepts of geography appropriately and accurately.
2. Analyze the interaction between human communities and the environment.
3. Analyze how physical and cultural processes have shaped human communities over time.
4. Evaluate the causes and effects of human migration patterns over time.
5. Analyze how various cultural regions have changed over time.
6. Analyze the relationship between geography and the development of human communities.

B. Periodization and chronological reasoning

1. Examine how and why historians divide the past into eras.
2. Identify and evaluate sources and patterns of change and continuity across time and place.
3. Analyze causes and effects of major political, economic, and social changes in U.S. and world history.

C. Change and continuity of political ideologies, constitutions, and political behavior

1. Evaluate different governmental systems and functions.
2. Evaluate changes in the functions and structures of government across time.
3. Explain and analyze the importance of civic engagement.

D. Change and continuity of economic systems and processes

1. Identify and evaluate the strengths and weaknesses of different economic systems.
2. Analyze the basic functions and structures of international economics.

E. Change and continuity of social groups, civic organizations, institutions, and their interaction

1. Identify different social groups (e.g., clubs, religious organizations) and examine how they form and how and why they sustain themselves.
2. Define the concept of socialization and analyze the role socialization plays in human development and behavior.
3. Analyze how social institutions (e.g., marriage, family, churches, schools) function and meet the needs of society.
4. Identify and evaluate the sources and consequences of social conflict.

F. Problem-solving and decision-making skills

1. Use a variety of research and analytical tools to explore questions or issues thoroughly and fairly.
2. Analyze ethical issues in historical, cultural, and social contexts.

II. Diverse Human Perspectives and Experiences

A. Multicultural societies

1. Define a "multicultural society" and consider both the positive and negative qualities of multiculturalism.
2. Evaluate the experiences and contributions of diverse groups to multicultural societies.

B. Factors that influence personal and group identities (e.g., race, ethnicity, gender, nationality, institutional affiliations, socioeconomic status)

1. Explain and evaluate the concepts of race, ethnicity, and nationalism.
2. Explain and evaluate the concept of gender.
3. Analyze diverse religious concepts, structures, and institutions around the world.
4. Evaluate how major philosophical and intellectual concepts influence human behavior or identity.
5. Explain the concepts of socioeconomic status and stratification.
6. Analyze how individual and group identities are established and change over time.

III. Interdependence of Global Communities

A. Spatial understanding of global, regional, national, and local communities

1. Distinguish spatial patterns of human communities that exist between or within contemporary political boundaries.
2. Connect regional or local developments to global ones.
3. Analyze how and why diverse communities interact and become dependent on each other.

B. Global analysis

1. Apply social studies methodologies to compare societies and cultures.

IV. Analysis, Synthesis, and Evaluation of Information

A. Critical examination of texts, images, and other sources of information

1. Identify and analyze the main idea(s) and point(s)-of-view in sources.
2. Situate an informational source in its appropriate contexts (contemporary, historical, cultural).
3. Evaluate sources from multiple perspectives.
4. Understand the differences between a primary and secondary source and use each appropriately to conduct research and construct arguments.
5. Read narrative texts critically.
6. Read research data critically.

B. Research and methods

1. Use established research methodologies.
2. Explain how historians and other social scientists develop new and competing views of past phenomena.
3. Gather, organize, and display the results of data and research.
4. Identify and collect sources.

C. Critical listening

1. Understand and interpret presentations (e.g., speeches, lectures, informal presentations) critically.

D. Reaching conclusions

1. Construct a thesis that is supported by evidence.
2. Recognize and evaluate counter-arguments.

V. Effective Communication

A. Clear and coherent oral and writtencommunication

1. Use appropriate oral communication techniques depending on the context or nature of the interaction.
2. Use conventions of standard written English.

B. Academic integrity

1. Attribute ideas and information to source materials and authors.

Cross-Disciplinary Standards

CROSS-DISCIPLINARY STANDARDS

Foundations of Learning and Knowing

Although the College and Career Readiness Standards (CCRS) are organized into four distinct disciplinary areas, English/language arts, mathematics, science, and social studies, there are elements that cut across one or more disciplines. In fact, some skill areas span all four subject areas. It is important to identify the cross-cutting knowledge and skills that underlie and connect the four disciplinary areas. This important need has been addressed through the addition of a section of cross-disciplinary standards.

Think of cross-disciplinary standards as tools that college instructors in all areas use to challenge, engage, and evaluate students in each specific subject area. They include key cognitive skills such as reasoning and problem solving, as well as foundational skills such as reading, writing, data analysis, and conducting research.

Many of these skills are also taught within the context of a single subject area. Reading and writing are excellent examples. While the primary responsibility for developing reading and writing skills in secondary school resides within English/language arts courses, first-year college students are expected to employ a range of subject-specific reading and writing strategies and techniques in all of their courses. For example, they will write a lab report in a biology class or read primary source documents in a history class.

Academic and business leaders emphasize the importance of being able to apply these skills across a variety of contexts and subject matter. They describe 21st century learning and work environments in which the cross-disciplinary skills are prerequisites to solving many of the most important problems students will encounter in college and the workplace. These problems increasingly require applying knowledge across disciplines and subject areas and the mastery of a base set of communication and analysis skills that span subject areas. Students, then, not only need to possess content knowledge, but also need to be able to apply key cognitive skills to the academic tasks presented to them, most of which require much more than simple recall of factual knowledge. These cross-disciplinary standards enable students to engage in deeper levels of thinking across a wide range of subjects. They help high school students prepare for the transition from high school's primary focus on acquiring content knowledge to a postsecondary environment in which complex cognitive skills are necessary to achieve deeper understanding.

Understanding and Using The Cross-Disciplinary Standards

The cross-disciplinary standards are organized into two major areas: Key Cognitive Skills and Foundational Skills. The Key Cognitive Skills specify intellectual behaviors that are prevalent in entry-level college courses. The list includes intellectual curiosity, reasoning, problem solving, academic behaviors, work habits, and academic integrity. Foundational Skills consist of proficiencies students need to be able to transfer knowledge and apply it across the curriculum. These include reading, writing, conducting research, understanding and using data, and using technology.

The first three levels of the cross-disciplinary standards are written to apply across subject areas. The performance indicators found in the appendix illustrate how the cross-disciplinary standards are manifested within the subject areas. The Vertical Teams created an example in each subject area of at least one performance indicator that could be applied in that subject area. These indicators are meant to exemplify how the cross-disciplinary standards could be demonstrated in all subject areas.

I. Key Cognitive Skills

A. Intellectual curiosity

1. Engage in scholarly inquiry and dialogue.
2. Accept constructive criticism and revise personal views when valid evidence warrants.

B. Reasoning

1. Consider arguments and conclusions of self and others.
2. Construct well-reasoned arguments to explain phenomena, validate conjectures, or support positions.

3. Gather evidence to support arguments, findings, or lines of reasoning.
4. Support or modify claims based on the results of an inquiry.

C. Problem solving

1. Analyze a situation to identify a problem to be solved.
2. Develop and apply multiple strategies to solve a problem.
3. Collect evidence and data systematically and directly relate to solving a problem.

D. Academic behaviors

1. Self-monitor learning needs and seek assistance when needed.
2. Use study habits necessary to manage academic pursuits and requirements.
3. Strive for accuracy and precision.
4. Persevere to complete and master tasks.

E. Work habits

1. Work independently.
2. Work collaboratively.

F. Academic integrity

1. Attribute ideas and information to source materials and people.
2. Evaluate sources for quality of content, validity, credibility, and relevance.
3. Include the ideas of others and the complexities of the debate, issue, or problem.
4. Understand and adhere to ethical codes of conduct.

II. Foundational Skills

A. Reading across the curriculum

1. Use effective prereading strategies.
2. Use a variety of strategies to understand the meanings of new words.
3. Identify the intended purpose and audience of the text.
4. Identify the key information and supporting details.
5. Analyze textual information critically.
6. Annotate, summarize, paraphrase, and outline texts when appropriate.
7. Adapt reading strategies according to structure of texts.
8. Connect reading to historical and current events and personal interest.

B. Writing across the curriculum

1. Write clearly and coherently using standard writing conventions.
2. Write in a variety of forms for various audiences and purposes.
3. Compose and revise drafts.

C. Research across the curriculum

1. Understand which topics or questions are to be investigated.
2. Explore a research topic.
3. Refine research topic based on preliminary research and devise a timeline for completing work.
4. Evaluate the validity and reliability of sources.
5. Synthesize and organize information effectively.
6. Design and present an effective product.
7. Integrate source material.
8. Present final product.

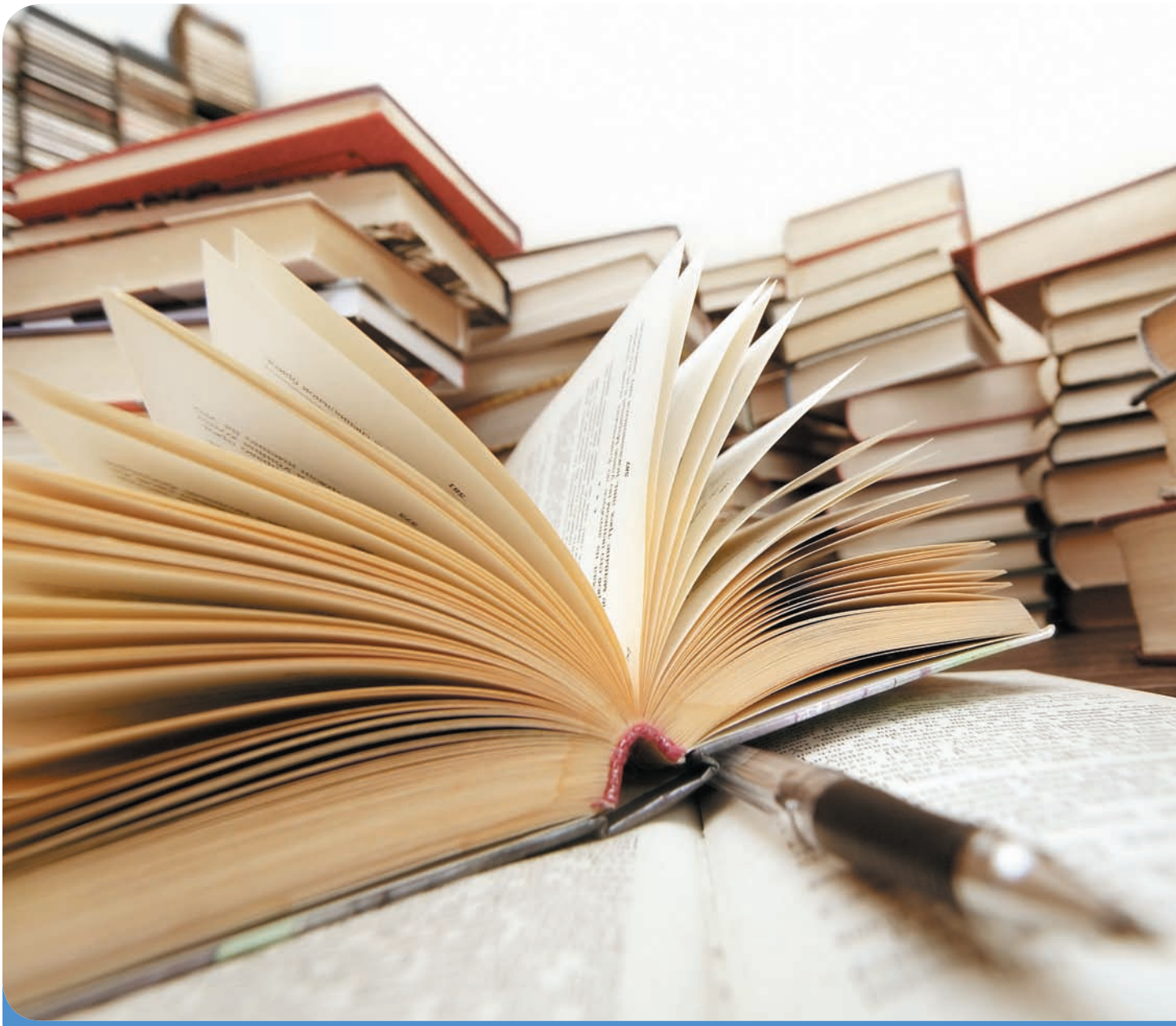
D. Use of data

1. Identify patterns or departures from patterns among data.
2. Use statistical and probabilistic skills necessary for planning an investigation and collecting, analyzing, and interpreting data.
3. Present analyzed data and communicate findings in a variety of formats.

E. Technology

1. Use technology to gather information.
2. Use technology to organize, manage, and analyze information.
3. Use technology to communicate and display findings in a clear and coherent manner.
4. Use technology appropriately.

Glossary of Terms



DOCUMENT GLOSSARY

Annotated list of sources
A bibliography that includes evaluation or comments on accuracy, completeness, usefulness, deficiencies, or other features of the sources.

Conjecture
A conclusion deduced by surmise or guesswork; a proposition (as in mathematics) before it has been proved or disproved.

Constant
Something invariable or unchanging, such as a number that has a fixed value in a given situation or universally.

Construction
The act or result of construing, interpreting, or explaining. Also involves creating a model that relates geometric principles.

Contrapositive
A proposition or theorem formed by negating both the hypothesis and conclusion of a given proposition or theorem and interchanging them (e.g., "if not-B then not-A" is the contrapositive of "if A then B").

Control
In experimental design, a sample or procedure that is virtually identical to the experimental sample except for the one variable (termed the independent variable) whose effect is being tested. If different results are obtained from the control and the experimental samples, this difference can be attributed to the effect of the independent variable.

Counterexample
An example that refutes or disproves a proposition or theory; the analysis of a set of facts in their relation to one another.

Culture
The integrated pattern of human knowledge, belief, and behavior that depends upon the capacity for learning and transmitting knowledge to succeeding generations; a society's way of life, including codes of manners, dress, language, religion, rituals, behavioral norms, and systems of belief.

Data
Factual information used as a basis for reasoning, discussion, or calculation. Reproducible observations that have been repeatedly confirmed are regarded as the highest quality data.

Deductive reasoning
The kind of reasoning in which the conclusion is necessitated by previously known premises. Usually understood as moving from a statement or description of a broad category to a description or conclusion regarding a specific instance or example within that category.

Diffusion
The geographic spread of phenomena such as culture, disease, or economic modes of production.

Dimensional analysis
A conceptual tool often applied in science and engineering to understand physical situations involving several different kinds of physical quantities. It is routinely used by scientists and engineers as a problem solving method to check the plausibility of derived equations and computations. It is also used to form reasonable hypotheses about complex physical situations that can be tested by experiment or by more developed theories of the phenomena. Calculations often require determining both the numerical value and the units of a variable in an equation. Dimensional analysis provides a useful method for determining the units of a variable in such cases.

Dissipative
A thermodynamically open system operating far from thermodynamic equilibrium in an environment with which it exchanges energy and matter. The term "dissipative system" is often used to describe one that releases heat. Simple examples include convection, cyclones, and hurricanes. More complex examples include lasers, Bénard cells, the Belousov-Zhabotinsky reaction, and at the most sophisticated level, life itself.

Diverse
Composed of distinct or unlike elements or qualities.

Domain
The set of elements to which a mathematical or logical variable is limited. Specifically, the set on which a function is defined.

Empirical
Originating in or based on observation or experience.

Ethnicity
A population of human beings whose members identify with each other, either on the basis of a presumed common genealogy or ancestry, recognition by others as a distinct group, or by common cultural, linguistic, religious, or physical traits.

DOCUMENT GLOSSARY

Function
In mathematics, a relation for which each element of the domain corresponds to exactly one element of the range.

Gender
The behavioral, cultural, or psychological traits typically associated with one sex.

Global community
The collective habitation of Earth by both humans and animals and the interconnection shared by means of inhabiting the same space.

Graphic organizers
Tools to visually categorize information such as calendars, outlines, or flow charts.

Human communities
Groups of people sharing an environment where intent, belief, resources, preferences, needs, risks, and a number of other conditions may be present and common, affecting the identity of the participants and their degree of cohesiveness.

Hypothesis
A tentative explanation or model to account for data, developed to draw out its logical or empirical consequences, and to guide the search for additional data.

Ideology
A systematic body of concepts, especially about human life or culture.

Inductive reasoning
The process of reasoning in which the premise of an argument is believed to support the conclusion but does not ensure it. Usually understood as moving from a statement or description of specific examples or instances to generalizable statements or descriptions of the entire class or category to which the examples belong.

Inquiry
A systematic investigation of facts or principles.

Key content
Overarching or keystone ideas of a discipline that reverberate as themes throughout the curriculum. The first and highest level in the organizing structure of the College and Career Readiness Standards (CCRS). Designated in this document by Roman numerals.

Law
In terms of science, a statement of order and relation in nature that has been found to be invariable under the same conditions.

Literary element
An individual aspect or characteristic of a whole work of literature.

Manipulatives
Objects (such as blocks) that a student is instructed to use in a way that teaches or reinforces a lesson.

Model
A system of postulates, data, and inferences presented as a mathematical description.

Multicultural
Of, relating to, reflecting, or adapted to a diverse range of cultures.

Natural phenomena
Facts or events observable in the natural world.

Organizing components
Knowledge and subject areas that organize a discipline around what students should retain, be able to transfer, and apply to new knowledge and skills. The second level in the organizing structure of the CCRS. Designated in this document by capital letters.

Performance expectations
Knowledge and skills that represent the important ideas of the current understanding of each organizing concept as well as the multiple contexts in which each organizing concept can be manifest. The third level in the organizing structure of the CCRS. Designated in this document by numbers.

Performance indicators
Examples of how to assess and measure performance expectations. The fourth level in the organizing structure of the CCRS. Designated in this document by lower-case letters.

Periodization
The organization of the past into units of inquiry, marked by key defining concepts.

Positive and negative controls
A controlled experiment generally compares the results obtained from an experimental sample against a control sample, which is practically identical to the experimental sample except for the one aspect whose effect is being tested. To be sure that the experimental procedures are working correctly, investigators

often include samples for which the expected result is already known. For example, in the widely-used Benedict's Test for glucose, the experimental set-up typically includes one sample in which sugar is known to be present (the positive control) and one sample in which sugar is known to be absent (the negative control). If the assay is working as expected, the positive control will yield the typical color change while the negative control will give no color change. If either of these samples produces results other than those expected, the investigator is alerted that something is interfering with the normal outcome of the assay, and all experimental results are unreliable.

Primary source
A document or other source of information that was created at or near the time being studied by an authoritative source, usually one with direct personal knowledge of the events being described.

Property
A quality or trait belonging to and especially peculiar to an individual or thing; an attribute common to all members of a class.

Qualitative
Description or distinction based on some quality rather than on some quantity.

Quantitative
A measurement based on a quantity or number rather than on a quality.

Quantitative inheritance
In genetics, traits that are determined by the combined influence of alleles at multiple loci. When studying such traits, geneticists often do not know the identities of the particular loci involved. Further, such traits do NOT show qualitatively discrete phenotypes, but rather these traits show continuous variation. Examples of human traits with continuous variation are height, athletic ability, and intelligence. Traits showing quantitative inheritance are determined by the combined influences of the genotype at many different loci, and the environmental setting in which the traits develop.

Race
A socially constructed segment of the human population defined by physical characteristics that are transmitted.

Recursive
In math, a procedure that can repeat itself indefinitely.

Region
A spatial area of the Earth's surface marked by specific criteria (e.g., multiple and overlapping political, cultural, and ecological regions existing in the present and the past).

Reliability
Ability of a system to perform and maintain its functions in routine circumstances, as well as in hostile or unexpected circumstances.

Rhetorical device
A technique that an author or speaker uses to evoke an emotional response in his audience (e.g., analogy, simile, metaphor).

Scientific ethics
Certain standards and guiding principles are universally accepted in scientific investigations, including the following:

- Data should never be falsified, either by reporting results that were not observed, or by failing to report completely all pertinent data. Neither should analyses be biased to favor one interpretation over other possible interpretations.
- Credit should be given to all individuals who made significant intellectual contributions to the investigation, and no credit should be claimed for someone else's work.
- Investigations should be carried out in ways that minimize danger to bystanders and participants should be informed in advance of any possible dangers. Part of an instructor's work is to train students to safely handle equipment, chemicals, and organisms in ways that minimize dangers to themselves and to others.
- If living organisms are used in investigations, they should be treated with respect and care. Efforts should be made to minimize or eliminate fear, pain, and suffering in those organisms, consistent with the nature of the investigation being done. Appropriate care guidelines as specified by institutional animal care policies should be rigorously followed.
- If humans are used as subjects in investigations, they must be fully apprised of any dangers or adverse effects that might result from the

investigation, and must voluntarily give informed consent to their participation, as specified by institutional review policies.

Secondary source
A work, such as a scholarly book or article, built from primary sources.

Social group
Grouping of people according to common characteristics (note: examples are given after this term is introduced in the standards).

Spatial
Relating to, occupying, or having the character of space.

Standard International Units
The modern form of the metric system of measurements. Units are defined for measurement of length, mass, time, electric current, thermodynamic temperature, amount of substance, and luminous intensity. Prefixes are added to units to produce a multiple (relative size) of the original unit (e.g., the factor 10 is named "deca" and symbolized by "da").

Strategy
A careful plan or method employed toward a goal.

System
A structured collection of parts or components that affect, influence, or interact with each other in defined, predictable ways; a form of social, economic, or political organization or practice; an organized set of doctrines, ideas, or principles usually intended to explain the arrangement or working of a systematic whole; an organized or established procedure; a manner of classifying, symbolizing, or schematizing.

Text
The main body of printed or written matter.

Theme
A unifying subject or idea.

Theory
A scientifically acceptable general principle, explanatory model, or body of principles offered to explain or account for observed phenomena. Usually understood to have been more extensively tested or supported by more data than a hypothesis.

Thesis
A position or proposition that a person advances and offers to maintain by argument; a proposition to be proved, or one advanced without proof.

Topic
A heading in an outlined argument or exposition; the subject of a discourse or of a section of a discourse.

Transactional
A communicative action or activity involving two parties or things that reciprocally affect or influence each other.

Validity
The quality of being well-grounded or justifiable; being at once relevant and meaningful.

Variable
Able or apt to vary; subject to variation or changes.

Vertical Team (VT)
For the purpose of this study, a panel of subject-specific secondary and postsecondary faculty established to develop CCRS that address what students must know and be able to do to succeed in entry-level courses offered at Texas institutions of higher education.

Vertical Team Members

The following faculty members served on the Vertical Teams that developed the draft version of the College and Career Readiness Standards contained in this document.

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Appendix

English/Language Arts Standards

with performance indicators

I. Writing

A. Compose a variety of texts that demonstrate clear focus, the logical development of ideas in well-organized paragraphs, and the use of appropriate language that advances the author's purpose.

1. **Determine effective approaches, forms, and rhetorical techniques that demonstrate understanding of the writer's purpose and audience.**

EXAMPLES

a. Prepare a topic proposal that specifies and justifies the topic, audience, and purpose.

b. Identify the types of writing (e.g., informational, analytical, polemical) and forms of writing (e.g., letter, editorial, essay) that are appropriate for the writer's particular purpose and audience.

c. Recognize rhetorical techniques appropriate to the purpose, audience, and form of a particular composition.

2. **Generate ideas and gather information relevant to the topic and purpose, keeping careful records of outside sources.**

EXAMPLES

a. Utilize effective prewriting strategies: outline and prioritize ideas, anticipate questions that might be raised by readers, and identify appropriate primary and secondary source material.

b. Evaluate the reliability of possible sources and prepare an annotated bibliography.

3. **Evaluate relevance, quality, sufficiency, and depth of preliminary ideas and information, organize material generated, and formulate a thesis.**

EXAMPLES

a. Craft a thesis statement that articulates a position and logically organize relevant evidence and examples that support the thesis statement.

b. Become familiar with the various forms of plagiarism related to both textual and electronic sources and appropriately cite all borrowed material.

c. Demonstrate familiarity with different perspectives on a topic in addition to the writer's. Marshal evidence to accomplish the writer's purpose for the specified audience.

4. Recognize the importance of revision as the key to effective writing. Each draft should refine key ideas and organize them more logically and fluidly, use language more precisely and effectively, and draw the reader to the author's purpose.

EXAMPLES

a. Produce drafts that are logically organized in relation to the writer's purpose, audience, and chosen form.

b. Produce drafts that create tone and style appropriate to topic, audience, and task, including non-standard English when appropriate.

c. Produce drafts that use precise and engaging vocabulary appropriate to audience, purpose, and task, using sentences that are well-crafted and varied in structure.

d. Strengthen thesis statements, supported by relevant evidence and examples, cogent reasoning, anecdotes, and illustrations.

e. Revise drafts of functional texts (e.g., application, resume, operations manual) so that they demonstrate clear language and effective organization and formatting.

f. Produce texts that present technical information accurately in accessible language and utilize appropriate formatting structures (e.g., headings, graphics, white space).

g. Submit multiple drafts that reflect judicious use of self, peer, and instructor assessment.

5. Edit writing for proper voice, tense, and syntax, assuring that it conforms to standard English, when appropriate.

EXAMPLES

a. Edit for correct spelling, capitalization, and punctuation.

b. Edit for subject-verb agreement.

c. Edit for pronoun reference and agreement.

d. Improve coherence by increasing logical connections within and between sentences.

e. Edit for correct sentence structure (e.g., subordination, coordination).

f. Consult reference guides for citation conventions, grammar, mechanics, and punctuation.

g. Use a variety of proofreading techniques to compensate for the limitations of automated aids such as electronic spell and grammar checks.

II. Reading

A. Locate explicit textual information, draw complex inferences, and analyze and evaluate the information within and across texts of varying lengths.

1. Use effective reading strategies to determine a written work's purpose and intended audience.

EXAMPLES

a. Examine introductory material to understand the organization of a text.

b. Examine headline sections or other division markers, graphics, or sidebars to form an overview of a text.

c. Reread to deepen understanding of a text's literal and figurative meaning.

d. Compare and contrast texts that have similar subjects and themes.

e. When appropriate, make connections between a text and current and historical events.

2. Use text features and graphics to form an overview of informational texts and to determine where to locate information.

EXAMPLES

a. Evaluate data in tables, graphs, and charts.

b. Use tables of contents, headings, and subheadings to locate information for answering questions.

3. Identify explicit and implicit textual information including main ideas and author's purpose.

EXAMPLES

a. Analyze connections between main ideas and supporting details.

b. Identify author's purpose in a variety of texts, such as magazine articles.

4. Draw and support complex inferences from text to summarize, draw conclusions, and distinguish facts from simple assertions and opinions.

EXAMPLES

a. Analyze moral dilemmas in works of literature as revealed by the behaviors and underlying motivations of characters.

b. Summarize key points in important historical documents.

c. Distinguish inductive and deductive reasoning and evaluate the effectiveness of each in particular texts.

5. Analyze the presentation of information and the strength and quality of evidence used by the author, and judge the coherence and logic of the presentation and the credibility of an argument.

EXAMPLES

a. Evaluate the logical effectiveness of arguments.

b. Draw conclusions based on the sufficiency and strength of evidence used in research papers.

c. Identify shifts in argument or point of view and how they affect meaning.

6. Analyze imagery in literary texts.

EXAMPLE

a. Analyze how imagery reveals theme, sets tone, and creates meaning in literary texts.

7. Evaluate the use of both literal and figurative language to inform and shape the perceptions of readers.

EXAMPLES

a. Analyze a passage for word choice and voice.

b. Describe and compare how authors use style to evoke specific cultures, social classes, geographical locations, and time periods.

c. Explain how authors use dialect to convey character.

8. Compare and analyze how generic features are used across texts.

EXAMPLES

a. Explain how form or genre communicates meaning.

b. Analyze the use of persona in texts with diverse voices.

9. Identify and analyze the audience, purpose, and message of an informational or persuasive text.

EXAMPLES

a. Draw inferences about prevailing public opinions or concerns by reading primary sources from specific historical periods.

b. Explain how the author's use of rhetorical devices influences the reader, evokes emotions, and creates meaning.

c. Identify shifts in argument or point of view and how they affect meaning.

10. Identify and analyze how an author's use of language appeals to the senses, creates imagery, and suggests mood.

EXAMPLES

a. Identify words that convey mood and voice to inform readers of aspects of a setting or time period.

b. Explain how the author's use of literary elements creates meaning.

c. Analyze a text's ambiguities, subtleties, or contradictions.

11. Identify, analyze, and evaluate similarities and differences in how multiple texts present information, argue a position, or relate a theme.

EXAMPLES

a. Analyze similarities and differences in how authors develop similar themes across texts.

b. Read diaries written during a particular event or period and use evidence from the diaries to demonstrate similarities and differences in how each author feels about the event.

c. Analyze how authors present opposing viewpoints on the same issue.

B. Understand new vocabulary and concepts and use them accurately in reading, speaking, and writing.

1. Identify new words and concepts acquired through study of their relationships to other words and concepts.

EXAMPLES

a. Describe meanings of words read in texts based on context clues (e.g., definitions, examples, comparison, contrast, cause and effect, details provided in surrounding text).

b. Explain how connotation determines meaning.

2. Apply knowledge of roots and affixes to infer the meanings of new words.

EXAMPLE

a. Identify word meanings based on their Greek or Latin roots.

3. Use reference guides to confirm the meanings of new words or concepts.

EXAMPLE

a. Consult dictionaries, glossaries, thesauruses, or other guides to confirm word or phrase meanings.

C. Describe, analyze, and evaluate information within and across literary and other texts from a variety of cultures and historical periods.

1. Read a wide variety of texts from American, European, and world literatures.

EXAMPLE

a. Know characteristic forms, subjects, and key authors of major periods.

2. Analyze themes, structures, and elements of myths, traditional narratives, and classical and contemporary literature.

EXAMPLES

a. Describe how contemporary authors adapt legends and myths to current settings and issues.

b. Analyze historical and social influences on literary works from various countries.

c. Use appropriate reading strategies to analyze a variety of literary and textual forms and genres.

d. Analyze universal or recurrent themes across a variety of works and genres.

3. Analyze works of literature for what they suggest about the historical period and cultural contexts in which they were written.

EXAMPLES

a. Analyze how significant historical events influence authors.

b. Describe how the social conditions of a particular geographic region or time influence authors.

4. Analyze and compare the use of language in literary works from a variety of world cultures.

EXAMPLES

a. Analyze works with similar themes to compare how the authors achieve their purpose.

b. Compare contemporary poems by writers from different nations and note similarities and differences in form, style, imagery, and theme.

D. Explain how literary and other texts evoke personal experience and reveal character in particular historical circumstances.

1. Describe insights gained about oneself, others, or the world from reading specific texts.

EXAMPLES

a. Compare a particular text to one's own life experiences and those of others.

b. Relate a text to current or historical events (e.g., compare current world events with those described in works from the early 20th Century).

2. Analyze the influence of myths, folktales, fables, and classical literature from a variety of world cultures on later literature and film.

EXAMPLE

a. Analyze how texts influence other texts, especially from another era, in terms of such elements as style, theme, and use of mythology.

III. Speaking

A. Understand the elements of communication both in informal group discussions and formal presentations (e.g., accuracy, relevance, rhetorical features, organization of information).

1. Understand how style and content of spoken language varies in different contexts and influences the listener's understanding.

EXAMPLES

a. Understand influences on language use (e.g., political beliefs, positions of social power, culture).

b. When speaking, observe audience reaction and adjust presentation (e.g., pace, tone, vocabulary, body language) to suit the audience.

2. Adjust presentation (delivery, vocabulary, length) to particular audiences and purposes.

EXAMPLE

a. Use effective verbal and non-verbal response strategies to adjust the message in response to audience's facial expressions and body language.

B. Develop effective speaking styles for both group and one-on-one situations.

1. Participate actively and effectively in one-on-one oral communication situations.

EXAMPLES

a. Communicate, in an appropriate format, information that was gathered by inquiry (e.g., research, interviews).

b. Communicate understanding of materials, concepts, and ideas (e.g., conference with instructor on a complex assignment).

2. Participate actively and effectively in group discussions.

EXAMPLES

a. Cooperate with peers to organize a group discussion: establish roles, responsibilities, ground rules; complete assignments; evaluate the work of the group based on agreed-upon criteria.

b. Use discussion techniques to arrive at a consensus or complete a task.

3. Plan and deliver focused and coherent presentations that convey clear and distinct perspectives and demonstrate solid reasoning.

EXAMPLES

a. Present research findings as appropriate in a variety of settings.

b. Use clear and concise language to explain complex concepts.

c. Practice speaking from notes as well as from a prepared speech.

d. Use appropriate media for public presentations.

IV. Listening

A. Apply listening skills as an individual and as a member of a group in a variety of settings (e.g., lectures, discussions, conversations, team projects, presentations, interviews).

1. Analyze and evaluate the effectiveness of a public presentation.

EXAMPLES

a. Critique the speaker's delivery skills (e.g., word choice, pitch, feelings, tone, voice).

b. Analyze, synthesize, and evaluate the effectiveness of a speaker's presentation.

c. Identify subtle uses of language.

2. **Interpret a speaker's message; identify the position taken and the evidence in support of that position.**

EXAMPLES

a. Evaluate the multiple levels of meaning and age, gender, social position, and cultural traditions of the speaker.

b. Analyze the effectiveness of a speaker's nonverbal messages (e.g., eye contact, gestures, facial expressions, posture, spatial proximity).

3. **Use a variety of strategies to enhance listening comprehension (e.g., focus attention on message, monitor message for clarity and understanding, provide verbal and nonverbal feedback, note cues such as change of pace or particular words that indicate a new point is about to be made, select and organize key information).**

EXAMPLES

a. Develop and ask questions related to the content for clarification and elaboration.

b. Follow complex verbal instructions that include technical vocabulary and processes.

c. Paraphrase or summarize information.

d. Take concise notes that accurately reflect the presentation or discussion.

B. Listen effectively in informal and formal situations.

1. **Listen critically and respond appropriately to presentations.**

EXAMPLES

a. Define new words and concepts, and note questions raised by the presentation to interpret the speaker's content and attitude toward the subject.

b. Take notes that synthesize or highlight ideas for critical reflection.

c. Use critical listening responses, such as refutation and commentary, to analyze, synthesize, and evaluate the accuracy and effectiveness of the presentation.

2. **Listen actively and effectively in one-on-one communication situations.**

EXAMPLES

a. Accurately paraphrase what has been heard.

b. Revise a draft based on oral peer critique.

3. **Listen actively and effectively in group discussions.**

EXAMPLES

a. Take effective notes during group discussion.

b. Participate in a productive deliberation.

c. Use effective listening techniques to complete a group task.

V. Research

A. Formulate topic and questions.

1. **Formulate research questions.**

EXAMPLES

a. Inventory one's knowledge of, attitude toward, and interest in the topic.

b. Use strategies like those in the writing process to generate questions and areas to pursue.

c. Conduct interviews with experts to identify questions central to a research topic.

d. List the fundamental questions that specialists and/or non-specialists raise about a research topic.

2. **Explore a research topic.**

EXAMPLES

a. Produce an annotated list of sources consulted, differentiating among primary, secondary, and other sources.

b. Outline the most significant controversies or questions on a research topic.

c. Write an account of the status of the subject in the research community, including what is known or surmised about the subject and what controversies or questions persist.

3. Refine research topic and devise a timeline for completing work.

EXAMPLES

a. Adjust topic based on preliminary research.

b. Develop a detailed and realistic schedule for researching and completing a project.

B. Select information from a variety of sources.

1. Gather relevant sources.

EXAMPLES

a. Use general and specialized reference works and databases to locate sources.

b. Locate electronic sources using advanced search strategies.

c. Select an appropriate range of source materials.

2. Evaluate the validity and reliability of sources.

EXAMPLES

a. Follow a set of criteria to determine the validity and reliability of sources.

b. Identify claims found in one or more of the sources that require support or verification and evaluate the validity of the information.

c. Evaluate data presented in graphics, tables, and charts.

3. Synthesize and organize information effectively.

EXAMPLES

a. Manage sources appropriately.

b. Explain how source materials on the same subject represent more than two points of view.

c. Select quotations that support the thesis.

d. Determine what evidence best supports the major points.

e. Determine the best order for presenting major and minor points.

C. Produce and design a document.

1. Design and present an effective product.

EXAMPLES

a. Use the composing process to develop a research product.

b. Integrate source material into text by a combination of summarizing, paraphrasing, and quoting.

c. Use citation system specified by or appropriate to the assignment.

d. Design a report using features such as headings and graphics appropriate to the writing task.

2. Use source material ethically.

EXAMPLES

a. Paraphrase accurately.

b. Use appropriate media for public presentation of research results.

c. Cite sources appropriately.

d. Document sources using a standard format appropriate to the assignment.

Mathematics Standards

with performance indicators

I. Numeric Reasoning

A. Number representation

1. Compare real numbers.

EXAMPLES

a. Classify numbers as natural, whole, integers, rational, irrational, real, imaginary, and/or complex.

b. Use and apply the relative magnitude of real numbers by using inequality symbols to compare them and locate them on a number line.

c. Order real numbers with and without a calculator using relationships involving decimals, rationals, exponents, and radicals.

d. Represent any rational number in scientific notation.

2. Define and give examples of complex numbers.

EXAMPLES

a. State the standard form used to represent complex numbers and describe their real and imaginary parts.

b. Represent i^n and square roots of negative numbers as complex numbers.

c. Understand that to solve certain problems and equations, number systems need to be extended from whole numbers to the set of all integers (positive, negative, zero), from integers to rational numbers, from rational numbers to real numbers (rational and irrational numbers), and from real numbers to complex numbers; define and give examples of each of these types of numbers.

B. Number operations

1. Perform computations with real and complex numbers.

EXAMPLES

a. Add, subtract, multiply, and divide real numbers accurately, including irrational numbers, numbers with exponents, and absolute value.

b. Transform numerical expressions using field properties (especially the distributive property), order of operations, and properties of exponents.

c. Solve problems involving rational numbers, ratios, percents, and proportions in context of the situation.

d. Calculate the sum, difference, product, and quotient of two complex numbers and express the result in standard form.

C. Number sense and number concepts

1. Use estimation to check for errors and reasonableness of solutions.

EXAMPLES

a. Identify the most reasonable solution for a given problem from a list of possible solutions; justify the choice.

b. Use mental estimates to detect potential errors when using a calculator.

c. Justify the need for an exact answer or an estimate in a given problem (e.g., doing taxes vs. determining amount of paint needed for a room).

II. Algebraic Reasoning

A. Expressions and equations

1. Explain and differentiate between expressions and equations using words such as "solve," "evaluate," and "simplify."

EXAMPLES

a. Define what an expression or equation represents.

b. Distinguish among and apply different uses of equations to: state a definition, represent a conditional statement, and represent an identity.

B. Manipulating expressions

1. Recognize and use algebraic (field) properties, concepts, procedures, and algorithms to combine, transform, and evaluate expressions (e.g., polynomials, radicals, rational expressions).

EXAMPLES

a. Use the algebraic (field) properties (e.g., commutative, associative, distributive) and order of operations to transform expressions to equivalent expressions.

b. Use the algebraic (field) properties and order of operations to evaluate variable expressions when given the value of the variables.

c. Explain why the algorithms and procedures used to transform algebraic expressions are valid.

C. Solving equations, inequalities, and systems of equations

1. Recognize and use algebraic (field) properties, concepts, procedures, and algorithms to solve equations, inequalities, and systems of linear equations.

EXAMPLES

a. Solve equations and inequalities in one variable (e.g., numerical solutions, including those involving absolute value, radical, rational, exponential, and logarithmic).

b. Solve for any variable in an equation or inequality that has two or more variables (e.g., literal equations).

c. Use equality and algebraic (field) properties to solve an equation by constructing a sequence of equivalent equations.

d. Use the elimination, substitution, and/or graphing method to solve a linear system of equations with two variables.

e. Use technology when using matrices to solve linear systems with two or three variables.

2. Explain the difference between the solution set of an equation and the solution set of an inequality.

EXAMPLES

a. Represent the solution set of an equation or inequality in various ways (e.g. set notation, interval notation, graphical representation, including shading).

b. Understand that the real solution to an equation can be represented as the x-coordinate of the point of intersection of two graphs.

c. Understand the relationship between a solution of a system of two linear equations with two variables and the graphs of the corresponding lines.

d. Graph a function and understand the relationship between its real zeros, roots, and the x-intercepts of its graph.

D. Representations

1. Interpret multiple representations of equations and relationships.

EXAMPLES

a. Interpret graphical representations of equations.
b. Understand how variables can be used to express generalizations and represent situations.
c. Recognize the solution(s) to an equation from a table of values.
d. Describe numerical patterns using algebraic expressions and equations in closed or recursive forms, such as arithmetic sequences.

2. Translate among multiple representations of equations and relationships.

EXAMPLES

a. Explain the common information presented in multiple representations of a relationship.
b. Translate one given representation to another representation (e.g., tabular to graphic, graphic to symbolic).
c. Use multiple representations to determine rate of change.
d. Determine if a relationship given in graphical, tabular, or symbolic form is linear or nonlinear.

III. Geometric Reasoning

A. Figures and their properties

1. Identify and represent the features of plane and space figures.

EXAMPLES

a. Construct and use drawings, models, and coordinate representations of plane and space figures in order to solve problems by hand and using technology.
b. Recognize and describe the plane-figure components of three-dimensional figures, such as prisms, pyramids, cylinders, and cones.
c. Describe and use cross-sections and nets of three-dimensional figures to relate them to plane figures.
d. Describe the conic sections as intersections of a plane with a cone.
e. Recognize and describe orthographic (top, front, side) and isometric views of three-dimensional geometric figures.

2. Make, test, and use conjectures about one-, two-, and three-dimensional figures and their properties.

EXAMPLES

a. Develop and verify attributes of lines and parts of lines in a plane and in space: parallel, intersecting, perpendicular, and skew lines; and angle relationships associated with transversals on parallel lines.
b. Develop and verify angle relationships: vertical, complementary, supplementary, angles on parallel lines, angle-side relations in a triangle, interior/exterior angles on polygons, and angles on circles.
c. Develop, verify, and extend properties of circles, including properties of angles, arcs, chords, tangents, secants, and spheres.
d. Develop and verify properties of triangles and quadrilaterals (e.g., triangle congruence conditions, properties of a parallelogram).
e. Develop and verify properties of parts of prisms, cylinders, pyramids, and cones.
f. Apply properties of geometric figures to solve problems.

3. Recognize and apply right triangle relationships including basic trigonometry.

EXAMPLES

a. Apply the Pythagorean Theorem and its converse to solve real-life situations in two and three dimensions.
b. Apply Pythagorean triples and special right triangle relationships to solve problems.
c. Solve right triangle situations using sine, cosine, and tangent.

B. Transformations and symmetry

1. Identify and apply transformations to figures.

EXAMPLES

a. Identify whether a transformation is a reflection, rotation, translation, or dilation.

b. Find the image or pre-image of a given plane figure under a congruence transformation (e.g., translation, reflection, rotation) or composition of these transformations in coordinate and non-coordinate plane settings.

c. Find the image or pre-image of a given plane figure under a dilation or composition of dilations in coordinate and non-coordinate plane settings.

d. Use transformations and compositions of transformations to investigate and justify geometric properties of a figure (e.g., the sum of the three angles inside any triangle is 180 degrees).

2. Identify the symmetries of a plane figure.

EXAMPLES

a. Identify and distinguish between reflectional and rotational symmetry in an object.

b. Identify congruent corresponding parts in a figure with reflectional or rotational symmetry.

c. Identify lines of symmetry in plane figures to show reflection.

3. Use congruence transformations and dilations to investigate congruence, similarity, and symmetries of plane figures.

EXAMPLES

a. Use congruence transformations to justify congruence among triangles and to identify congruent corresponding parts.

b. Use dilations and scale factors to investigate similar figures and determine missing image or pre-image dimensions.

c. Identify symmetries in design situations and describe transformations used to create the symmetry and design (e.g., tiling problems).

C. Connections between geometry and other mathematical content strands

1. Make connections between geometry and algebra.

EXAMPLES

a. Describe lines in the coordinate plane using slope-intercept and point-slope form.

b. Use slopes to describe the steepness and direction of lines in the coordinate plane and to determine if lines are parallel, perpendicular, or neither.

c. Relate geometric and algebraic representations of lines, segments, simple curves, and conic sections [e.g., describe algebraically a circle centered at (h, k) with radius (r)].

d. Investigate and justify properties of triangles and quadrilaterals using coordinate geometry.

e. Relate the number of solutions to a system of equations of lines to the number of intersections of two or more graphs.

2. Make connections between geometry, statistics, and probability.

EXAMPLES

a. Compute probabilities using lengths of segments or areas of regions representing desired outcomes.

b. Construct a trend line or a regression line for a scatter plot and use it to make predictions.

3. Make connections between geometry and measurement.

EXAMPLES

a. Determine perimeter and area of two-dimensional figures and surface area and volume of three-dimensional figures using measurements and derived formulas.

b. Find the measures of the lengths and areas of similar figures and of the lengths, surface areas, and volumes of similar solids.

c. Find arc length and sector area for a given central angle on a circle.

D. Logic and reasoning in geometry

1. Make and validate geometric conjectures.

EXAMPLES

a. Use drawings, manipulatives (e.g., paper folding, transformations) and constructions (e.g., compass/straight-edge, computer graphing utility) to investigate patterns and make conjectures about geometric properties of figures.

b. Use counterexamples to verify that a geometric conjecture is false.

c. Give a logical argument in a variety of formats to verify that a geometric conjecture is true.

d. Use a conditional statement to describe a property of a geometric figure. State and investigate the validity of the statement's converse, inverse, and contrapositive.

e. Make the connection between a biconditional statement and a true conditional statement with a true converse.

2. Understand that Euclidean geometry is an axiomatic system.

EXAMPLES

a. Distinguish among theorems, properties, definitions, and postulates and use them to verify conjectures in Euclidean geometry.

b. Understand that non-Euclidean geometries exist.

IV. Measurement Reasoning

A. Measurement involving physical and natural attributes

1. Select or use the appropriate type of unit for the attribute being measured.

EXAMPLES

a. Determine appropriate units of measurement needed for the object being measured in a given situation (e.g., unit analysis, degree, or radian measure of an angle.)

b. Select and accurately use an appropriate tool to make measurements.

c. Recognize and use significant digits to determine the accuracy of a measurement in problem situations.

d. Use the appropriate level of precision when providing solutions to measurement problems.

e. Know when to estimate and approximate measurements for given problem situations.

B. Systems of measurement

1. Convert from one measurement system to another.

EXAMPLE

a. Convert between basic units of measurement from one system to another system (e.g., inches to centimeters, kilometers to miles, pounds to kilograms).

2. Convert within a single measurement system.

EXAMPLE

a. Convert between basic units of measurement within a system (e.g., inches to feet, square inches to square feet, grams to milligrams).

C. Measurement involving geometry and algebra

1. Find the perimeter and area of two-dimensional figures.

EXAMPLES

a. Describe the difference between perimeter and area of two-dimensional figures and the units of measurement used in their calculation.

b. Solve problems involving perimeter and area of two-dimensional simple and composite figures with some unknown dimensions (e.g., triangles, quadrilaterals, circles).

c. Solve problems involving the distance between two points in the coordinate plane and make algebraic and geometric connections.

2. Determine the surface area and volume of three-dimensional figures.

EXAMPLES

a. Describe the difference between surface area and volume of three-dimensional figures and the relationship in the units of measurement used in their calculation.

b. Solve problems involving surface area and volume of three-dimensional simple and composite figures with some unknown dimensions, including prisms, pyramids, cylinders, cones, and spheres.

3. Determine indirect measurements of figures using scale drawings, similar figures, the Pythagorean Theorem, and basic trigonometry.

EXAMPLES

a. Determine how changes in dimension affect the perimeter, area, and volume of common geometric figures and solids.

b. Solve problems using proportional relationships in similar two-dimensional and three-dimensional figures to determine unknown measurements.

c. Determine unknown sides and angles in a right triangle using the Pythagorean Theorem and basic trigonometry.

D. Measurement involving statistics and probability

1. Compute and use measures of center and spread to describe data.

EXAMPLES

a. Select, compute, and justify measurements of center (e.g., mean, median, mode) based on the data set and other influential information.

b. Select, compute, and justify measurements of variation (e.g., range, IQR, percentiles, variance, standard deviation) based on the data set and other influential information.

c. Calculate weighted averages, indices, and ratings.

2. Apply probabilistic measures to practical situations to make an informed decision.

EXAMPLES

a. Justify decisions made from probability measures from a set of data.

b. Interpret given probability measures in a problem.

c. Use and interpret a normal distribution as a mathematical model of measurement for summarizing some sets of data.

V. Probabilistic Reasoning

A. Counting principles

1. Determine the nature and the number of elements in a finite sample space.

EXAMPLES

a. Make lists, tables, and tree diagrams to represent all possible outcomes in determining specifics of the sample space.

b. Determine the number of ways an event may occur using combination and permutation formulas and the Fundamental Counting Principle.

B. Computation and interpretation of probabilities

1. Compute and interpret the probability of an event and its complement.

EXAMPLES

a. Conduct an experiment or simulation to compute the empirical probability of an event and its complement.

b. Compute and interpret the theoretical probability of a simple event and its complement.

c. Compare the empirical and theoretical probabilities of an event (e.g., experimental probabilities converge to theoretical probability as the number of trials increases).

2. Compute and interpret the probability of conditional and compound events.

EXAMPLES

a. Distinguish between independent and dependent events.

b. Explain the meaning of conditional probability and know when to use it.

c. Compute conditional probability.

d. Compute the probability of compound events using tree diagrams, tables, and other methods.

e. Compute the probability for dependent or independent compound events.

VI. Statistical Reasoning

A. Data collection

1. Plan a study.

EXAMPLES

a. Determine question(s) that can be answered with data.

b. Explain the difference between observational and experimental studies.

c. Design and employ a plan of study to collect appropriate data.

d. Use a variety of sampling methods (e.g., census, systematic sampling, random vs. non-random sampling).

e. Identify sampling techniques used in our world (e.g., political polls, medical studies) and determine possible sources of bias.

f. Compare and contrast data variability using different sampling methods.

B. Describe data

1. Determine types of data.

EXAMPLES

a. Recognize and describe the differences between quantitative and qualitative data.

b. Recognize and describe univariate and bivariate data.

2. Select and apply appropriate visual representations of data.

EXAMPLES

a. Organize and construct graphical displays of data (e.g., line plots, bar graphs, histograms, box plots, scatter plots) to describe the distribution of data.

b. Read and interpret graphical displays of data.

3. Compute and describe summary statistics of data.

EXAMPLES

a. Calculate, describe, and use the appropriate measure of center (e.g., mean, median, mode) and spread (e.g., range, IQR, percentiles, variance, standard deviation).

b. Describe the effect of outliers on summary statistics.

4. Describe patterns and departure from patterns in a set of data.

EXAMPLES

a. Describe any natural variability evident in the results within the context of the situation.

b. Describe any influences that may have induced variability within the context of the situation.

C. Read, analyze, interpret, and draw conclusions from data

1. Make predictions and draw inferences using summary statistics.

EXAMPLES

a. Make a prediction about long-run behavior (e.g., coin toss).

b. Draw conclusions from analyzing a set of data.

2. Analyze data sets using graphs and summary statistics.

EXAMPLES

a. Analyze and compare distributions by describing similarities and differences of centers and spreads within and between data sets.

b. Analyze and describe similarities and differences by comparing graphical distributions (e.g., parallel box plots, back-to-back stem-leaf plots) within and between data sets.

3. Analyze relationships between paired data using spreadsheets, graphing calculators, or statistical software.

EXAMPLES

a. Describe relationship and trend of paired data observed from scatter plots in the context of the situation.

b. Choose an appropriate linear or non-linear regression model to fit paired data based on graphical analysis.

c. Make a prediction using the appropriate regression model and describe any limitations to the calculated prediction.

4. Recognize reliability of statistical results.

EXAMPLES

a. Evaluate media reports by analyzing the study design, data source, graphical representation of data, and analyzed data results reported (or not reported).

b. Describe generalizations and limitations of results from observational studies, experiments, and surveys.

c. Identify and explain misleading uses of data.

d. Describe the reliability of statistical results from a set of data.

VII. Functions

A. Recognition and representation of functions

1. Recognize whether a relation is a function.

EXAMPLE

a. Determine if a relationship given in tabular, graphic, symbolic, or verbal form defines a function.

2. Recognize and distinguish between different types of functions.

EXAMPLES

a. Recognize general forms of linear, quadratic, rational, absolute value, square root, exponential, and logarithmic functions, and other advanced forms such as trigonometric or power functions.

b. Recognize the distinction between a discrete and a continuous function.

c. Recognize a sequence as a function whose domain is a set of whole numbers.

d. Recognize computations (e.g., sums, products, GCF, LCM, mean, surface area) as evaluating a function with two or more inputs and one output.

e. Recognize a plane geometric transformation as evaluating a function with two inputs and two outputs.

B. Analysis of functions

1. Understand and analyze features of a function.

EXAMPLES

a. Understand functional notation and evaluate a function at a specified point in its domain.

b. Determine the domain and range of a function defined by a table of values, graph, symbols, or verbal description.

c. Approximate or determine the x- and y-values of a function given in tabular, graphical, symbolic, or verbal form.

d. Determine and explain if a function, defined verbally or given in tabular, graphical, or symbolic form, is one-to-one.

2. Algebraically construct and analyze new functions.

EXAMPLES

a. Determine the domain and range of a combination or composition of two functions.

b. Formulate the composition of two functions.

c. Apply basic transformations to parent functions [e.g., af(x), f(x)+b, f(x+c)] and interpret the results verbally and graphically.

d. Analyze the effects of parameter changes of basic functions, [e.g., f(x)=mx+b, where m and/or b changes].

e. Analyze and apply piece-wise defined functions (e.g., step functions).

f. Determine the inverse function of a given function in tabular, symbolic, or graphical form, if it exists (e.g., the inverse of an exponential function is a logarithmic function).

g. Use properties of inverse functions to solve problems (e.g., inverse trigonometric functions to find angles in a right triangle).

C. Model real world situations with functions

1. Apply known function models.

EXAMPLES

a. Apply a linear model for a situation represented by a constant rate of change.

b. Apply given quadratic models to solve problems (e.g., area, velocity, projectile motion).

c. Apply exponential models (e.g., compound interest, growth and decay models) to solve problems.

d. Apply proportional or inverse variation models to solve problems.

e. Recognize and solve problems that can be modeled using a system of two equations in two variables, such as mixture problems.

2. Develop a function to model a situation.

EXAMPLES

a. Analyze a situation algebraically or graphically and determine if the relationship suggests a linear trend.

b. Use technology to determine a linear regression model for a given situation.

c. Identify real world situations that can be modeled by functions (e.g., situations in science, business, economics).

VIII. Problem Solving and Reasoning

A. Mathematical problem solving

1. Analyze given information.

EXAMPLES

a. Extract needed facts and relationships from given information.

b. Identify what is known, not known, and what one wants to know in a problem.

c. Distinguish relevant from irrelevant information in a given situation.

d. Determine the problem(s) to be solved.

e. Identify additional information needed to reach a solution.

f. Test ideas with specific cases.

2. Formulate a plan or strategy.

EXAMPLES

a. Select or develop an appropriate problem-solving strategy (e.g., drawing a picture, looking for a pattern, systematic guessing and checking, acting it out, making a table, working a simpler problem, working backwards).

b. Identify needed algorithms or formulas.

c. Determine the nature of a possible solution and the degree of precision required.

3. Determine a solution.

EXAMPLES

a. Make and test conjectures.

b. Find an approximate solution with or without technology.

c. Identify and solve sub-problems.

d. Use multiple representations (e.g., analytic, numerical, verbal, and graphical) to support a solution.

4. Justify the solution.

EXAMPLES

a. Provide a clear explanation of the reasoning used to determine a solution.

b. Evaluate the reasonableness of the solution in the context of the original problem.

c. Verify a general solution in special cases.

d. Review and check strategies and calculations, using an alternative approach when possible.

e. Demonstrate an understanding of the mathematical ideas behind the steps of a solution, not just the solution.

5. Evaluate the problem-solving process.

EXAMPLES

a. Reflect on the problem-solving process and use mathematical knowledge to evaluate its effectiveness.

b. Recognize that a mathematical problem can be solved in a variety of ways.

c. Consider extensions and generalizations of the problem, process, or solution.

B. Logical reasoning

1. Develop and evaluate convincing arguments.

EXAMPLES

a. Use examples to formulate conjectures.

b. Use counterexamples to refute conjectures.

c. Determine the validity of a conditional statement, its converse, its inverse, and its contrapositive.

2. Use various types of reasoning.

EXAMPLES

a. Use inductive reasoning to formulate a conjecture.

b. Use deductive reasoning to prove a statement or validate a conjecture.

c. Use geometric and visual reasoning.

d. Use multiple representations (e.g., analytic, numerical, verbal, graphical) to support an argument.

C. Real world problem solving

1. Formulate a solution to a real world situation based on the solution to a mathematical problem.

EXAMPLES

a. Make simplifying assumptions about a real world situation to formulate and solve an idealized mathematical problem.

b. Convert given information into an appropriate mathematical model.

c. Interpret results of the mathematical problem in terms of the original real world situation.

2. Use a function to model a real world situation.

EXAMPLES

a. Choose a function suitable for modeling a real world situation presented using words or data.

b. Determine and interpret the meaning of rates of change, intercepts, zeros, extrema, and trends.

c. Use an appropriate linear or non-linear function (e.g., quadratic, exponential).

d. Use a sequence expressed in recursive or closed form.

3. Evaluate the problem-solving process.

EXAMPLES

a. Evaluate a real world solution for accuracy and effectiveness.

b. Compare and analyze various methods for solving a real world problem.

IX. Communication and Representation

A. Language, terms, and symbols of mathematics

1. Use mathematical symbols, terminology, and notation to represent given and unknown information in a problem.

EXAMPLES

a. Use variables to represent quantities in contextual situations.

b. Analyze problem situations and represent them using algebraic expressions and equations.

c. Use and understand the many ways an "=" sign is used (e.g., to state a definition or formula; to represent an identity; to express a conditional equation; to identify constant and variable terms in expressions, equations, and inequalities).

d. Understand and use interval, set, and function notation.

e. Understand that certain symbols and words can have multiple meanings [e.g., (1, 2) can represent a point or an interval].

2. Use mathematical language to represent and communicate the mathematical concepts in a problem.

EXAMPLES

a. Represent information in a problem using algebraic expressions, equations, and inequalities.

b. Recognize contextual problems represented by linear and non-linear models.

3. Use mathematics as a language for reasoning, problem solving, making connections, and generalizing.

EXAMPLES

a. Use inductive and deductive reasoning to reach valid conclusions.

b. Write the converse, inverse, and contra-positive of any given conditional statement.

B. Interpretation of mathematical work

1. Model and interpret mathematical ideas and concepts using multiple representations.

EXAMPLES

a. Make tables of inputs and outputs for mathematical relations/functions.

b. Write symbolic representations for a verbal description of a relationship.

c. Construct visual representations (e.g., a graph) of relationships.

d. Describe orally or in written format the behavior of a mathematical idea using graphs, diagrams, tables, and algebraic representations.

e. Represent inequalities using graphs, interval notation, and set notation.

f. Use multiple representations of rate of change.

2. Summarize and interpret mathematical information provided orally, visually, or in written form within the given context.

EXAMPLES

a. Interpret mathematical information in an article from a media source.

b. Summarize mathematical information given orally and visually in a media report.

C. Presentation and representation of mathematical work

1. Communicate mathematical ideas, reasoning, and their implications using symbols, diagrams, graphs, and words.

EXAMPLES

a. Communicate ideas mathematically using symbols (e.g., equal signs, parentheses, subscripts, superscripts, order relations, set notation).

b. Develop geometric models to represent concepts and relationships (e.g., scatter plots).

c. Recognize and explain the meaning of information presented using mathematical notation.

2. Create and use representations to organize, record, and communicate mathematical ideas.

EXAMPLES

a. Use Venn diagrams to represent sets of real numbers, surveys, and other set relationships.

b. Show solutions of equations and inequalities, and solutions of systems of equations and inequalities, using the real number line and rectangular coordinate system.

c. Construct and use graphic organizers (e.g., tables, bubble maps, Venn diagrams, tree diagrams).

3. Explain, display, or justify mathematical ideas and arguments using precise mathematical language in written or oral communications.

EXAMPLES

a. Explain reasoning in both oral and written forms using notation, terminology, and logic.

b. Communicate reasons associated with performing steps in algebraic methods (e.g., explaining why a quadratic equation must be written in standard form first when solving by factoring).

c. Identify units associated with any variables and constants used in a problem solution.

X. Connections

A. Connections among the strands of mathematics

1. Connect and use multiple strands of mathematics in situations and problems.

EXAMPLES

a. Represent a geometric two-dimensional figure on the rectangular coordinate plane using a set of equations or inequalities.

b. Connect the concepts of ratios, rates, proportions, and percents (e.g., show slope as constant rate of change using similar triangles).

c. Compare and contrast different mathematical concepts and procedures that could be used to complete a particular task.

d. Combine appropriate numeric, algebraic, geometric, and statistical/probabilistic methods to solve a given problem.

2. Connect mathematics to the study of other disciplines.

EXAMPLES

a. Use mathematical models to solve problems in areas such as science, business, and economics.

b. Use applications of mathematics (e.g., carbon dating, exponential population growth, amortization tables).

c. Use geometric concepts and properties to solve problems in fields such as art and architecture.

B. Connections of mathematics to nature, real world situations, and everyday life

1. Use multiple representations to demonstrate links between mathematical and real world situations.

EXAMPLES

a. Model a given real world situation using an appropriate combination of sketches, graphs, and algebraic expressions.

b. Describe a given real world situation in algebraic terms, use that description to produce a geometric description, and vice-versa.

c. Connect mathematically created tables, graphs, and functions to fit real life situations (e.g., download data from the Internet).

2. Understand and use appropriate mathematical models in the natural, physical, and social sciences.

EXAMPLES

a. Identify mathematical sequences, ratios, and patterns in nature (e.g., Fibonacci sequence, golden ratio).

b. Explain the importance of margin of error in results of surveys.

c. Apply known mathematical relations (e.g., Ohm's Law, Hardy-Weinberg Law, rule for continuously compounded interest) to solve real world problems.

3. Know and understand the use of mathematics in a variety of careers and professions.

EXAMPLES

a. Identify mathematics used in several careers and professions.

b. Identify several careers or professions that are mathematically intensive fields.

Science Standards

with performance indicators

I. Nature of Science: Scientific Ways of Learning and Thinking

A. Cognitive skills in science

1. Utilize skepticism, logic, and professional ethics in science.

EXAMPLES

a. Read or listen to statements of arguments carefully and critically, evaluate what evidence deserves attention and what should be dismissed, and distinguish careful arguments from questionable ones.

b. Recognize indicators and symptoms of faulty or unreliable statements or arguments. These indicators include the following:

- Premises of the argument are not made explicit.
- Conclusions do not follow logically from the evidence.
- Argument is based on analogy but the comparison is faulty.
- Fact and opinion intermingle, opinions are presented as fact, or it is not clear which is which.
- Celebrity is used as authority.
- Vague attributions are used in place of specific references or citations.
- Reports of experimental results fail to describe appropriate controls.
- Faulty graphs distort appearance of results by omitting data, omitting part of the scale, using no scale at all, etc.

- Average (mean) results are reported, but not the amount of variation around the mean.
- Absolute and proportional quantities or percentages are mixed together without clarification.
- Other incorrect, misleading, or shoddy practices are used, as described in more detail in Science for All Americans, a report from Project 2061, AAAS, 1990.

c. Base alternate explanations on data and follow accepted, logical rules.

d. Demonstrate ability to review and evaluate articles from a variety of sources, including scientific journals, websites, and

popular publications to identify examples of proper statements and arguments, as well as examples where good practices were not exhibited.

2. Use creativity and insight to recognize and describe patterns in natural phenomena.

EXAMPLES

a. Categorize a given collection of objects and describe the criteria for categorization (e.g., by constructing a dichotomous key).

b. Determine a line of best fit for a given set of graphical data and predict by interpolation or extrapolation where additional data points are likely to occur.

c. Formulate explanatory models, mechanisms, or narratives that relate observed features to each other and that describe cause-effect or other relationships among natural phenomena.

d. Examine and analyze new situations or problems in light of previously understood principles.

3. Formulate appropriate questions to test understanding of natural phenomena.

EXAMPLES

a. Determine what additional data needs to be collected to draw conclusions from a given series of observations.

b. Make recommendations at the conclusion of an experiment to extend, adjust, or apply the research conducted.

4. Rely on reproducible observations of empirical evidence when constructing, analyzing, and evaluating explanations of natural events and processes.

EXAMPLES

a. Know how to keep and have experience in keeping a journal or other record that accurately describes observations; that distinguishes actual observations from ideas, speculations, and opinions about what was observed; and that is understandable weeks or months later.

b. Review and evaluate articles from a variety of scientific journals and pseudo-scientific/non-scientific publications and determine if the information is based on empirical evidence.

c. Distinguish between personal opinion and evidence gathered by observation and analysis.

B. Scientific inquiry

1. Design and conduct scientific investigations in which hypotheses are formulated and tested.

EXAMPLES

a. Develop hypotheses that lead to if/then predictions and know that hypotheses leading to accurate predictions are tentatively accepted, while hypotheses that lead to inaccurate predictions are rejected or discarded.

b. Formulate and clarify the method(s) of investigation, anticipating difficulties or needs for special equipment, time schedules, expenses, safety precautions, etc.

c. Identify appropriate controls and variables in the investigation.

d. Collect, organize, display, and analyze data according to an orderly plan, using data tables, graphs, narrative descriptions, or other methods as appropriate.

e. Compare predictions from hypotheses to data, and revise or discard hypotheses as appropriate.

f. Present results and seek critiques from others.

g. Predict the effect on a dependent variable when an independent variable is altered.

C. Collaborative and safe working practices

1. Collaborate on joint projects.

EXAMPLE

a. Work in teams and share responsibilities, acknowledging, encouraging, and valuing contributions of all team members.

2. **Understand and apply safe procedures in the laboratory and field, including chemical, electrical, and fire safety and safe handling of live or preserved organisms.**

EXAMPLES

a. Use Materials Safety Data Sheet (MSDS) information and demonstrate safe laboratory practices.

b. Apply MSDS information to evaluate and guide safe practices in temporary storage and handling of chemicals in the classroom.

c. Apply safe handling procedures for live and preserved organisms.

3. **Demonstrate skill in the safe use of a wide variety of apparatuses, equipment, techniques, and procedures.**

EXAMPLE

a. Troubleshoot equipment and experimental set-ups under supervision and identify unsafe conditions or practices.

D. Current scientific technology

1. **Demonstrate literacy in computer use.**

EXAMPLE

a. Use a variety of hardware platforms and software applications effectively, including word processing, data analysis and statistics packages, detectors and data-gathering probes, and other peripheral equipment.

2. **Use computer models, applications, and simulations.**

EXAMPLE

a. Use computer models, simulations, databases, visualizations, spreadsheets, and other applications to describe, analyze, and synthesize data and explanatory descriptions of natural phenomena.

3. **Demonstrate appropriate use of a wide variety of apparatuses, equipment, techniques, and procedures for collecting quantitative and qualitative data.**

EXAMPLE

a. Select a device from a given assortment of measuring devices that is most appropriate for data collection and explain why that device was chosen.

E. Effective communication of scientific information

1. **Use several modes of expression to describe or characterize natural patterns and phenomena. These modes of expression include narrative, numerical, graphical, pictorial, symbolic, and kinesthetic.**

EXAMPLE

a. Translate information presented in any of these modes into any other of these modes of expression to produce equivalent statements.

2. **Use essential vocabulary of the discipline being studied.**

EXAMPLE

a. Define and use a basic set of technical terms correctly and in context for each discipline studied.

II. Foundation Skills: Scientific Applications of Mathematics

A. Basic mathematics conventions

1. **Understand the real number system and its properties.**

EXAMPLES

a. Calculate sums, differences, products, and quotients of real numbers.

b. Determine rates from magnitudes (e.g., speed from time and distance) and magnitudes from rates (e.g., the expected number of births if the birth rate and population size are known; the estimated age of an artifact from carbon-14 data).

c. Convert compound units (e.g., kilometers per hour into meters per second).

d. Calculate circumference and area of rectangles, triangles, and circles, and the volumes of rectangular solids.

2. Use exponents and scientific notation.

EXAMPLE

a. Calculate sums, differences, quotients, and products using scientific notation.

3. Understand ratios, proportions, percentages, and decimal fractions, and translate from any form to any other.

EXAMPLES

a. Calculate the relationships among common fractions, decimal fractions, and percentages.

b. Calculate what percentage one number is of another and take a percentage of any number (e.g., 10 percent off, 60 percent gain).

c. Find the reciprocal of any number.

4. Use proportional reasoning to solve problems.

EXAMPLE

a. Solve problems in which the result is expressed as a ratio or proportion of the starting conditions (e.g., predict genotype of parents if traits of offspring are known; starting from a known concentration, calculate the new concentration after serial dilutions; calculate doubling time of a population from growth rate).

5. Simplify algebraic expressions.

EXAMPLE

a. Determine by numeric substitution the value of simple algebraic expressions [e.g., the expressions aX+bY, a(A+B), and (A-B)/(C+D)].

6. Estimate results to evaluate whether a calculated result is reasonable.

EXAMPLES

a. Estimate familiar lengths, weights, and time periods.

b. Estimate distances and travel times from maps.

c. Estimate actual sizes of objects based on scale drawings.

d. Estimate probabilities of outcomes of familiar situations, either on the basis of history (e.g., the fact that a certain football team has won its opening game eight times in the last 10 years) or on the basis of the number of possible outcomes (e.g., there are six sides on a die).

e. Trace the source of any large disparity between the estimate and the calculated answer.

f. Figure out what the unit (e.g., seconds, square centimeters, dollars per tankful) of the answer will be from the inputs to the calculation.

7. Use calculators, spreadsheets, computers, etc., in data analysis.

EXAMPLES

a. Read and follow step-by-step instructions given in calculator manuals when learning new procedures.

b. Make up and write out simple algorithms for solving problems that take several steps.

c. Report the appropriate units with the numerical answer.

d. Judge whether an answer is reasonable by comparing it to an estimated answer.

e. Round off the number appearing in the answer to an appropriate number of significant figures.

f. Demonstrate competency in using scientific notation features on calculators.

B. Mathematics as a symbolic language

1. Carry out formal operations using standard algebraic symbols and formulae.

EXAMPLE

a. Solve for unknown variables in an algebraic equation (e.g., solve for gas pressure, volume, or temperature given an initial set of gas conditions).

2. Represent natural events, processes, and relationships with algebraic expressions and algorithms.

EXAMPLE

a. Translate a narrative into an algebraic expression (e.g., write an equation from a word problem).

C. Understand relationships among geometry, algebra, and trigonometry

1. Understand simple vectors, vector notations, and vector diagrams, and carry out simple calculations involving vectors.

EXAMPLES

a. Carry out simple mathematical operations such as those presented in pre-calculus courses (e.g., determining slopes of lines or rates of change).

b. Convert a numerical vector quantity (e.g., magnitude and direction) into a graphical vector representation.

c. Perform graphical vector addition and subtraction.

2. Understand that a curve drawn on a defined set of axes is fully equivalent to a set of algebraic equations.

EXAMPLES

a. Construct graphs from given equations.

b. Predict the shape of a curve without graphing.

c. Plot the values of a given algebraic equation for a reasonable set of numerical parameters.

3. Understand basic trigonometric principles, including definitions of terms such as sine, cosine, tangent, cotangent, and their relationship to triangles.

EXAMPLE

a. Use sine, cosine, tangent, etc., to carry out numerical and algebraic calculations using these terms.

4. Understand basic geometric principles.

EXAMPLES

a. Use geometric principles to solve problems dealing with molecular angles, optics, and surface area to volume ratios.

b. Compute angle values using various geometric principles including the sum of angles in a triangle, alternate interior angles, and similar triangles.

D. Scientific problem solving

1. Use dimensional analysis in problem solving.

EXAMPLES

a. Use dimensional analysis to facilitate setting up calculations and to judge whether a final solution is reasonable.

b. Convert complex metric units using dimensional analysis (e.g., kilograms per cubic meter to grams per cubic centimeter).

E. Scientific application of probability and statistics

1. Understand descriptive statistics.

EXAMPLES

a. Given a set of data, compute the mean, median, mode, range, standard deviation, standard error, and percent error.

b. Evaluate whether two or more data sets show significant differences by comparing means, standard deviations, and standard errors.

c. Use appropriate statistical tests to evaluate hypotheses.

F. Scientific measurement

1. Select and use appropriate Standard International (SI) units and prefixes to express measurements for real-world problems.

EXAMPLES

a. Know common SI prefixes (pico to tera), their abbreviations, and their associated powers of 10.

b. Use SI base units (e.g., kilograms, meters) and derived units (e.g., liters, joules, grams per cubic centimeter).

c. Understand the relationship and usage of SI and standard English units in daily measurements.

2. Use appropriate significant digits.

EXAMPLES

a. Know the rules for adding, subtracting, multiplying, and dividing measurements using the appropriate number of significant digits.
b. Apply an understanding of significant digits and estimated digits to evaluate and guide selection of appropriate measuring devices.
c. Make measurements using various devices and record data with the correct number of significant figures.
d. Distinguish between accuracy (i.e., closeness to true value), and precision (i.e., reproducibility).

3. Understand and use logarithmic notation (base 10).

EXAMPLES

a. Using log tables or calculators, determine the log of a number between 1 and 10, and determine the value of a number from its logarithm (base 10).
b. Express the value of the log (base 10) of a number greater than 10 or less than 1, using scientific notation.
c. Recognize, without the help of log tables or calculators, the log (base 10) of any power of 10.
d. Add or subtract numbers expressed as logs accurately to determine values represented.
e. Use logarithms for calculations involving numbers less than one or greater than 10 (i.e., numbers expressed with exponents of ten in scientific notation).
f. Calculate the pH of a given molar concentration of an acid or alkaline (basic) solution.

III. Foundation Skills: Scientific Applications of Communication

A. Scientific writing

1. Use correct applications of writing practices in scientific communication.

EXAMPLES

a. Construct word (narrative) descriptions of apparatuses, equipment, techniques and procedures, data, and other features of scientific investigations with sufficient clarity that a layman reader can comprehend and replicate the items or arrangements being described.
b. Write accurate and understandable lab reports and technical documents.
c. Prepare a summary or abstract of a technical article or report, extracting in brief form the pertinent information.
d. Use appropriate terminology and data expression to communicate information in a concise manner.
e. Give credit to original authors including online or electronic sources and never take credit for words that are not one's own.
f. Write a technical report including a bibliography and proper documentation of sources using a standard style.

B. Scientific reading

1. Read technical and scientific articles to gain understanding of interpretations, apparatuses, techniques or procedures, and data.

EXAMPLES

a. Describe the contents of a technical or scientific article.
b. Explain the importance of a technical or scientific article.
c. Make reasonable conclusions or predictions from given scientific article data.

2. Set up apparatuses, carry out procedures, and collect specified data from a given set of appropriate instructions.

EXAMPLE

a. Follow a written procedure to set up and perform a lab activity.

3. Recognize scientific and technical vocabulary in the field of study and use this vocabulary to enhance clarity of communication.

EXAMPLE

a. Identify and define key scientific terminology from technical and scientific documents.

4. List, use and give examples of specific strategies before, during, and after reading to improve comprehension.

EXAMPLES

a. List strategies to use before reading, including: activate prior knowledge of the topic, gain a clear understanding of the goal or purpose of the reading, and analyze the way in which the material is structured.

b. List strategies to use during reading, including: focus attention on the text; anticipate and predict what information the text is likely to contain; monitor understanding by self-questioning and the use of strategies (e.g., mental imagery, paraphrasing, information in glossaries) to re-examine the text if comprehension fails; reread difficult passages or read ahead for additional clarification; seek outside help for clarification; and frequently self-monitor and summarize the information that has been gained.

c. List strategies to use after reading, including: summarize the major points in the text and use graphic organizers (e.g., concept maps, problem-solution diagrams, cycle diagrams) to organize terms and concepts from the text in a visual manner.

C. Presentation of scientific/technical information

1. Prepare and present scientific/technical information in appropriate formats for various audiences.

EXAMPLES

a. Make presentations using posters, spoken words, printed graphics, electronic applications (e.g., MS PowerPoint), and other formats.

b. Present data or explanations extemporaneously without word-by-word reading of a prepared text.

c. Answer questions generated by an oral presentation appropriately.

D. Research skills/information literacy

1. Use search engines, databases, and other digital electronic tools effectively to locate information.

EXAMPLE

a. Use electronic tools to locate relevant information.

2. Evaluate quality, accuracy, completeness, reliability, and currency of information from any source.

EXAMPLES

a. Distinguish relevant and reliable sources from other search results.

b. Develop referencing skills to find needed background information.

IV. Science, Technology, and Society

A. Interactions between innovations and science

1. Recognize how scientific discoveries are connected to technological innovations.

EXAMPLE

a. Give examples of technological innovations that resulted from various scientific discoveries.

B. Social ethics

1. Understand how scientific research and technology have an impact on ethical and legal practices.

EXAMPLES

a. Describe how scientific research and technology have an impact on ethical and legal practices in society.

b. Recognize that honest and complete reporting of data, and fair, logically valid interpretation of data are the hallmarks of good science, and consistently follow these practices.

2. **Understand how commonly held ethical beliefs impact scientific research.**

EXAMPLE

a. Discuss positive and negative influences of commonly held ethical beliefs on scientific practice.

C. History of science

1. **Understand the historical development of major theories in science.**

EXAMPLE

a. Describe and explain the significance of historical development of quantum theory, modern atomic theory, biological evolution, plate tectonics, etc.

2. **Recognize the role of people in important contributions to scientific knowledge.**

EXAMPLE

a. Describe the contribution of selected individuals who have made major contributions to particular disciplines.

V. Cross-Disciplinary Themes

A. Matter/states of matter

1. **Know modern theories of atomic structure.**

EXAMPLES

a. Describe the characteristics and typical locations of sub-atomic particles such as protons, neutrons, and electrons.

b. Describe what happens when an atom becomes an ion.

2. **Understand the typical states of matter (solid, liquid, gas) and phase changes among these.**

EXAMPLES

a. Explain the differences in volume, shape, and strength of attractive forces for each state of matter.

b. Predict changes in the behavior of a gas sample as pressure, volume, or temperature is changed.

c. Identify the conditions under which a compound will be solid, liquid, or gas from a given phase diagram of a compound.

B. Energy (thermodynamics, kinetic, potential, energy transfers)

1. **Understand the Laws of Thermodynamics.**

EXAMPLES

a. Express thermodynamic principles in mathematical or symbolic statements.

b. List and give examples of each law of thermodynamics.

2. **Know the processes of energy transfer.**

EXAMPLES

a. Cite specific examples of such transfer processes in biological, chemical, physical, and geological systems.

b. Compare and contrast kinetic and potential energy.

C. Change over time/equilibrium

1. **Recognize patterns of change.**

EXAMPLES

a. Describe examples of physical and biological systems that remain stable over time, as well as examples of systems that undergo change.

b. Describe feedback mechanisms that lead to stability in a system (homeostasis) and provide examples of such mechanisms.

c. Describe cyclic change in terms of frequency, amplitude (maximum and minimum values), duration, and controlling factors, and illustrate these descriptions with examples of real cycles.

d. Know that things can change in detail but remain the same in general (e.g., players are substituted in and out of the game but the team continues, individual cells are replaced but the organism remains alive), and give discipline-specific examples.

e. Know that in biological systems, present forms arise from the materials and forms of the past both at the individual level (growth/development) and at the population level (evolution/speciation), and in ways that can be explained. Describe examples that illustrate such events and processes.

f. Use graphs, symbolic equations, and other techniques for depicting and analyzing patterns of change.

D. Classification

1. Understand that scientists categorize things according to similarities and differences.

EXAMPLES

a. Correctly use nomenclature for classification.

b. Describe the characteristics of the different domains, kingdoms, and major phyla within the animal and plant kingdoms.

c. Understand the Periodic Table and the atomic characteristics on which it is based.

d. Know the major categories of minerals and describe characteristics that distinguish one from another.

e. Recognize various soil types and the various horizons in soil structure; describe characteristics that distinguish one from the other.

f. Know the Linnaean system of classification, taxonomy of organisms, and alternative classification systems such as cladistics.

g. Distinguish among elements, compounds, and mixtures.

E. Measurements and models

1. Use models to make predictions.

EXAMPLE

a. Create a model of a system and use that model to predict the behavior of a larger system.

2. Use scale to relate models and structures.

EXAMPLE

a. Create a model of a larger system, properly scaling the model.

3. Demonstrate familiarity with length scales from sub-atomic particles through macroscopic objects.

EXAMPLE

a. Compare the order of magnitude estimates for metric sizes of a variety of objects (e.g., atomic nucleus, atom, molecule, grain of sand, pinhead, fingernail, baseball, city, state, country, planet, star).

VI. Biology

A. Structure and function of cells

1. Know that although all cells share basic features, cells differentiate to carry out specialized functions.

EXAMPLES

a. Describe criteria for recognizing different functional cell types and give examples of such types including nervous, epithelial, muscle, and other cells.

b. Name and describe basic cell types found in living organisms.

c. Give examples of particular modifications of cells, and explain how these modifications are related to each type's function in an organism.

d. Recognize and describe major features that distinguish plant, animal, and fungal cells.

2. Explain how cells can be categorized into two major types: prokaryotic and eukaryotic, and describe major features that distinguish one from the other.

EXAMPLE

a. Describe or recognize major features that distinguish prokaryotic from eukaryotic cells.

3. Describe the structure and function of major sub-cellular organelles.

EXAMPLE

a. Describe or recognize the appearance or structure of ribosomes, cytoplasmic membrane, chromosomes, cell wall, eukaryotic nucleus, nucleolus, lysosomes, vacuoles, cytoskeleton, centrioles, cilia, flagella, Golgi apparatus, chloroplasts, mitochondria, and endoplasmic reticulum, and describe important functions of each.

4. Describe the major features of mitosis and relate this process to growth and asexual reproduction.

EXAMPLES

a. Draw, describe, and place in sequence the various stages of mitosis.
b. Identify the stages of mitosis when presented on a microscope slide, computer animation, or drawing during a practical lab exam.
c. Arrange pictures or word descriptions of the stages of mitosis into correct sequence and describe or explain any significant events occurring in each stage.

5. Understand the process of cytokinesis in plant and animal cells and how this process is related to growth.

EXAMPLE

a. Describe the major features and events of cytokinesis with pictures or word descriptions.

6. Know the structure of membranes and how this relates to permeability.

EXAMPLE

a. Describe and explain the processes of osmosis and diffusion, and explain how the structure of plasma membranes permits and influences these events.

B. Biochemistry

1. Understand the major categories of biological molecules: lipids, carbohydrates, proteins, and nucleic acids.

EXAMPLES

a. Describe the role of each type of biological molecule within a living system.
b. Identify a biological molecule based on its formula and structure.
c. Describe the major role of each biological molecule in biological structure and metabolism.

2. Describe the structure and function of enzymes.

EXAMPLES

a. Describe the environmental effects (e.g., pH, temperature) on enzyme activity and explain why these affect enzymes.
b. Give specific examples of enzymes and why they are important in the human body.
c. Describe the chemical structure of proteins, including amino acids, peptide bonds, and polypeptide formation.
d. Describe the effects of enzymes on reaction rates, including effects on activation energy requirements.

3. Describe the major features and chemical events of photosynthesis.

EXAMPLES

a. Explain the importance of chlorophyll.
b. Describe patterns of electron flow through light reaction events.
c. Describe significant features of the Calvin cycle.

4. Describe the major features and chemical events of cellular respiration.

EXAMPLES

a. Describe what Adenosine Triphosphate (ATP) is and its importance as an energy carrier molecule.
b. Describe major features of glycolysis, Krebs cycle, electron transport system, and chemiosmosis.

5. Know how organisms respond to presence or absence of oxygen, including mechanisms of fermentation.

EXAMPLES

a. Conduct lab experiments regarding fermentation, respiration, and photosynthesis.
b. Describe the role of oxygen in respiration and describe pathways of electron flow in the absence of oxygen.
c. Explain the advantages and disadvantages of fermentation and aerobic respiration.

6. Understand coupled reaction processes and describe the role of ATP in energy coupling and transfer.

EXAMPLE

a. Describe reactions that produce and consume ATP.

C. Evolution and populations

1. Know multiple categories of evidence for evolutionary change and how this evidence is used to infer evolutionary relationships among organisms.

EXAMPLE

a. Describe features of biogeography/plate tectonics, fossil record, metabolism, DNA/protein sequences, homology, embryology, artificial selection/agriculture, and antibiotic resistance that contribute to our understanding of evolutionary change.

2. Recognize variations in population sizes, including extinction, and describe mechanisms and conditions that produce these variations.

EXAMPLES

a. Describe mechanisms that produce variations in population sizes.

b. Recognize, describe, and explain typical patterns of change in population size (e.g., the logistic growth curve).

c. Describe particular examples of extinction and describe conditions that produced these extinctions (e.g., Permian, Cretaceous dinosaur, wooly mammoth, passenger pigeon).

d. Know that populations of organisms have changed, and continue to change over time, showing patterns of descent with modification from common ancestors to produce the organismal diversity observed today.

e. Describe general features of the history of life on Earth, including generally accepted dates and sequence of the geologic time scale and characteristics of major groups of organisms present during these time periods.

f. Describe mechanisms that produce change in populations from generation to generation (e.g., artificial selection, natural selection, genetic drift, mutation, recombination).

g. Describe and explain processes and major events in natural selection, genetic drift, mutation, etc., and distinguish these processes from each other.

D. Molecular genetics and heredity

1. Understand Mendel's laws of inheritance.

EXAMPLES

a. Describe the laws of Mendelian genetics.

b. Predict outcomes of a variety of test crosses and be able to predict parental genotypes for offspring.

c. Use the laws of inheritance to carry out numerical calculations analyzing and predicting genetic characteristics of parents and offspring.

d. Read a "genetics problem" and identify the information needed to complete a Punnett square.

e. Determine phenotypes and genotypes of offspring from a given set of data about parental phenotypes and/or genotypes, expressing these features in numerical terms for cases of monohybrid and dihybrid crosses and other typical cases.

f. Determine phenotypes and genotypes of parents from a given set of data about offspring phenotypes and/or genotypes, expressing these features in numerical terms.

2. Know modifications to Mendel's laws.

EXAMPLE

a. Determine phenotypes and genotypes of offspring from a given data set about parental phenotypes and/or genotypes; express these features in numerical terms for cases of co-dominance, quantitative inheritance, sex-linked traits, and other typical cases.

3. Understand the molecular structures and functions of nucleic acids.

EXAMPLES

a. Research a genetic disorder and describe the cause of the disorder.

b. Describe in words or pictures the molecular structure of DNA, RNA, and proteins.

c. Describe in words or pictures the molecular events of replication, transcription, translation, and mutation.

d. Describe the events and processes of molecular genetics: DNA controls synthesis of several types of RNA, RNA molecules plus proteins cooperate to synthesize new proteins, and proteins control structure and metabolism of cells.

e. Describe the processes of electrophoresis and polymerase chain reaction, and explain their function in identifying DNA, RNA, and proteins.

4. Understand simple principles of population genetics and describe characteristics of a Hardy-Weinberg population.

EXAMPLES

a. Calculate phenotypes and genotypes of offspring populations from a given set of data about phenotypes and/or genotypes present in a population, using the Hardy-Weinberg equations.

b. Describe and explain features of a population that must be present in order for Hardy-Weinberg calculations to be accurate.

5. Describe the major features of meiosis and relate this process to Mendel's laws of inheritance.

EXAMPLES

a. Explain the events of meiosis and the significance of these events to maintain chromosomal numbers.

b. Explain how the events of meiosis produce the genetic effects described by Mendel's laws of inheritance.

c. Arrange pictures or word descriptions of the stages of meiosis into their correct sequence and describe or explain any significant events occurring in each stage.

d. Compare and contrast mitosis and meiosis.

E. Classification and taxonomy

1. Know ways in which living things can be classified based on each organism's internal and external structure, development, and relatedness of DNA sequences.

EXAMPLES

a. Explain the relationship between DNA sequences and physical characteristics.

b. Describe the characteristics of each taxon and explain the significance in separating organisms.

c. Distinguish similarities and differences among a given set of pictures or drawings of vertebrates during their development.

d. Describe species diversity and cladistics, including the types of evidence and procedures that can be used to construct diagrams (e.g., phylogenetic trees).

e. Construct cladograms and/or phylogenetic trees from simple data sets for major groups of organisms.

f. Determine the correct classification and taxonomy of organisms from narrative or pictorial descriptions.

F. Systems and homeostasis

1. Know that organisms possess various structures and processes (feedback loops) that maintain steady internal conditions.

EXAMPLES

a. Describe examples of organisms that possess various structures and processes (feedback loops) that maintain steady internal conditions.

b. Describe examples of homeostasis (e.g., temperature regulation, osmotic balance, glucose levels) and describe the major features of feedback loops that produce such homeostasis.

2. Describe, compare, and contrast structures and processes that allow gas exchange, nutrient uptake and processing, waste excretion, nervous and hormonal regulation, and reproduction in plants, animals, and fungi; give examples of each.

EXAMPLES

a. Describe common gas exchange systems in plants and animals including anatomical features and functions.

b. Describe common nutrient acquisition systems in plants, animals, and fungi, including anatomical features and functions.

c. Describe common waste excretion systems in plants and animals, including anatomical features and functions.

d. Describe common nervous/hormonal control systems in plants and animals, including anatomical features and functions.

e. Describe common reproductive systems in plants, animals, and fungi, including anatomical features and functions.

G. Ecology

1. Identify Earth's major biomes, giving their locations, typical climate conditions, and characteristic organisms.

EXAMPLE

a. Name and describe Earth's major biomes, including tundra, boreal forests, temperate deciduous forests, grasslands, deserts, tropical rain forests, estuaries and other wetlands, and marine biomes, including their typical locations, the typical organisms found in each, and important physical factors (e.g., temperature, rainfall rates) that produce these distribution patterns.

2. Know patterns of energy flow and material cycling in Earth's ecosystems.

EXAMPLES

a. Describe patterns of energy flow and nutrient cycling through ecosystems.

b. Describe and explain a trophic pyramid, including descriptions of typical organisms to be found at each trophic level in an ecosystem.

c. Describe patterns of energy flow and nutrient cycling through ecosystems including the role of microorganisms.

3. Understand typical forms of organismal behavior.

EXAMPLE

a. Describe and give examples of organismal behavior (e.g., fixed action patterns, releasers, fight-or-flight responses, territorial displays, circadian rhythms).

4. Know the process of succession.

EXAMPLE

a. Describe events and processes that occur in succession, including changes in organismal populations, species diversity, and life history patterns over the course of succession.

VII. Chemistry

A. Matter and its properties

1. Know that physical and chemical properties can be used to describe and classify matter.

EXAMPLES

a. Distinguish between physical properties (e.g., density, melting point) and chemical properties (e.g., ability to react, combustibility). Know that chemical changes create new substances (e.g., rusting), while physical changes do not (e.g., boiling).

b. Understand that, as an intrinsic property, density does not change as sample size is changed, and be able to perform density calculations.

2. Recognize and classify pure substances (elements, compounds) and mixtures.

EXAMPLES

a. Describe separation techniques for both mixtures and compounds.

b. Distinguish between homogeneous and heterogeneous mixtures.

c. Understand that, as an intrinsic property, density does not change as sample volume is changed, and be able to perform density calculations.

B. Atomic structure

1. Summarize the development of atomic theory. Understand that models of the atom are used to help understand the properties of elements and compounds.

EXAMPLES

a. Describe the discoveries of Dalton (atomic theory), Thomson (the electron), Rutherford (the nucleus), and Bohr (planetary model of the atom); understand how each discovery contributed to modern atomic theory.

b. Identify the masses, charges, and locations of the major components of the atom (protons, neutrons, and electrons); describe Rutherford's "gold foil" experiment that led to the discovery of the atomic nucleus; and describe Millikan's "oil drop" experiment that led to determining the charge on an electron.

c. Describe basic wave properties (calculate wavelength, frequency, or energy of light) and understand that electrons can be described by the physics of waves.

d. Explain the importance of quantized electron energy and its relationship to atomic emission spectra.

e. Understand the electron configuration in atoms (Aufbau principle, the Pauli exclusion principle, Hund's rule) and their connection with the periodic table.

C. Periodic table

1. Know the organization of the periodic table.

EXAMPLES

a. Identify periods and groups on the periodic table.

b. Identify metals, metalloids, and non-metals on the periodic table.

c. Distinguish between and describe patterns in electron configurations for representative elements, transition elements, inner-transition elements, and noble gases. Predict the common charges on the representative elements from the periodic table.

2. Recognize the trends in physical and chemical properties as one moves across a period or vertically through a group.

EXAMPLES

a. Define and describe the periodic trend: atomic radii, ionic radii, ionization energy, electron affinity, and electronegativity.

b. Use the periodic trends to compare the size and behavior of atoms and ions.

D. Chemical bonding

1. Characterize ionic bonds, metallic bonds, and covalent bonds. Describe the properties of metals and ionic and covalent compounds.

EXAMPLES

a. Draw Lewis dot structures for simple molecules, including simple hydrocarbons.

b. Use Valence Shell Electron Pair Repulsion (VSEPR) model to predict molecular shapes.

c. Describe nonpolar and polar covalent bonds. Use a chart of electronegativities to determine bond polarity.

d. Determine if a molecule is polar (contains a dipole moment).

E. Chemical reactions

1. Classify chemical reactions by type. Describe the evidence that a chemical reaction has occurred.

EXAMPLES

a. Write equations for chemical reactions using appropriate symbols and balance the equations by applying the Law of Conservation of Mass. Write net ionic equations.

b. Predict the products of a reaction that fall within the five general types of chemical reactions (synthesis, decomposition, single replacement, double replacement, and combustion).

c. Use an activity series to predict whether a single replacement reaction will occur.

d. Use solubility rules to determine the precipitate formed in a double replacement precipitation reaction.

2. Describe the properties of acids and bases and identify the products of a neutralization reaction.

EXAMPLES

a. Define pH and describe acid and base solutions in terms of pH. Use hydrogen ion or hydroxide ion concentrations to determine the pH of an acid or base solution.

b. Use both commercial and non-commercial indicators to identify acid, base, and neutral solutions in a lab experiment.

c. Distinguish between the Arrhenius and Brønsted definitions of acids and bases. Identify conjugate acid-base pairs.

d. Describe how a titration is performed and how this process can be used to determine the concentration of an unknown acid or base solution.

e. Measure and compare the pH of various common acids and bases (e.g., household cleaners, vinegar, citrus juice).

3. Understand oxidation-reduction reactions.

EXAMPLES

a. Differentiate between oxidation and reduction, and between oxidizing agent and reducing agent.

b. Understand the consequences of corrosion processes and define and describe the electroplating process.

c. Determine the oxidation number of any atom in an element, ion, or compound.

4. Understand chemical equilibrium.

EXAMPLES

a. Identify the factors that cause a shift in equilibrium (e.g., temperature, concentration, volume, pressure).

b. Explain LeChatelier's principle and use this principle to predict changes in the equilibrium position of a reaction.

5. Understand energy changes in chemical reactions.

EXAMPLES

a. Distinguish between endothermic and exothermic reactions. Draw energy diagrams for endothermic and exothermic reactions.

b. Describe the Law of Conservation of Energy.

6. Understand chemical kinetics.

EXAMPLES

a. Describe collision theory and use this theory to explain effects of concentration, temperature, and nature of reactants on reaction rate.

b. Define catalyst and describe how a catalyst affects a reaction rate.

F. Chemical nomenclature

1. Know formulas for ionic compounds.

EXAMPLE

a. Name and write formulas for binary and ternary ionic compounds, using Group A (representative) metals and Group B (transition) metals, including those containing common polyatomic ions (e.g., nitrate, sulfate, carbonate, ammonium, phosphate, hydroxide).

2. Know formulas for molecular compounds.

EXAMPLES

a. Name and write formulas for binary molecular compounds and acids.

b. Categorize a compound as ionic or molecular.

G. The mole and stoichiometry

1. Understand the mole concept.

EXAMPLE

a. Use Avogadro's number and molar mass to convert to moles of a substance. Determine the percent composition of a compound. Calculate the empirical formula of a compound from mass or percent composition data.

2. **Understand molar relationships in reactions, stoichiometric calculations, and percent yield.**

EXAMPLES

a. Construct mole ratios for a reaction to calculate the reactant amounts needed or product amounts formed in terms of moles or mass.

b. Calculate percent yield, theoretical yield, or actual yield for a reaction.

H. Thermochemistry

1. **Understand the Law of Conservation of Energy and processes of heat transfer.**

EXAMPLES

a. Distinguish among radiation, convection, and conduction as means of heat transfer.

b. Describe processes of heat transfer.

c. Perform calculations involving heat transfer, using specific heat and latent heat (phase changes).

2. **Understand energy changes and chemical reactions.**

EXAMPLES

a. Describe and give examples of renewable and non-renewable energy resources.

b. Describe endothermic and exothermic reactions.

c. Know that systems naturally tend to move in a direction that increases disorder or randomness (entropy).

I. Properties and behavior of gases, liquids, and solids

1. **Understand the behavior of matter in its various states: solid, liquid, and gas.**

EXAMPLES

a. Describe how gas pressure is affected by volume, temperature, and the addition of gas.

b. Describe the behavior of solids, liquids, and gases under changes in pressure.

2. **Understand properties of solutions.**

EXAMPLES

a. Describe factors affecting solubility, units of concentration, colligative properties, and colloids.

b. Calculate the molarity and molality of solutions.

c. Determine boiling point elevation and freezing point depression for a solution.

3. **Understand principles of ideal gas behavior and kinetic molecular theory.**

EXAMPLES

a. Use kinetic molecular theory to explain how gas pressure is affected by volume, temperature, and the addition of gas.

b. Distinguish between real and ideal gas behavior, and identify the criteria in the kinetic molecular theory that conflict with the properties of real gases.

4. **Apply the concept of partial pressures in a mixture of gases.**

EXAMPLE

a. Use Dalton's Law to determine the partial pressure of a gas in a mixture of gases.

5. **Know properties of liquids and solids.**

EXAMPLES

a. Describe the properties of liquids (e.g., surface tension, capillary action).

b. Describe the structure of solids (e.g., crystal lattice structure, unit cell, amorphous solids).

6. **Understand the effect of vapor pressure on changes in state; explain heating curves and phase diagrams.**

EXAMPLES

a. Define boiling, freezing, sublimation, etc.

b. Explain heating curves and phase diagrams.

7. **Describe intermolecular forces.**

EXAMPLE

a. Distinguish between dispersion forces, dipole interactions, and hydrogen bonding. Identify the most important intermolecular force acting on a substance.

J. Basic structure and function of biological molecules: proteins, carbohydrates, lipids, and nucleic acids

1. Understand the major categories of biological molecules: proteins, carbohydrates, lipids, and nucleic acids.

EXAMPLE

a. Recognize each type of biological molecule by its structural formula, and describe simple chemical tests or procedures to detect, identify, or characterize each type.

K. Nuclear chemistry

1. Understand radioactive decay.

EXAMPLES

a. Identify the types of radioactive decay particles that occur, compare their properties (e.g., mass, charge, composition, penetrating ability), and write equations representing the decay processes.

b. Explain the concept of half-life for a radioisotope, and use this concept to determine the amount of a certain sample of radioisotope remaining after a period of time, given the length of the half-life.

c. Determine the length of time that has passed, given the remaining amount of radioisotope, the original amount of radioisotope, and the length of the half-life.

d. Explain how carbon-14 is used to date artifacts.

e. Compare and contrast the nuclear processes of fission and fusion.

VIII. Physics

A. Matter

1. Demonstrate familiarity with length scales from sub-atomic particles through macroscopic objects.

EXAMPLE

a. Compare order of magnitude estimates for metric sizes of a variety of objects (e.g., atomic nucleus, atom, molecule, grain of sand, pinhead, fingernail, baseball, city, state, country, planet, star).

2. Understand states of matter and their characteristics.

EXAMPLES

a. Describe the states of matter in terms of volume, shape, and cohesive strength.

b. State the physical changes associated with a change in phase.

3. Understand the concepts of mass and inertia.

EXAMPLES

a. Describe the concept of mass as a measurement of inertia.

b. Compare order of magnitude estimates for masses of a variety of objects (e.g., electron, grain of sand, pebble, baseball, person, car, planet, star).

4. Understand the concept of density.

EXAMPLES

a. Define density as the ratio of mass to volume. Apply the definition to calculate mass, volume, or density given two of the three quantities.

b. Calculate density of a homogeneous material and use it to identify the material.

5. Understand the concepts of gravitational force and weight.

EXAMPLES

a. Qualitatively and quantitatively describe Newton's Law of Gravitation and the factors that affect the gravitational force between two objects.

b. Describe weight as a force of attraction to a large body and make computations of weight (using W=mg).

c. Give examples to differentiate between mass and weight.

B. Vectors

1. Understand how vectors are used to represent physical quantities.

EXAMPLES

a. State several examples of scalar quantities.

b. State several examples of vector quantities.

c. Convert a numerical vector quantity (magnitude and direction) into a graphical vector representation.

2. Demonstrate knowledge of vector mathematics using a graphical representation.

EXAMPLES

a. Resolve a vector quantity (magnitude and direction) into perpendicular components using paper, a ruler, and a protractor.

b. Add and subtract various vectors using paper, a ruler, and a protractor.

3. Demonstrate knowledge of vector mathematics using a numerical representation.

EXAMPLES

a. Resolve a numerical vector quantity (magnitude and direction) into perpendicular components using trigonometric functions and a calculator.

b. Add and subtract various vectors using trigonometric functions and a calculator.

C. Forces and motion

1. Understand the fundamental concepts of kinematics.

EXAMPLES

a. State the definitions for displacement, distance, velocity, speed, and acceleration.

b. Solve problems involving displacement, distance, velocity, speed, and acceleration.

c. Solve one-dimensional kinematics problems for the case of constant acceleration.

d. Create and interpret graphs of one-dimensional motion (e.g., position vs. time, velocity vs. time).

e. Describe two-dimensional trajectory motion qualitatively and quantitatively.

f. Describe the concept of relative motion and define a frame of reference.

2. Understand forces and Newton's Laws.

EXAMPLES

a. State Newton's Laws of Motion and demonstrate understanding of their application through lab activities.

b. Solve for an unknown quantity using Newton's Second Law and the concept of equilibrium.

c. Distinguish qualitatively between static and kinetic friction, and describe their effects on the motion of objects.

3. Understand the concept of momentum.

EXAMPLES

a. Define and calculate momentum and impulse. Clearly indicate how momentum is a vector.

b. State the conditions under which momentum is conserved.

c. Describe the term "impulse" in terms of force, time, and momentum. Illustrate the principle of impulse by citing several examples.

d. Solve problems using impulse and the conservation of momentum.

D. Mechanical energy

1. Understand potential and kinetic energy.

EXAMPLES

a. Calculate potential energy values for various types of potential energy (gravitational, elastic, electrical).

b. Calculate kinetic energy values (translational, rotational).

c. Using a diagram of a pendulum or another energy conserving system, identify potential and kinetic energy at various locations.

2. Understand conservation of energy.

EXAMPLES

a. Describe the conversion of potential energy into kinetic energy (and vice-versa) in closed systems for which only conservative forces are present.

b. Describe the conversion of energy in systems in which dissipative forces are present.

c. Describe the general conservation of energy.

3. Understand the relationship of work and mechanical energy.

EXAMPLES

a. Compute net work as the product of net force and displacement, as the change in kinetic energy, and as the negative change in potential energy.

b. Describe the concept of power and calculate average power.

c. Distinguish between energy and power qualitatively, and state the dimensional units for each.

E. Rotating systems

1. Understand rotational kinematics.

EXAMPLES

a. Describe the relationships between the concepts and equations used for translational motion and those used for rotational motion.

b. Define qualitatively: angular displacement, angular velocity, and angular acceleration.

c. Complete computations including angular displacement, angular velocity, angular acceleration, tangential acceleration, and centripetal (radial) acceleration.

d. Use examples to illustrate differences between tangential acceleration and centripetal (radial) acceleration.

e. Explain why a net force (called centripetal) is required in order for an object to move in a circular path.

2. Understand the concept of torque.

EXAMPLES

a. Describe the concept of torque and compute torque values for various situations.

b. Describe the concept of moment of inertia and compute moment of inertia values for various objects.

c. Perform calculations using Newton's Second Law of Motion as applied to rotation.

3. Apply the concept of static equilibrium.

EXAMPLES

a. Describe the two conditions for which an object is in static equilibrium.

b. Construct an equation using the concept of static equilibrium and solve for an unknown quantity.

4. Understand angular momentum.

EXAMPLES

a. Describe the concept of angular momentum.

b. Describe changes in angular velocity when moment of inertia changes.

F. Fluids

1. Understand pressure in a fluid and its applications.

EXAMPLES

a. Define pressure and make basic pressure computations using pressure=force/area in appropriate units.

b. Describe qualitatively and quantitatively how the pressure in a fluid changes with depth and explain the physical basis for the relationship.

c. Describe the cause of atmospheric pressure and its variations.

2. Understand Pascal's Principle.

EXAMPLES

a. Describe and calculate changes in fluid pressure when external pressure is applied, especially as observed in hydraulic systems.

b. Show how Pascal's Principle applies to hydraulic systems and calculate forces on both sides of a hydraulic system.

3. Understand buoyancy.

EXAMPLES

a. Define buoyant force and state Archimedes' Principle.

b. Draw all the forces acting on an object submerged in a fluid. Discuss the conditions for sinking and floating in terms of the forces in the diagram.

4. Understand Bernoulli's principle.

EXAMPLE

a. Qualitatively describe the relationship between fluid speed and fluid pressure in a closed system.

G. Oscillations and waves

1. Understand basic oscillatory motion and simple harmonic motion.

EXAMPLES

a. Identify examples of oscillatory motion.

b. Recognize examples of simple harmonic motion.

2. Understand the difference between transverse and longitudinal waves.

EXAMPLE

a. Describe the motion of the medium as compared to the wave motion for both transverse and longitudinal waves.

3. Understand wave terminology: wavelength, period, frequency, and amplitude.

EXAMPLES

a. Perform computations using the formula (wave speed)=(wavelength)*(frequency).

b. Describe wavelength, period, frequency, and amplitude, and identify each from various wave graphs.

4. Understand the properties and behavior of sound waves.

EXAMPLES

a. Describe the properties and behavior of sound including compressions, rarefactions, and travel through various media.

b. Compare and contrast sound and electromagnetic waves in terms of wave speed, wave type, wavelength, frequency, and medium.

c. Describe the apparent change in frequency of waves due to the motion of a source or a receiver (the Doppler Effect).

H. Thermodynamics

1. Understand the gain and loss of heat energy in matter.

EXAMPLES

a. Describe, qualitatively and quantitatively, the relationship between heat and change in temperature, including the effects of mass and specific heat.

b. Identify and compute the energy involved in changes of state.

c. Explain the relationships among evaporation, condensation, cooling, and warming.

d. Describe the transfer of heat by conduction, convection, and radiation.

2. Understand the basic laws of thermodynamics.

EXAMPLES

a. State and describe the laws of thermodynamics.

b. Describe qualitative applications of the laws of thermodynamics and relate each to the concept of conservation of energy.

I. Electromagnetism

1. Discuss electric charge and electric force.

EXAMPLES

a. Describe electrical repulsion and attraction.

b. State Coulomb's Law and use it to compute electrical force.

c. Describe the concept of an electric field.

2. Gain qualitative and quantitative understandings of voltage, current, and resistance.

EXAMPLES

a. Describe the concept of electric potential.

b. Describe the concept of electrical charge flow and what limits that flow.

c. Describe the concept of electrical resistance to charge flow.

3. Understand Ohm's Law.

EXAMPLES

a. Solve for unknown quantities using Ohm's Law.

b. Determine electrical resistance from graphs of voltage versus current.

4. Apply the concept of power to electricity.

EXAMPLE

a. Define electrical power as the product of current and voltage; perform simple calculations of power consumption.

5. Discuss basic DC circuits that include voltage sources and combinations of resistors.

EXAMPLES

a. Summarize the electrical characteristics (current, voltage, total resistance) of a circuit consisting of two or more resistors wired in series.

b. Summarize the electrical characteristics (e.g., current, voltage) of a circuit consisting of two or more resistors wired in parallel.

c. Compare the electrical characteristics (e.g., current, voltage) of a circuit consisting of two or more resistors wired in parallel with those of the same components wired in series.

6. Discuss basic DC circuits that include voltage sources and combinations of capacitors.

EXAMPLES

a. Describe what a capacitor is and how it works.

b. Summarize the electrical characteristics (e.g., current, voltage) of a DC circuit consisting of a battery and a capacitor.

c. Summarize the electrical characteristics (e.g., current, voltage) of a DC circuit consisting of a capacitor and a resistor wired in series.

7. Understand magnetic fields and their relationship to electricity.

EXAMPLES

a. Describe the force experienced by a moving electric charge in a magnetic field.

b. Describe moving electrical charge as the source of magnetic fields.

c. Describe Faraday's Law and Lenz's Law.

d. Describe the source of magnetism in matter.

e. State the law of magnetic poles.

8. Relate electricity and magnetism to everyday life.

EXAMPLES

a. Explain how an electric motor works. State which electromagnetic laws or principles govern the workings of a motor.

b. Explain how an electric generator works. State which electromagnetic laws or principles govern the workings of a generator.

c. Make quantitative predictions of whether or not a circuit breaker will "trip" when a variety of electrical appliances are in use.

J. Optics

1. Know the electromagnetic spectrum.

EXAMPLES

a. Discuss the regions of the electromagnetic spectrum, including radio waves, microwaves, infrared, visible, ultraviolet, x-rays, and gamma rays.

b. Discuss visible light as part of the electromagnetic spectrum. Emphasize that light is an electromagnetic wave.

c. Recognize that electromagnetic waves are transverse waves and travel at the speed of light through a vacuum.

d. Compare and contrast transmission, reflection, and absorption of radiation.

2. Understand the wave/particle duality of light.

EXAMPLES

a. Describe the behavior of light and why scientists have chosen to model it as both a particle and a wave.

b. Give a practical example that illustrates light acting as a wave. Give a practical example that illustrates light acting as a particle.

3. Understand concepts of geometric optics.

EXAMPLES

a. Predict the path of a reflected light ray by applying the law of reflection to both diffuse and specular reflection.

b. Define index of refraction. Predict the path of a light ray through a transparent material by application of Snell's Law.

c. Identify convex, concave, and plane mirrors.

d. Identify convex and concave lenses.

e. Discuss qualitatively the images formed by mirrors and single lenses.

f. Discuss qualitatively the images formed by combinations of mirrors and lenses (e.g., telescopes, microscopes, cameras).

IX. Earth and Space Sciences

A. Earth systems

1. Know the major features and characteristics of atmosphere, geosphere, hydrosphere, and biosphere.

EXAMPLES

a. Describe major components and interactions within the atmosphere: gas composition, temperatures at various levels, ozone formation, and breakdown.

b. Describe characteristics that identify and distinguish the core, mantle, and crust, including their locations, compositions, interactions with each other, and changes through time.

c. Describe major components and interactions within the hydrosphere (the global ocean and its components).

d. Describe major components and interactions within the biosphere, including major biogeochemical cycles (e.g., carbon cycle, oxygen-water cycle, nitrogen cycle, sulfur cycle, flow and storage of energy).

2. Understand relationships and interactions among atmosphere, geosphere, hydrosphere, and biosphere.

EXAMPLES

a. Describe interactions between oceans and climate.

b. Describe effects of catastrophic events (e.g., volcanoes, earthquakes) on Earth systems.

c. Describe impacts of the oceans on the Earth system (e.g., how the Earth's geologic history and present structure would have differed if the ocean had never formed).

d. Describe effects of biological activity on the atmosphere (e.g., CO_2 levels, O_2 levels).

e. Describe major effects of solar activity on the Earth's atmosphere and hydrosphere, including climate, ocean circulation, ozone formation, etc.

3. Possess a scientific understanding of the history of Earth's systems.

EXAMPLES

a. Describe methods and techniques for absolute and relative dating of geologic events and deposits.

b. Describe general features of the geological history of Earth, including generally-accepted dates and sequence of the geologic time scale, physical and chemical conditions prevailing on Earth at different times, and major extinction events among organisms during these time periods.

c. Explain how different surface processes (e.g., volcanism, erosion, tectonics, cratering) affect the planetary surface.

4. Utilize the tools scientists use to study and understand the Earth's systems.

EXAMPLE

a. Use remote sensing tools (e.g., maps, visualizations, satellites, GPS/GIS, seismographs, weather balloons, buoys) and the data they provide.

B. Sun, Earth, and moon system

1. Understand interactions among the sun, Earth, and moon.

EXAMPLE

a. Describe solar system processes that produce phases of the moon, solar and lunar eclipses, seasons, and tides.

2. Possess a scientific understanding of the formation of the Earth and moon.

EXAMPLE

a. Describe current scientific theories and evidence for the origin of Earth and its moon.

C. Solar system

1. Describe the structure and motions of the solar system and its components.

EXAMPLE

a. Identify and describe the major components of the solar system (e.g., star, planets, comets, dwarf planets, kuiper objects, asteroids).

2. Possess a scientific understanding of the formation of the solar system.

EXAMPLES

a. Describe the formation of the sun and the evidence that supports our understanding of this process.

b. Explain the differences between the formation of rocky and gaseous planets.

D. Origin and structure of the universe

1. Understand scientific theories for the formation of the universe.

EXAMPLES

a. Describe current scientific theories and evidence for the origin of the universe (the Big Bang) and formation of galaxies (Red Shift observations).

b. Describe the life cycle of stars using the Hertzsprung-Russell diagram.

2. Know the current scientific descriptions of the components of the universe.

EXAMPLES

a. Describe types of galaxies and the characteristics that distinguish them.

b. Describe general features of quasars and pulsars and the characteristics that distinguish them.

E. Plate tectonics

1. Describe the evidence that supports the current theory of plate tectonics.

EXAMPLES

a. Describe general features of the Earth's interior.

b. Describe the role of convection currents in plate motion.

2. Identify the major tectonic plates.

EXAMPLE

a. Locate and identify the major tectonic plates and plate boundaries on a map.

3. Describe the motions and interactions of tectonic plates.

EXAMPLE

a. Describe the geologic features that result from convergent, divergent, and transformed plate boundaries.

4. Describe the rock cycle and its products.

EXAMPLES

a. Identify common rocks and rock-forming minerals.

b. Classify and describe the formation of rocks (igneous, metamorphic, sedimentary).

F. Energy transfer within and among systems

1. Describe matter and energy transfer in the Earth's systems.

EXAMPLE

a. Describe Earth's principal sources of internal and external energy (e.g., radioactive decay, gravity, solar energy).

2. Give examples of effects of energy transfer within and among systems.

EXAMPLES

a. Describe energy sources and energy transfer processes (e.g., convection, conduction, radiation) that produce thunderstorms, hurricanes, tornadoes, and other weather events.

b. Provide examples of how the uneven heating of Earth influences global circulation patterns (e.g., currents, winds, weather).

c. Describe the effects of ocean currents on weather patterns.

d. Describe the effects of large impacts on geological structures and atmospheric conditions, and cite examples of evidence of large impacts in Earth's history.

X. Environmental Science

A. Earth systems

1. Recognize the Earth's systems.

EXAMPLE

a. Describe the characteristics that identify and distinguish the geosphere, atmosphere, hydrosphere, and biosphere.

2. Know the major features of the geosphere and the factors that modify them.

EXAMPLES

a. Describe the characteristics that identify and distinguish the core, mantle, crust, and tectonic plates, including their locations, compositions, interactions among them, and changes through time.

b. Describe processes of weathering, erosion, deposition, etc., that make up the rock cycle.

c. Describe factors such as earthquakes, volcanoes, and other natural disasters and their impact on the size and location of populations of organisms, and the habitats they occupy.

3. Know the major features of the atmosphere.

EXAMPLES

a. Describe the physical and chemical characteristics that identify different regions of the atmosphere.

b. Describe the factors that influence weather and climate, including atmospheric circulation, Coriolis Effect, and atmosphere-ocean interactions.

4. Know the major features of the hydrosphere.

EXAMPLES

a. Describe the composition and location of bodies of salt water and fresh water.

b. Describe patterns of ocean circulation, including currents and upwellings.

5. Be familiar with Earth's major biomes.

EXAMPLES

a. Name and describe Earth's major terrestrial and aquatic biomes, including their locations, the characteristic organisms found in each, and important physical factors (e.g., temperature, rain fall) that produce these distribution patterns.

b. Describe the adaptations of organisms found in each biome.

6. Describe the Earth's major biogeochemical cycles.

EXAMPLE

a. Describe the carbon, oxygen-water, sulfur, nitrogen, and phosphorus cycles, including the chemical forms of each element at each stage of the cycle, and the chemical patterns of winds and ocean currents and provide information about changes in these patterns during events such as El Niño/La Niña.

B. Energy

1. Understand energy transformations.

EXAMPLES

a. Describe patterns of winds and ocean currents and provide information about changes in these patterns during events such as El Niño/La Niña.

b. Describe how energy flows through the Earth's ecosystems while materials cycle repeatedly within these systems (e.g., food chains and webs, trophic levels, niches, predator-prey interactions, succession).

2. Know the various sources of energy for humans and other biological systems.

EXAMPLES

a. Describe the major sources of energy, including fossil fuels, geothermal sources, wind energy, solar energy, nuclear energy, and others.

b. Describe methods and practices of energy conservation.

C. Populations

1. Recognize variations in population sizes, including human population and extinction, and describe mechanisms and conditions that produce these variations.

EXAMPLES

a. Describe and explain carrying capacity, cultural and economic influences, urbanization, distribution, loss of biodiversity, endangered plants and animals, and deforestation.

b. Explain how the demographic structure of a population, birth and death rates, doubling times, and demographic transitions affect or produce changes in population size and composition.

c. Explain how evolution through natural selection can result in changes in biodiversity through the increase or decrease of genetic diversity within a population.

D. Economics and politics

1. Name and describe major environmental policies and legislation.

EXAMPLE

a. Describe and explain the goals and provisions of the Clean Water Act, the Endangered Species Act, and other major environmental policies and legislation.

2. Understand the types, uses, and regulations of the various natural resources.

EXAMPLE

a. Name the major U.S. National Parks and Monuments, stating where each is located, and the important features of each that justify protection.

E. Human practices and their impacts

1. Describe the different uses for land (land management).

EXAMPLE

a. Describe features of landscape and geology that lead different locations to be used for different purposes (e.g., agriculture, mining, recreation, urban settlement).

2. Understand the use and consequences of pest management.

EXAMPLE

a. Describe major types of pesticides and herbicides, and other methods of controlling pests (e.g., biocontrol, genetically-modified organisms).

3. Know the different methods used to increase food production.

EXAMPLE

a. Describe the features that identify and distinguish intensive agriculture, sustainable agriculture, organic agriculture, and other food and fiber production methods, including genetically-modified organisms and livestock practices.

4. Understand land and water usage and management practices.

EXAMPLES

a. Describe forestry practices (e.g., tree plantations, fire management).

b. Describe rangeland management practices (e.g., grazing practices, conversion to grasslands, federal regulation).

c. Describe management of urban land development, transportation infrastructure, public lands, and land conservation options.

d. Describe regulation and management of mining practices.

e. Describe regulation and management of fishing practices.

5. Understand how human practices affect air, water, and soil quality.

EXAMPLES

a. Describe the formation and effects of acid deposition, ozone depletion, greenhouse effect, and global warming.

b. Describe different methods of managing waste.

c. Describe the essential components and features of recycling, reuse, remediation, renew, landfills, wastewater, and water recycling.

Social Studies Standards

with performance indicators

I. Interrelated Disciplines and Skills

A. Spatial analysis of physical and cultural processes that shape the human experience

1. Use the tools and concepts of geography appropriately and accurately.

EXAMPLES

a. Identify features of the Earth's physical and cultural regions (e.g., landforms, bodies of water, linguistic patterns, hemispheric divisions).

b. Create a map from textual information to show movement of people and ideas across space and time.

c. Define the concepts of latitude and longitude and how they are used to determine location.

d. Use maps and diagrams to report physical, cultural, and demographic information from a spatial perspective.

2. Analyze the interaction between human communities and the environment.

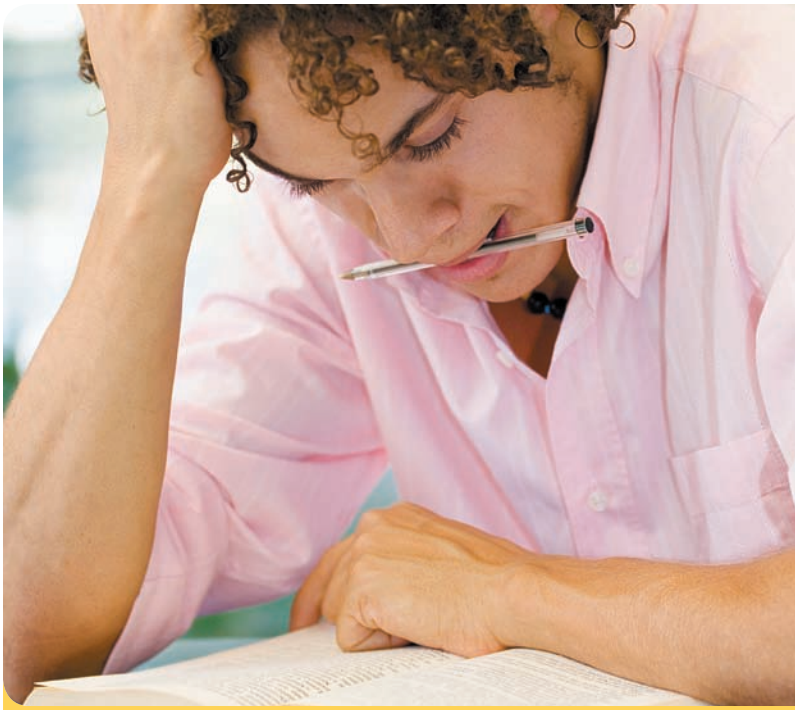
EXAMPLES

a. Compare agricultural and nomadic pastoral societies.

b. Explain the Industrial Revolution and analyze its impact on human societies and the growth of cities.

c. Examine the impact of human migration on culture and the environment.

3. Analyze how physical and cultural processes have shaped human communities over time.



EXAMPLES

a. Explain how climate has influenced human communities over time.

b. Identify barriers to human exchange (e.g., commercial, cultural, biological) in the past, explain efforts by human communities to overcome them, and analyze how these efforts have influenced historical developments.

c. Analyze how human activities (e.g., irrigation, land use policies) have altered the Earth's physical landscape.

4. Evaluate the causes and effects of human migration patterns over time.

EXAMPLES

a. Identify and explain shifts in urban population centers over time and space.

b. Trace the influence of human migration upon domesticated plant and animal distribution over space and time.

c. Explain how technology and economic forces can influence patterns of migration and population distribution.

5. Analyze how various cultural regions have changed over time.

EXAMPLES

a. Explain the impact of borderland regions (such as those of the United States and Mexico) on human interaction and cultural development.

b. Examine how human characteristics and cultural elements (e.g., race, ethnicity, language, religion) distinguish specific regions of the world from each other in the past and present.

6. Analyze the relationship between geography and the development of human communities.

EXAMPLES

a. Explain how desert cultures might develop differently from coastal cultures or others that have ready access to water.

b. Explain how significant physical features and environmental conditions have influenced the cultural, political, and economic characteristics of selected regions in the past and present.

B. Periodization and chronological reasoning

1. Examine how and why historians divide the past into eras.

EXAMPLES

a. Describe the rationale for dividing U.S. history before and after particular dates (e.g., from 1865-1914).

b. Evaluate to what extent World War II can be described as a significant turning point in American history, examining such issues as the expansion of civil rights, the economic influences of the G. I. Bill, and the international role of the United States.

2. Identify and evaluate sources and patterns of change and continuity across time and place.

EXAMPLES

a. Examine how technology has affected culture and community (e.g., the impact of the automobile on the characteristics of cities such as Los Angeles and Houston).

b. Analyze the impact of immigration on the United States at different times in its history.

3. Analyze causes and effects of major political, economic, and social changes in U.S. and world history.

EXAMPLES

a. Examine the sources of the American Revolution and delineate the cultural and political forces that gave rise to the Declaration of Independence and the Constitution.

b. Examine how technology and ideas have been diffused from one region to another along historic trade routes and analyze their impact.

c. Examine how the discovery of oil in such countries as Saudi Arabia and Venezuela has effected economic, political, and cultural change.

C. Change and continuity of political ideologies, constitutions, and political behavior

1. Evaluate different governmental systems and functions.

EXAMPLES

a. Explain the key concepts of democracy expressed in the Declaration of Independence and how they shaped the government and culture of the United States.

b. Compare the Articles of Confederation and the U. S. Constitution and the different views of governance they represent.

c. Distinguish between different systems of government such as fascism, socialism, and Communism, and give examples of each.

d. Explain differences between the governmental system of the United States and other countries (e.g., Canada, the United Kingdom, China).

2. Evaluate changes in the functions and structures of government across time.

EXAMPLES

a. Explain how major historical events such as wars and social and political movements have affected the functions and structure of governments.

b. Analyze how economic and technological developments have changed the function and structure of governments.

c. Delineate and explain several changes to the U.S. Constitution in response to political and social movements.

d. Examine the effects of U.S. court decisions on the Civil Rights Movement over the last 150 years.

e. Analyze the formation and role of key political parties in U.S. history.

f. Consider to what extent political events influence Supreme Court appointments and decisions.

3. Explain and analyze the importance of civic engagement.

EXAMPLES

a. Identify three extraordinary examples of civic responsibility in American history and evaluate their impact on American culture.

b. Explain why high levels of civic participation are essential in democratic societies.

c. Examine the emergence and impact of civil disobedience in different societies and different historical moments.

D. Change and continuity of economic systems and processes

1. Identify and evaluate the strengths and weaknesses of different economic systems.

EXAMPLES

a. Examine the role of the free enterprise system in the U.S. economy and its general impact on American culture.

b. Compare and contrast a traditional, command, and market economy and give examples of the strengths and weaknesses of each.

c. Explain the influence of mercantilism on European colonization practices and analyze its influence on the development of the American colonies.

d. Identify and evaluate examples of government intervention in the marketplace intended to address market failure.

e. Describe how the New York Stock Exchange works and the central role it plays in the U.S. economy.

2. Analyze the basic functions and structures of international economics.

EXAMPLES

a. Explain how changes in a country's economic situation affect its foreign exchange rate and its trade relationships with other countries.

b. Analyze the impact of free trade between countries, examining not only economic effects but cultural and political ones as well.

c. Explain the functions of international economic organizations such as the World Bank, the International Monetary Fund, and the World Trade Organization.

E. Change and continuity of social groups, civic organizations, institutions, and their interaction

1. Identify different social groups (e.g., clubs, religious organizations) and examine how they form and how and why they sustain themselves.

EXAMPLE

a. Identify at least three social groups or civic organizations in your community and analyze the role they play in shaping social relations, public values, and personal identity.

2. Define the concept of socialization and analyze the role socialization plays in human development and behavior.

EXAMPLES

a. Identify the major agents of socialization and how they influence individual identity.

b. Analyze how popular culture (e.g., film, television, music) shape public attitudes.

3. Analyze how social institutions (e.g., marriage, family, churches, schools) function and meet the needs of society.

EXAMPLES

a. Analyze how American universities have played a central role in the formation of American culture and character.

b. Compare and contrast the present-day functions of religious institutions in the United States with those in other parts of the world.

c. Compare and contrast the role of the family in different cultures.

4. Identify and evaluate the sources and consequences of social conflict.

EXAMPLES

a. Identify and analyze how different religious values have led to social conflict in different regions of the world.

b. Explain how modern governments have attempted to reduce social conflict and evaluate the effectiveness of these efforts.

F. Problem-solving and decision-making skills

1. Use a variety of research and analytical tools to explore questions or issues thoroughly and fairly.

EXAMPLES

a. Design a research project that analyzes various points of view on a current controversial issue, such as global climate change.

b. Use both primary and secondary sources to develop a group presentation that analyzes the causes of the U.S. Civil War from the perspectives of residents of both the North and the South.

c. Use both primary and secondary sources to analyze the actions of Abraham Lincoln to end the Civil War and restore national unity.

d. Collect and present visual images (e.g., photographs, paintings, illustrations) that trace shifting attitudes toward women in American culture and analyze changes.

e. Use maps and graphs to compare levels of economic development and standards of living in various countries and suggest reasons for any disparities.

2. Analyze ethical issues in historical, cultural, and social contexts.

EXAMPLES

a. Examine changes over time in American ethical conventions regarding the expression of views on race, ethnicity, and gender.

b. Identify and evaluate ethical guidelines in professional circumstances such as the practice of law and medical research.

c. Evaluate how science and technology have raised concerns about ethical issues, such as the right of privacy.

d. Identify either a national organization or an institution that seeks to promote ethical behavior, and analyze its success and impact.

II. Diverse Human Perspectives and Experiences

A. Multicultural societies

1. Define a "multicultural society" and consider both the positive and negative qualities of multiculturalism.

EXAMPLES

a. Consider whether the United States is a multicultural society and whether multiculturalism is compatible with the principle, "One nation under God."

b. Compare the experience of American multiculturalism with that of other countries with long experiences of immigration.

c. Analyze the sources of violent cultural conflict in several countries and assess whether these cultural differences can be resolved peacefully.

2. Evaluate the experiences and contributions of diverse groups to multicultural societies.

EXAMPLES

a. Describe the contributions of various immigrant groups to the culture of the United States.

b. Trace the growth of minority religious populations in various regions of the world and examine their impact.

B. Factors that influence personal and group identities (e.g., race, ethnicity, gender, nationality, institutional affiliations, socioeconomic status)

1. Explain and evaluate the concepts of race, ethnicity, and nationalism.

EXAMPLES

a. Explain how the concepts of race and ethnicity have evolved in the United States and consider where we stand in regard to becoming a "color-blind" and "hyphenless" nation.

b. Evaluate the concepts of "assimilation" and "acculturation" and determine the impact of each on efforts to preserve American identity.

c. Explain how national identity is distinct from both racial and ethnic identities and consider whether it is possible to hold multiple identities simultaneously.

d. Analyze how national identities are likely to be affected by globalization.

2. Explain and evaluate the concept of gender.

EXAMPLES

a. Trace changes in notions of gender in U.S. history and explain how those changes have led to the expansion of women's roles.

b. Compare and contrast economic opportunities for women in various regions of the world.

3. Analyze diverse religious concepts, structures, and institutions around the world.

EXAMPLES

a. Explain similarities and differences between Judaism, Christianity, and Islam.

b. Use maps to show how religions have diffused across time and space.

c. Describe the roles that different religious groups played in the founding of the United States.

4. Evaluate how major philosophical and intellectual concepts influence human behavior or identity.

EXAMPLES

a. Trace the origins of philosophical concepts such as freedom of religion, inalienable rights, and the pursuit of happiness, and analyze their influence in the founding of the United States.

b. Identify and explain the founding philosophical concepts of various countries and societies.

c. Evaluate the influence of the Protestant Ethic on various countries, including the United States.

5. Explain the concepts of socioeconomic status and stratification.

EXAMPLES

a. Define the concept of class and consider its relationship to race and ethnicity in American history.

b. Describe the impact of poverty on various measures of economic and social success (e.g., education, social mobility, access to health care).

c. Define the concept of caste and analyze its legacy in various societies.

6. Analyze how individual and group identities are established and change over time.

EXAMPLES

a. Explain how certain religious, political, and philosophical traditions have shaped American identity over time.

b. Create a visual presentation that demonstrates the changing depiction by the media of social identities.

c. Analyze how various court decisions or governmental initiatives have shaped individual or group identities over time.

III. Interdependence of Global Communities

A. Spatial understanding of global, regional, national, and local communities

1. Distinguish spatial patterns of human communities that exist between or within contemporary political boundaries.

EXAMPLES

a. Create a map that identifies areas and regions around the world where major world religions have a significant following.

b. Create a map that demonstrates the linguistic diversity of multilingual countries.

2. Connect regional or local developments to global ones.

EXAMPLES

a. List and explain the significance of various technologies developed in a specific location that ultimately shaped world history.

b. Analyze how international events can influence regional or local politics and popular culture.

c. Create a visual presentation to reflect either a regional or local area's global economic connections (e.g., worldwide distribution of local products).

d. Analyze how decisions made by multinational institutions (e.g., OPEC, the International Monetary Fund, the United Nations) affect regional or local circumstances around the world.

3. Analyze how and why diverse communities interact and become dependent on each other.

EXAMPLES

a. Analyze how contact between formerly separate regions has altered societies and their world views.

b. Analyze the causes and long-term impact of immigration from a given region to a given country.

B. Global analysis

1. Apply social science methodologies to compare societies and cultures.

EXAMPLES

a. Compare and contrast the governing policies of the British and Spanish empires over time, explaining how each sought to sustain order and stability.

b. Compare and contrast the historic use of forced labor in various societies.

c. Examine the roots and consequences of decolonization in Africa over the last 100 years.

d. Examine world population trends and recommend ways to reduce infant mortality rates in poor countries.

e. Use a variety of sources and methods to hypothesize the possible economic, political, and cultural impact of globalization on multiple regions of the world over the next 50 years.

IV. Analysis, Synthesis, and Evaluation of Information

A. Critical examination of texts, images, and other sources of information

1. Identify and analyze the main idea(s) and point(s) of view in sources.

EXAMPLES

a. Read an editorial or opinion column from a major newspaper, periodical, or Internet blog, identify the author's main idea(s) and point(s) of view, and evaluate the credibility of evidence used.

b. Evaluate the message and the techniques used to influence public opinion in a variety of media (e.g., film, television, Internet, editorial cartoons).

2. Situate an informational source in its appropriate contexts (contemporary, historical, cultural).

EXAMPLES

a. Analyze a film's presentation of a historical event and the factors influencing this interpretation.

b. Analyze a novel's presentation of a historical event and the factors influencing this interpretation.

c. Examine the coverage of an important event in several major newspapers (e.g., *The New York Times*, *The Washington Post, The Wall Street Journal*) and analyze differences in perspective.

3. Evaluate sources from multiple perspectives.

EXAMPLES

a. Examine the U. S. Constitution as a living document and why it has been subject to different interpretations.

b. Analyze the Equal Rights Amendment and explain why it generated controversy in the United States.

c. Examine the founding of the United Nations and use sources from different countries to prepare a presentation on its effectiveness at accomplishing its original mission.

4. Understand the differences between a primary and secondary source and use each appropriately to conduct research and construct arguments.

EXAMPLES

a. Identify and collect credible and high quality primary and secondary sources that are germane to a given topic.

b. Create an argument (e.g., an essay, letter to the editor, verbal presentation) that uses relevant primary sources.

5. Read narrative texts critically.

EXAMPLES

a. Preview book-length texts by reading introductory material and examining organizational strategies and sources to determine key questions and issues explored.

b. Write a review of a social science text that evaluates the main arguments and the quality of supporting evidence. Conclude with any questions and points of clarification needed to understand the argument.

6. Read research data critically.

EXAMPLES

a. Analyze the results of a public opinion poll noting the size of the polling sample, the margin of error, the manner in which questions were constructed, and the respondent categories.

b. Examine data in any research document carefully to ensure that collected data were gathered in conformity with high standards of research, and that borrowed data came from respected sources, such as the U.S. Census Bureau.

B. Research and methods

1. Use established research methodologies.

EXAMPLES

a. Propose or present theories only when they are supported by extensive credible research and when other possible theories have been eliminated by the evidence.

b. Understand the concept of independent and dependent variables and apply it correctly in developing hypotheses regarding social phenomena (e.g., crime, divorce rates, rates of population growth).

2. Explain how historians and other social scientists develop new and competing views of past phenomena.

EXAMPLES

a. Compare and contrast two works of history that disagree over the causes of the Cold War rivalry between the United States and the Soviet Union, and explain how the authors came to different conclusions.

b. Demonstrate, using specific examples, how historians or other social scientists can come to different perceptions and conclusions about historical events, such as the Great Depression, by using different types of sources and data.

c. Analyze a specific event based on the works of various social scientists and develop an essay that demonstrates points of contention and agreement among these scholars.

3. Gather, organize, and display the results of data and research.

EXAMPLES

a. Display relative quantitative or cartographic information when presenting research analysis in appropriate fashion, such as databases, spreadsheets, GIS, image analysis tools, or graphs.

b. Create, administer, and report on a survey of fellow classmates' positions on an issue.

c. Examine the voting data for particular elections and analyze aspects of voter activity.

4. Identify and collect sources.

EXAMPLES

a. Collect credible primary and secondary sources that provide various points of view on a selected topic.

b. Use a library database to identify key academic journals relevant to the research question at hand.

c. Create an annotated bibliography on a specific topic.

C. Critical listening

1. Understand and interpret presentations (e.g., speeches, lectures, informal presentations) critically.

EXAMPLES

a. Analyze a speech of historical importance (such as Lincoln's Gettysburg Address, Ronald Reagan's 1987 Brandenburg Gate speech, or Martin Luther King, Jr.'s "I Have a Dream" speech) and summarize its main points.

b. Listen to a lecture and write down questions that require clarification, either by consulting the lecturer or other students.

c. Listen to a lecture and connect the new information with previously studied topics.

D. Reaching conclusions

1. Construct a thesis that is supported by evidence.

EXAMPLES

a. Develop a thesis statement, outline, and organizational strategy that will be used to support the thesis in a written paper.

b. Utilize the conventions of the discipline and a variety of sources to write a research paper on a topic germane to a given course.

2. Recognize and evaluate counter arguments.

EXAMPLES

a. Write a short paper advocating a specific cause or action on an important national issue, such as federal immigration policy. Acknowledge counterarguments and explain why your position is preferable to the counterargument(s). Cite evidence that strengthens your argument.

b. Identify and summarize relevant primary or secondary sources that pose contradictory arguments on an issue.

V. Effective Communication

A. Clear and coherent oral and written communication

1. Use appropriate oral communication techniques depending on the context or nature of the interaction.

EXAMPLES

a. Debate the pros and cons of a research question.

b. Prepare for and actively participate in a class discussion on a historical conflict.

2. Use conventions of Standard Written English.

EXAMPLES

a. Utilize standard written English in formal writing assignments and proof-read to correct grammar, spelling, and punctuation errors.

b. Share drafts of writing assignments with teachers, parents, or other students, and then revise as appropriate.

B. Academic integrity

1. Attribute ideas and information to source materials and authors.

EXAMPLES

a. Identify ethical issues and consequences surrounding plagiarism.

b. Demonstrate knowledge of copyright and fair use laws by adherence to these laws in all assignments.

c. Reference research material using appropriate citation/referencing styles (e.g., *The Modern Language Handbook for Writers of Research Papers*, *The University of Chicago Manual of Style*).

d. Write an essay that includes citations of both paraphrased material and directly quoted material.

e. Identify the code of conduct involving academic honesty at your school, a local college, or university, and list several examples of what constitutes a violation of this code and the punishment for violating it.

f. Explain why an academic integrity standard is necessary and the consequences of violating it.

Cross-Disciplinary Standards

with performance indicators

I. Key Cognitive Skills

A. Intellectual curiosity

1. Engage in scholarly inquiry and dialogue.

EXAMPLES

a. Identify what is known, not known, and what one wants to know in a problem.

b. Conduct investigations and observations.

c. Cite examples or illustrations in which a clear-cut answer cannot be reached.

2. Accept constructive criticism and revise personal views when valid evidence warrants.

EXAMPLES

a. Articulate a point of view and provide valid evidence to support findings.

b. Demonstrate willingness to take intellectual risks by investigating novel, controversial, or unpopular opinions or conclusions.

c. Examine alternative points of view, taking different roles to defend, oppose, and remain neutral on issues.

d. Recognize conflicting information or unexplained phenomena.

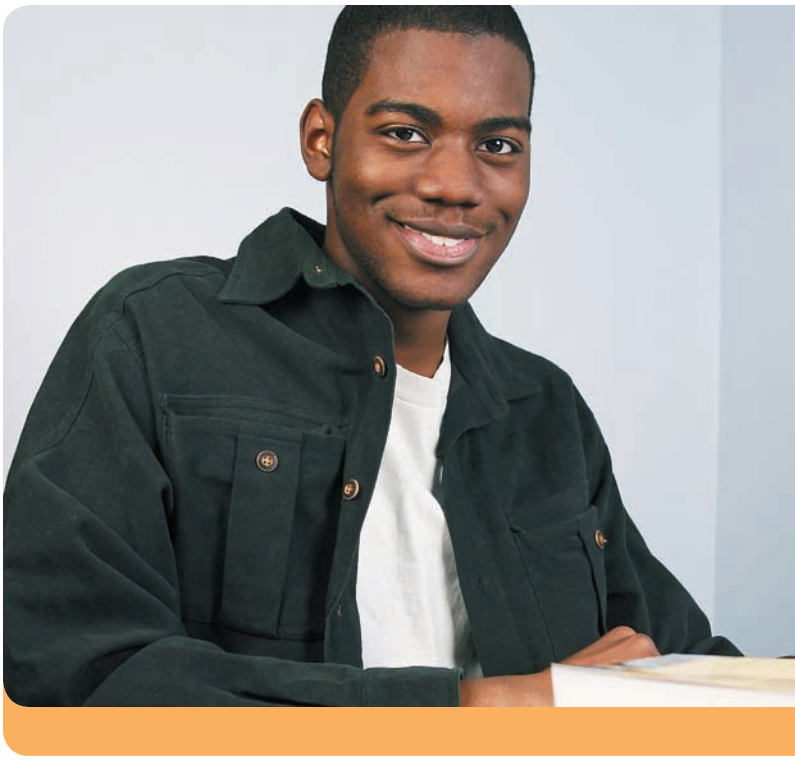
B. Reasoning

1. Consider arguments and conclusions of self and others.

EXAMPLES

a. Know and apply logic to analyze patterns and descriptions and to evaluate conclusions.

b. Cite valid examples or illustrations that support the conclusions.



c. Question whether the claims and conclusions of self and others are supported by evidence.

d. Identify counter examples to disprove a conclusion.

2. Construct well-reasoned arguments to explain phenomena, validate conjectures, or support positions.

EXAMPLES

a. Participate in a debate that is based on facts and has a logical structure.

b. Construct a visual presentation, including hypothesis, data, results, and conclusion.

c. Write a paper that addresses counter-arguments to advocated positions.

EXAMPLES

d. Recognize and apply techniques of statistical or probabilistic analysis to judge reliability of information.

e. Organize an argument separating fact from opinion.

3. Gather evidence to support arguments, findings, or lines of reasoning.

EXAMPLES

a. Use different kinds of data (e.g., case studies, statistics, surveys, documents) to support an argument.

b. Evaluate evidence in terms of quality and quantity.

c. Describe limitations of data collection methods.

4. Support or modify claims based on the results of an inquiry.

EXAMPLES

a. Refine claims and adjust a position in response to inquiry.

b. Review and check strategies and calculations, using alternative approaches when possible.

C. Problem solving

1. Analyze a situation to identify a problem to be solved.

EXAMPLES

a. Represent and/or restate the problem in one or more ways (e.g., graph, table, equation), showing recognition of important details and significant parameters.

b. Break complex problems into component parts that can be analyzed and solved separately.

c. Apply previously learned knowledge to new situations.

d. Analyze a media report, identify any misuse of statistics, and suggest ways to more accurately depict this information.

2. Develop and apply multiple strategies to solve a problem.

EXAMPLES

a. Use a range of standard methods, devices, techniques, and strategies to gather and analyze information.

b. Use knowledge gained from other subject areas to solve a given problem.

3. Collect evidence and data systematically and directly relate to solving a problem.

EXAMPLES

a. Use general and specialized reference works and databases to locate sources.

b. Collect evidence and data directly related to solving the problem and eliminate irrelevant information.

c. Produce charts, graphs, and diagrams accurately, including scale, labeling, units, and organization.

d. Present the collected data visually, describe the data collection procedure, and defend choosing that procedure over other possibilities.

D. Academic behaviors

1. Self-monitor learning needs and seek assistance when needed.

EXAMPLES

a. Ask questions to check for understanding or to clarify information.

b. Use a systematic method for recording, storing, and organizing materials and resources; avoid haphazard or messy accumulation of information.

2. Use study habits necessary to manage academic pursuits and requirements.

EXAMPLES

a. Manage time effectively to complete tasks on time.

b. Demonstrate accurate note-taking.

c. Use the appropriate level of detail necessary to complete an assigned task.

d. Balance academic and non-academic activities to successfully participate in both.

3. Strive for accuracy and precision.

EXAMPLES

a. Collect and report experimental data carefully and correctly.

b. Produce charts, graphs, and diagrams accurately, including scale, labeling, units, and organization.

c. Eliminate irrelevant information from an assignment.

4. Persevere to complete and master tasks.

EXAMPLES

a. Persevere until a task is completed by working even when faced with uncertainty or open-ended assignments.

b. Seek assistance when needed to complete the assignment.

c. Recognize when a task is completed.

E. Work habits

1. Work independently.

EXAMPLES

a. Plan a project, establish its parameters, and complete it with minimal supervision, seeking assistance accordingly.

b. Follow directions or procedures independently.

c. Complete assignments outside the classroom setting in a timely manner.

2. Work collaboratively.

EXAMPLES

a. Work collaboratively with students from various cultural and ethnic backgrounds.

b. Distinguish between situations where collaborative work is appropriate and where it is not.

c. Work in small groups to investigate a problem or conduct an experiment.

F. Academic integrity

1. Attribute ideas and information to source materials and people.

EXAMPLES

a. Document the work of others, giving credit where credit is due and never claim credit for work that is not one's own.

b. Use standard bibliographic and reference citation formats, choosing the style appropriate to the subject and the audience.

c. Define plagiarism and articulate the consequences of academic dishonesty.

2. Evaluate sources for quality of content, validity, credibility, and relevance.

EXAMPLES

a. Verify validity of a source within a submitted work.

b. Compare and contrast coverage of a single topic from multiple media sources.

3. Include the ideas of others and the complexities of the debate, issue, or problem.

EXAMPLES

a. Present multiple perspectives of an issue.

b. Represent accurately the data, conclusions, or opinions of others.

4. Understand and adhere to ethical codes of conduct.

EXAMPLES

a. Follow copyright laws and restrictions.

b. Use technology responsibly (e.g., avoiding malice, misrepresentation, or misleading use of information).

II. Foundational Skills

A. Reading across the curriculum

1. Use effective prereading strategies.

EXAMPLES

a. Use the title, knowledge of the author, and place of publication to make predictions about a text.

b. Use a table of contents to preview a text and understand its design.

c. Scan headline sections or other division markers, graphics, or sidebars to form an overview of a text.

2. Use a variety of strategies to understand the meanings of new words.

EXAMPLES

a. Use context clues, including definitions, examples, comparison, contrast, cause and effect, and details provided in surrounding text.

b. Consult references (e.g., dictionary, thesaurus) effectively.

c. Understand notation specific to discipline (e.g., mathematical notation, scientific symbols).

3. Identify the intended purpose and audience of the text.

EXAMPLES

a. Predict purpose and audience of a text based on the title, preface, and other features of a text.

b. Explain how the language of an effective text targets an intended audience.

c. Explain the importance of a technical and/or scientific article.

4. Identify the key information and supporting details.

EXAMPLES

a. Outline a chapter of an informational text.

b. Summarize the major points in a text, and use graphic organizers (e.g., concept maps, diagrams) to organize ideas and concepts in a visual manner.

c. Analyze connections between major and minor ideas.

d. Identify and define key terminology from technical and/or scientific documents.

5. Analyze textual information critically.

EXAMPLES

a. Identify faulty premises in an argument.

b. Identify stated and implied assumptions.

c. Identify conclusions unsupported by sufficient evidence in informational texts.

d. Use inductive and deductive reasoning.

e. Draw conclusions based on evidence, support, or data through logical reasoning.

f. Compare a primary source and an interpretation in a textbook.

6. Annotate, summarize, paraphrase, and outline texts when appropriate.

EXAMPLES

a. Outline an informational or literary text.

b. Annotate text for comprehension and analysis.

c. Summarize an article to demonstrate comprehension.

d. Paraphrase a writer's ideas or findings.

7. Adapt reading strategies according to structure of texts.

EXAMPLES

a. Identify a variety of textual forms and genres (e.g., long and short texts) and adapt reading strategies accordingly.

b. List strategies to use during reading, including:

- Anticipate and predict what information the text is likely to contain.
- Monitor understanding by self-questioning.
- Use strategies (e.g., mental imagery, paraphrasing, information in glossaries) to re-examine the text if comprehension fails.
- Reread difficult passages.
- Read ahead for additional clarification.
- Seek assistance for clarification.
- Self-monitor and summarize the information gained.

c. Explain how form or genre communicates meaning.

8. Connect reading to historical and current events and personal interest.

EXAMPLE

a. Locate an article or source that relates to a class topic and explain the relevance.

B. Writing across the curriculum

1. Write clearly and coherently using standard writing conventions.

EXAMPLES

a. Prepare a topic proposal that specifies a purpose and justifies the choice of audience to achieve that purpose.

b. Craft a thesis statement that articulates a position and list relevant evidence and examples in logical groupings.

c. Use symbols, diagrams, graphs, and words to communicate ideas.

d. Use appropriate terminology and data expression to communicate information in a concise manner.

e. Use a variety of reference guides for citation conventions, grammar, mechanics, and punctuation.

2. Write in a variety of forms for various audiences and purposes.

EXAMPLES

a. Present an argument supported by relevant evidence, examples, and counterarguments.
b. Prepare a summary or abstract of a journal article or report, extracting in brief form the pertinent information.
c. Evaluate articles by analyzing the study design, data source, graphical representation of data, and analyzed data results reported (or not reported).
d. Write a reflection about the process selected to conduct research or solve a problem.
e. Write accurate and understandable lab reports and technical documents.

3. Compose and revise drafts.

EXAMPLES

a. Submit a writing assignment to be proofread by a teacher, parent, or other student. Revise the paper, incorporating constructive criticism when appropriate.
b. Edit text for correct spelling, capitalization, and punctuation.
c. Edit for appropriate tense and voice.
d. Edit for correct word use.
e. Use a variety of reference guides for citation conventions, grammar, mechanics, and punctuation.
f. Submit a final draft that is easily read and has few or no grammatical or spelling errors.

C. Research across the curriculum

1. Understand which topics or questions are to be investigated.

EXAMPLES

a. Formulate research questions.
b. Use strategies like those in the writing process to generate questions and areas to pursue.
c. Consult previous studies or conduct interviews with experts to identify questions central to a research topic.
d. Propose explicit, testable hypotheses, using the "if ..., then ..." format.

2. Explore a research topic.

EXAMPLES

a. Produce an annotated list of sources consulted, differentiating among primary, secondary, and other sources and explain their relevance to the research topic.
b. Outline the most significant controversies or questions on a research topic.
c. Plan an investigative study.
d. Explain reasons for valid competing points of view on a given topic.

3. Refine research topic based on preliminary research and devise a timeline for completing work.

EXAMPLES

a. Gather information from a variety of relevant sources.
b. Use general and specialized reference works and databases to locate sources.
c. Locate electronic sources, when appropriate, using advanced search strategies.
d. Select an appropriate range of source materials.
e. Analyze a wide range of sources, including technical texts, primary and secondary sources, conflicting points of view, and interdisciplinary research when appropriate.
f. Design and carry out hands-on experimental investigations, choosing appropriate apparatuses, identifying controls and variables, tentatively predicting the outcome of the procedures, and evaluating whether actual results agree with predicted results.
g. Use numerical and mathematical tools such as software, including databases, spreadsheets, and other tools, in investigations and explanations.

4. Evaluate the validity and reliability of sources.

EXAMPLES

a. State explicitly characteristics or identifying features that indicate accuracy or reliability of sources, to determine whether sources are biased, incomplete, or otherwise unreliable.

b. Follow a set of criteria to determine the validity and reliability of sources.

c. Identify claims found in one or more of the sources that require support or verification, and evaluate the information's validity.

d. Evaluate the data presented in graphics, tables, charts, and maps when appropriate to the topic.

5. Synthesize and organize information effectively.

EXAMPLES

a. Select quotations and evidence that support the thesis.

b. Determine what evidence best supports conclusions.

c. Use well-organized strategies to collect and organize information gathered.

d. Determine the best order for presenting evidence that supports conclusions.

6. Design and present an effective product.

EXAMPLES

a. Determine the best order for presenting major and minor points.

b. Design a report using features such as headings and graphics appropriate to the writing task.

c. Use a citation system specified by or appropriate to the assignment.

7. Integrate source material.

EXAMPLES

a. Integrate source material into text by a combination of accurately summarizing, paraphrasing, and quoting.

b. Balance use of source material with relevant explanations.

c. Use source material ethically.

d. Understand and avoid all types of plagiarism.

8. Present final product.

EXAMPLES

a. Use appropriate media for presentation of research results.

b. Document sources using a standard format appropriate to the subject area.

D. Use of data

1. Identify patterns or departures from patterns among data.

EXAMPLES

a. Identify patterns from multiple representations of data such as graphical and tabular forms.

b. Review current news events and evaluate possible connections (e.g., linking economic data with political events).

2. Use statistical and probabilistic skills necessary for planning an investigation and collecting, analyzing, and interpreting data.

EXAMPLES

a. Create representations of data (e.g., data tables, correctly labeled and scaled graphs, narrative descriptions).

b. Evaluate a given published report for missing information and misuse of data.

3. Present analyzed data and communicate findings in a variety of formats.

EXAMPLES

a. Compose a written document detailing a research project.

b. Use appropriate visuals and statistical results to convey findings to a specified audience.

E. Technology

1. Use technology to gather information.

EXAMPLES

a. Use the Internet or other appropriate technologies to post survey questions on an assigned topic.

b. Use devices to measure physical properties.

c. Use online databases to access scholarly work on an assigned research topic.

2. Use technology to organize, manage, and analyze information.

EXAMPLES

a. Use data analysis software to analyze survey results.

b. Use spreadsheets to manage and organize statistical data.

3. Use technology to communicate and display findings in a clear and coherent manner.

EXAMPLES

a. Create spreadsheets and graphs to communicate findings in a presentation that includes graphics, visuals, or other supporting images.

b. Utilize technology to present information and/or data in a variety of ways.

4. Use technology appropriately.

EXAMPLES

a. Explain how technology is a useful and effective tool to communicate findings.

b. Identify when technology may not be necessary or appropriate to communicate findings.

c. Formulate strategies to communicate findings with and without technology.

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