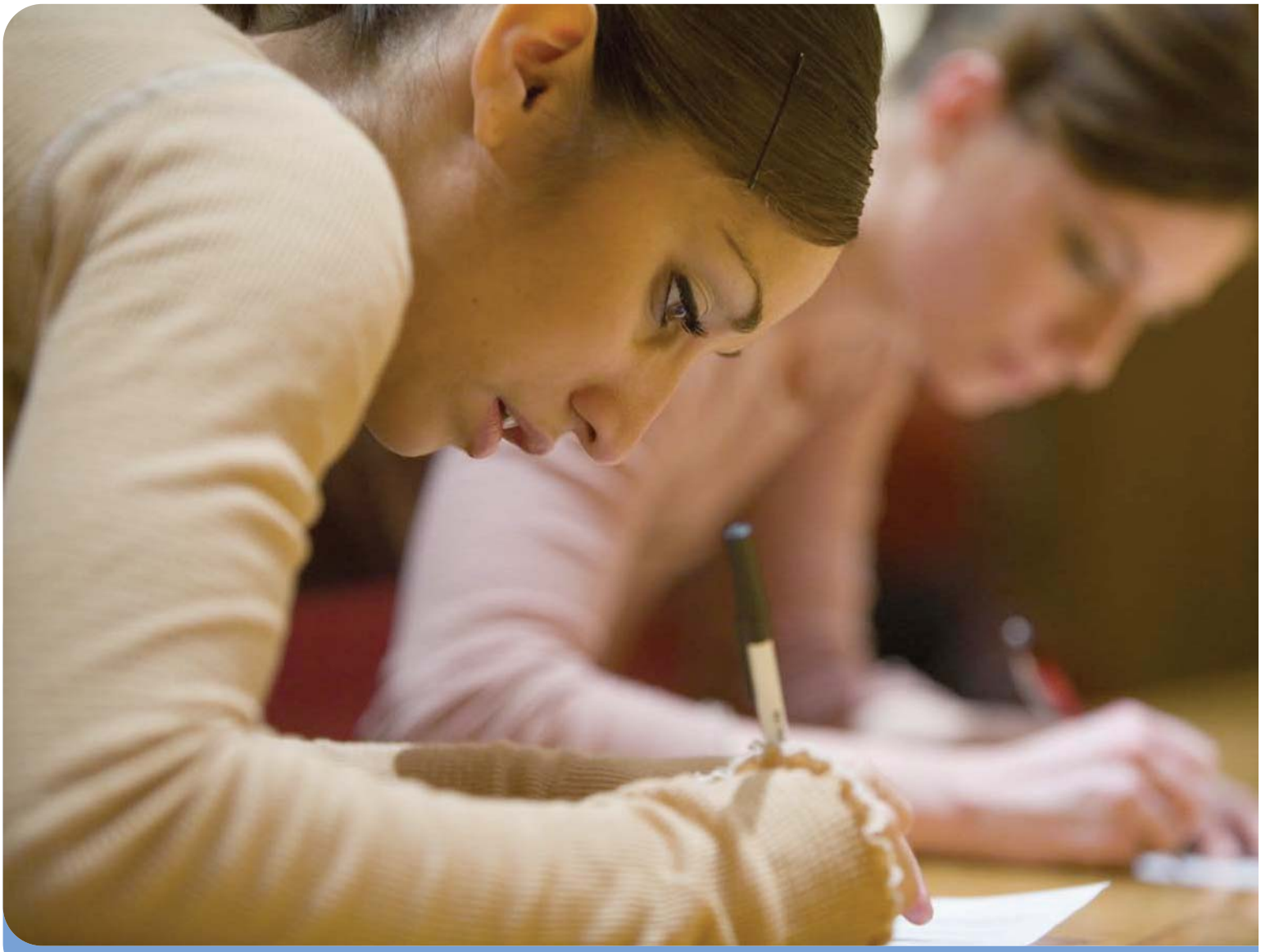
Draft Texas College Readiness Standards

Prepared on behalf of the Texas Higher Education Coordinating Board and the Commissioner of Education by the Educational Policy Improvement Center

October 25, 2007



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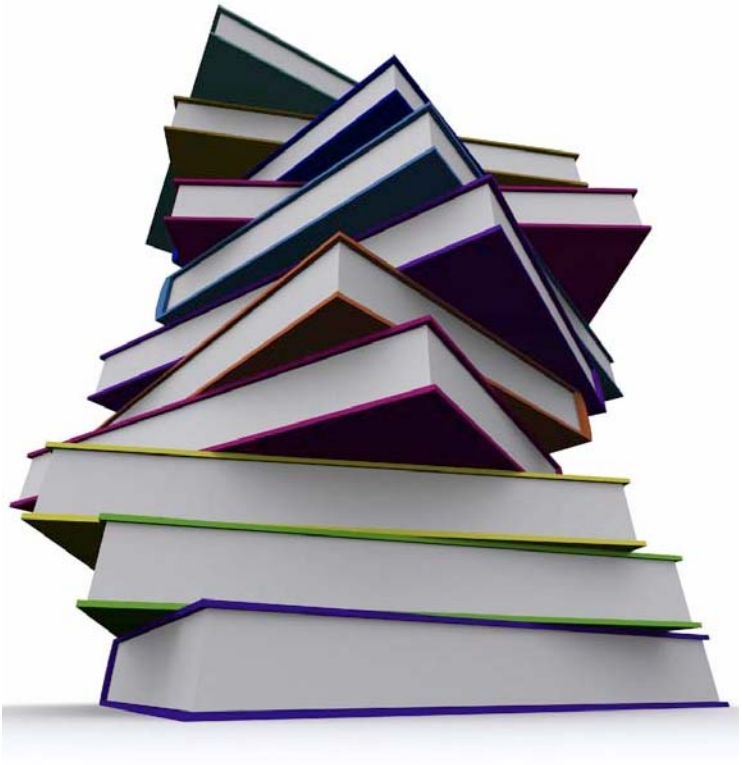
Overview of the Process

The Third Special Called Session of the 79th Texas Legislature passed House Bill 1, which became Section 28.008 of the Texas Education Code under the title, "Advancement of College Readiness in Curriculum." This section requires the Texas Education Agency (TEA) and the Texas Higher Education Coordinating Board (THECB) to establish Vertical Teams (VTs) to develop College Readiness Standards (CRS) that address what students must know and be able to do to succeed in entry-level courses offered at Texas institutions of higher education.

The statute required the formation and convening of VTs comprised of secondary and post-secondary faculty* from four subject areas: English/language arts, mathematics, science, and social science. The VTs met four times, in February, March, June, and August 2007, and also worked between meetings in order to produce a draft set of the CRS that could be presented to the THECB and the State Board of Education (SBOE) and then be reviewed more broadly within the state. The statute further required that the results of the VT process ultimately be adopted by the THECB and approved by the Commissioner of Education for alignment with the Texas Essential Knowledge and Skills (TEKS).

This document contains a draft of the CRS produced by the Vertical Team process. This draft was presented to the THECB at its October 25 meeting, at which time the board accepted the CRS for the purpose of releasing the standards in draft form for public comment between October 26 and December 10, 2007. The standards will also be presented to the State Board of Education during its November 14-16 meeting. Upon completion of the public comment period, the VTs will reconvene to review and consider the comments received during the review period in order to develop a final version of the CRS, which will be submitted to the THECB and the Commissioner of Education in January 2008.

Vertical Team members are listed on page 100 of this report



The Nature of College Readiness Standards

The CRS being developed by the VTs are not the same as high school standards, which exist to inform the education of all students for a range of possible futures beyond high school. The CRS, by contrast, are for one purpose: to specify the knowledge and skills necessary to succeed in entry-level college courses, which are the gateway to college success. This is an important distinction. High school standards can be self-referential to some degree because they are designed to prepare students for so many different possible futures. In other words, high school standards can be an end in and of themselves. They can consist of the knowledge and skills deemed most important by the state for a range of social goals and purposes.

The CRS, by contrast, must be referenced against a specific criterion: success in a range of entry-level college courses. The CRS do not specify what one needs to know to graduate from college, but what one needs to know in order to have a reasonable probability of success in the first courses taken in college. Research suggests that success in these courses is a critical predictor of eventual graduation from college. Research also suggests that the need to take a developmental education course upon admission to college substantially reduces the probability of an on-time graduation. The CRS exist to help ensure that students are prepared for the demands of an entry-level course and to avoid remedial placements.

High school provides a more defined and focused set of core skills that are mastered in a relatively limited and defined set of courses. The CRS help prepare students for a wide range of futures. College consists of literally hundreds of possible futures in the form of diverse majors. Preparing students for college success cannot mean preparing them for specific majors; it must mean equipping them with the tools necessary to make informed choices among possible futures and majors. The CRS help specify a range of foundational skills that high schools can reasonably be expected to help develop in students who may wish to pursue a postsecondary program of study.

Another key way in which the CRS may differ from high school graduation standards is their emphasis on using content knowledge as a means to stimulate students to engage in deeper levels of thinking about a subject area. While high school studies may quite appropriately focus on content knowledge acquisition, college courses utilize content knowledge to engage students in the development of complex cognitive skills that are necessary for intellectual behavior that leads to deeper understanding of content. In addition, college students are routinely expected to understand discipline-based thinking and to begin to think like an expert in a given field. For example, college instructors expect students to draw inferences, interpret results, analyze conflicting source documents, support arguments with evidence, solve complex problems that have no obvious answers, draw conclusions, offer explanations, conduct research, and think deeply about what they are being taught.

A college education is about learning to deal with controversy and conflicting points of view to a much greater degree than faced in high school. While this may be uncomfortable to some, it is central to the intellectual community of scholars and instructors in postsecondary institutions. These individuals are accustomed to thinking about difficult and significant issues in their fields of study, whether as researchers or teachers, and challenging their students to think about these issues as well. This means that students are exposed to new ideas and ways of thinking about issues or phenomena. Many times this creates discomfort for the student, whose own opinions or points of view may be challenged.

The CRS, developed by the Texas VTs and presented in this document, reflect these aims and ends. They are designed to outline at a high level of specificity the knowledge and skills necessary for success in entry-level college courses and to indicate the importance of the key cognitive strategies students will be expected to utilize in order to understand and retain the content taught in those courses.

Organization of the College Readiness Standards

The structure of the standards as presented in this document reflects the ways that English/language arts, mathematics, science, and social science are approached in higher education. Rather than a simple, one-level checklist of things to memorize or facts to repeat, the CRS consist of a multi-level hierarchical framework that suggests what is important to know and understand conceptually within a subject area and how that subject area is organized overall. This is critical because one of the most important results of studying a subject in postsecondary education is to understand the structure of that subject and, by extension, the ways of knowing and thinking about the phenomena the subject represents. This type of understanding of and insight into a subject area is the threshold necessary for the kinds of deeper investigation and learning that occur as students pursue the more in-depth courses they encounter within their chosen major. Without this deep understanding of the structure of their discipline, students cannot easily make sense of much of what they are taught in upper-division courses. Therefore, the CRS introduce these disciplinary structures at the entry-level in order to help familiarize students with key concepts and content.

The standards are organized in four nested levels of specificity. **Roman numerals** indicate the large organizing structures of the subject area. **Capital letters** specify the primary distinctive conceptual topics within each large area. The **numbered headings** delineate the general goals for each of the conceptual areas. The **lower-case letters** present examples of indicators of the specific skills students should be able to demonstrate in each area.

It is very important to emphasize that the indicator level (*lower-case letters*) is just that—a set of general indicators or examples of how students would be expected to demonstrate their knowledge of a particular topic. The indicators serve primarily to illustrate the cognitive complexity and mastery of the tasks associated with each of the general goal areas, not to define or restrict the specific ways in which college instructors elicit knowledge in any given area.

It is very important to emphasize that the indicator level is just that - a set of general indicators or examples of how students would be expected to demonstrate their knowledge of a particular topic.

The indicators should not be thought of as a checklist. However, as a general rule, the more indicators a student can demonstrate successfully, the more likely it is that the student will be college ready, and, perhaps more importantly, the more options that the student will have in terms of the subjects for which the student is prepared to succeed.

The reader should keep in mind two important distinctions when reviewing these draft standards. First, while it is entirely possible to restate in exquisite detail all the prerequisite knowledge and skills that students must master to be college ready, the standards as currently organized and structured attempt to achieve a certain parsimony by focusing more on what might best be described as "keystone" knowledge and skills. These keystone standards can only be mastered if the student has achieved facility and fluency in the necessary prerequisite areas. The college readiness standards are based on the assumption that necessary prerequisite knowledge is delineated in greater detail in the Texas Essential Knowledge and Skills (TEKS). To the degree to which students have mastered the TEKS, they are assumed to be prepared to undertake the CRS. This important assumption will need to be validated, but establishing a clear connection between the TEKS and the CRS is a critical component of system alignment that will result in more students who are ready for college.

Organization of the College Readiness Standards

Second, these standards represent the knowledge and skill level necessary for a student to succeed in a credit-bearing college course. For example, in mathematics, that course would typically be at the level of college algebra. It is possible to find credit-bearing college mathematics courses that would not require this level of readiness in order to succeed. However, the goal of the college readiness mathematics standards is to ensure that students who enter college are capable of undertaking a specific level of college coursework and are able to proceed to the next course in the sequence, as well as apply what they learn in the class successfully to a related subject area. This assumption implies a set of "reference" courses will eventually be established statewide and that college readiness will be gauged in relation to these courses.

The final section of this document is a listing of cross-discipline foundational cognitive skills that may be as important as any particular piece of content knowledge. Some of them, such as problem solving, are also contained within subject area standards but are given additional emphasis by their inclusion in the cross-disciplinary skills statements. Research on the content of entry-level college courses conducted with literally thousands of college instructors has confirmed the importance of these skills in entry-level courses and of student shortcomings in these areas. While the inclusion of these cross-disciplinary standards helps emphasize their importance, it also leads to a measure of redundancy. Subject-specific indicators have been added to help illustrate how these standards play out differently in each subject area as a way to further differentiate the cross-disciplinary standards from any similar corresponding subject-specific standard.

Next Steps

Finally, these CRS should be viewed primarily as a crucial foundational step to enable additional important work to define college readiness. During the second phase of work, the VTs will be reconvened to: evaluate current high school and college curriculum and to recommend strategies for aligning curriculum at both levels to the CRS; to develop instructional strategies that support college readiness; and to establish minimum standards for curricula, professional development materials, and online support materials for students who need more assistance achieving college readiness.

Concurrently, the Educational Policy Improvement Center (EPIC), in conjunction with the THECB, will be undertaking a series of activities to improve the alignment between secondary and postsecondary institutions in Texas. The CRS will serve as the foundation for an analysis of existing entry-level courses at Texas postsecondary institutions, the identification of "reference" entry-level college course syllabi and supporting materials, and the development of college readiness assignments for high school seniors. These combined efforts to operationalize the CRS place the State of Texas at the forefront of the movement to increase the number of students prepared to succeed in college.

Organization of the Texas College Readiness Standards

Organization

The goal of the Texas CRS 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 CRS are organized into four levels of specificity. The levels are defined as follows:

I. <u>Key Content:</u> ***overarching or keystone ideas of a discipline that reverberate as themes throughout the curriculum. Designated by roman numerals.***

A. <u>Organizing Components:</u> 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. **<u>Performance Expectations:</u> 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. Designated by numbers.**

    a. <u>Examples of Performance Indicators:</u> examples of how to assess and measure performance expectations. This list of indicators is not meant to be an exhaustive representation; the operating premise is that the more of these indicators a student is successfully able to demonstrate, the increased probability that the student will be prepared to succeed in college. Designated by lower-case letters.

English/Language Arts Standards

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English/Language Arts Standards

Introductory Narrative

English as a Way of Knowing

Listening, speaking, writing, and reading are vehicles for communication; they are also *the* vehicle through which people express their thoughts and demonstrate what they have learned. In the past, students were taught specific lessons under the rubric of language, but the resulting skills were then naturally practiced, reinforced, and commented upon throughout the day as they studied subjects such as geography, history, and science. Today the teaching of language arts is often considered to be the exclusive responsibility of English teachers. However, the complex role of language in education makes it clear that the language arts cannot and should not 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. The language arts, as conceived of in these standards, should be viewed as being fundamental to pedagogy in *any* subject.

English teachers do have particular expertise they impart to students. The discipline of English asks, explores, and helps students answer fundamental questions about language. Among these questions are:

- 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?
- How does one structure and organize text?
- What is Standard American English?
- What are its rules for spelling, mechanics, and usage, and how do they affect communication?
- How might one become a more skillful reader who can understand the text's surface and deeper meanings?
- What shared and unique features characterize specific literary genres?
- How does a writer's style create meaning?
- 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 studied a matrix that included exemplary CRS along with state and national standards in English. The resulting standards draw from this research and from the experience of VT members in Texas secondary and postsecondary classrooms.

These standards are designed to be simple and straightforward to read. The VT members sought to avoid redundancy, wordiness, or the use of specialized terminology. The danger with this approach is that even though each statement may be simple, the underlying meaning may not be. The mastery level necessary on any particular standard is dependent 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.

English/Language Arts Standards

The next phase of the Texas CRS process will focus on building a deeper understanding of these standards by gathering numerous examples of what the standards mean in terms of assignments and student work in entry-level classes in literature and composition, as well as in other general education courses outside of English. These artifacts will allow high school educators to flesh out the developmental sequence that student writing and reading needs to follow throughout secondary school to enable students to be college ready. Educators can then align curriculum with the Texas Essential Knowledge and Skills (TEKS) in English and communications to develop effective course sequences.

In this document, the rules of Standard American English are embedded into the composing process because a student must use language correctly in order to be college 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 outside of English classes.

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, college readiness 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.

English/Language Arts Standards

I. Writing

A. Compose a variety of texts for a variety of reasons.

1. **Determine purpose, audience, and task.**
   a. Prepare a topic proposal that specifies a purpose and justifies the choice of audience to achieve that purpose.
   b. Write an analysis that specifies similarities and differences between two plausible audiences for a writing task.
   c. Produce an audience analysis and stated purpose appropriate for assignment.

2. **Explore a topic by generating ideas and gathering information.**
   a. Design a search strategy appropriate for an assignment.
   b. Name at least two prewriting strategies appropriate for an assignment and specify four to six ideas they generate.
   c. Identify a prewriting strategy that is inappropriate for an assignment and explain why it is inappropriate.

3. **Evaluate relevance and sufficiency of preliminary ideas and information, organize material generated, and formulate a thesis.**
   a. Craft thesis statements that articulate a position and list relevant evidence and examples in logical groupings.
   b. Explain how certain evidence, examples, or counterarguments proved not to be relevant to the emerging thesis.

4. **Compose a draft of an essay or other form of writing.**
   a. Explain how purpose has become more focused or otherwise changed in the process of composing.
   b. Produce a draft that reflects a judicious assessment of relevance and sufficiency of preliminary ideas and information.
   c. Use a variety of methods to further develop ideas (e.g., offering an anecdote or illustration) in response to an evolving sense of purpose.
   d. Produce a draft that creates a tone and style appropriate to topic, audience, and task.
   e. Produce a draft that uses precise, engaging vocabulary appropriate to audience, purpose, and task using sentences that are well crafted and varied in structure.
   f. Explain why particular evidence, examples, or counterarguments proved not to be relevant to the thesis.
   g. Present a position through a thesis statement supported by relevant evidence and examples, cogent reasoning, and anticipation of counterarguments.

5. **Revise a draft of an essay or other form of writing.**
   a. Submit multiple drafts that reflect self, peer, and instructor assessment.
   b. Produce a final text that conveys a tone and style appropriate for the audience, purpose, and task.
   c. Produce a final text that uses precise, engaging vocabulary in sentences that are varied and well crafted.
   d. Explain why a draft was revised in response to feedback and why certain changes were made, including why some feedback was not incorporated.

6. **Edit according to the conventions of Standard American English**
   a. Edit text for correct spelling, capitalization, and punctuation.
   b. Edit for subject-verb agreement.
   c. Edit for pronoun reference and agreement.
   d. Edit for appropriate tense and voice.

e. Edit for correct word use.
f. Edit text for correct syntax (e.g., misplaced modifiers).
g. Improve coherence by increasing logical connections within and between sentences.
h. Edit for correct sentence structure.
i. Create a log of spelling, capitalization, and punctuation errors found in early drafts; note patterns and articulate a plan to address these errors.
j. Consult a variety of reference guides for citation conventions, grammar, mechanics, and punctuation.
k. Use a variety of proofreading techniques to compensate for the limitations of automated aids such as electronic spell and grammar checks.
l. Proofread writing for correct spelling, capitalization, and punctuation.

Note: *The Performance Indicators are examples of ways students demonstrate the performance expectation. They do not constitute an exhaustive list.*

II. Reading

A. Comprehend texts of varying lengths.

1. **Use effective prereading strategies to situate a text.**
   a. Use the title, knowledge of author, and place of publication to make predictions about a text.
   b. Use the 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.**
   a. Use context clues (e.g., definitions, examples, comparison, contrast, cause and effect, details provided in surrounding text).
   b. Consult and use references (e.g., dictionary or thesaurus) correctly and effectively.
   c. Use knowledge of roots and affixes to infer word meaning.
   d. Explain how connotation determines meaning.

3. **Identify the intended purpose and audience of the text.**
   a. Predict a text's purpose and audience based on features such as the title and preface.
   b. Explain how the language of an effective text targets an intended audience.

4. **Identify the major and minor details.**
   a. Analyze connections between major and minor ideas.
   b. Evaluate discrepancies among various texts addressing the same major idea.
   c. Outline a chapter of an informational text.
   d. Explain how and why the writer uses details to show rather than tell.
   e. Explain how seemingly minor details provide rich insights into the meaning of a text.

5. **Evaluate texts for validity, meaning, and relevance.**
   a. Predict developments and outcomes after reading the opening pages of a short story or novel.
   b. Locate preference statements not identified by lexical markers (e.g., "I believe", "the best is") to distinguish facts from opinions.
   c. Identify provable statements and evaluate the sufficiency of the evidence.
   d. Draw conclusions based on evidence or support through logical reasoning.
   e. Assess whether cumulative textual claims justify the thesis or main message of text.
   f. Predict likely exam questions based upon comparisons and contrasts, causes and effects, reasons and categories.
   g. Identify stated and implied assumptions.
   h. Identify significant features or meanings that emerge in the rereading of a given text.
   i. Identify logical fallacies.
   j. Identify faulty premises.
   k. Discern and evaluate inductive and deductive reasoning.

6. **Annotate, summarize, paraphrase, and outline texts.**
   a. Annotate text for comprehension and analysis.
   b. Summarize effectively.
   c. Paraphrase a writer's ideas.
   d. Outline a reading passage.
   e. Compare and contrast two articles on the same subject.

f. Compare and contrast literary works with similar themes.
g. Make connections to current and historical events.

B. Understand meaning across a variety of texts.

1. Recognize the basic structures of texts.
a. Identify a variety of literary and textual forms and genres (e.g., long and short texts) and adapt reading strategies accordingly.
b. Explain how form or genre communicates meaning.

2. Understand the effects of an author's choice of style and words.
a. Identify shifts in argument or point of view and how they affect meaning.
b. Analyze a passage for syntax, vocabulary, and voice.
c. Explain how the author's use of rhetorical devices influences the reader and evokes emotions and creates meaning.
d. Explain how the author's use of literary elements creates meaning.
e. Recognize explicit and implied meaning.
f. Identify innuendo in texts.
g. Analyze a text's ambiguities, subtleties, or contradictions.

C. Read literary and other texts from a variety of cultures and historical periods.

1. Read works from both English-speaking and non-English-speaking authors.
a. Identify major authors and works.
b. Identify influences of one writer upon another writer, explicating deliberate borrowings intended as a homage or alterations intended as a critique of the original.
c. Discuss themes across a variety of works and genres.

2. Know the characteristic forms, subjects, and authors of the major periods of British, American, and world literatures.
a. Analyze historical and social influences on texts.
b. Analyze stylistic similarities and differences of texts.
c. Critique historical and social stereotypes in texts.

D. Make connections through reading.

1. Connect reading to current events and to personal interest.
a. Relate a character's situation to self and/or others.
b. Relate a character's situation to current and historical events.
c. Use reading to develop insights about self or world.

Note: *The Performance Indicators are examples of ways students demonstrate the performance expectation. They do not constitute an exhaustive list.*

III. Speaking

A. Understand the transactional nature of communication.

1. **Recognize diverse rhetorical situations and purposes.**
   a. Explain how communication is transactional.
   b. Present new information to audiences with different backgrounds and educations, expert and non-expert.
   c. Craft argument to appeal to either a hostile or neutral audience.

2. **Interpret reactions of audience during one-on-one communication, delivery of a presentation, and group work/ discussion and adapt accordingly.**
   a. Analyze how the presentation was altered in response to the audience's facial expressions and body language.
   b. Analyze how an interlocutor's reaction affected a debating strategy.

B. Speak effectively in a variety of settings.

1. **Participate actively in one-on-one oral communication contexts.**
   a. Interview a source for an assignment.
   b. Engage in peer critique.
   c. Conference with instructor on a complex assignment.

2. **Participate actively in group discussion.**
   a. Facilitate group discussion.
   b. Work productively in small groups on an assignment.
   c. Participate successfully in a debate.

3. **Prepare and deliver effective oral presentations.**
   a. Present research findings to a class.
   b. Teach a complex lesson to a class.
   c. Read aloud effectively.

IV. Listening

A. Understand the transactional nature of communication.

1. **Recognize diverse rhetorical situations and purposes.**
   a. Identify subtle uses of language.
   b. Assess the effectiveness of a public presentation.

2. **Interpret a speaker's message.**
   a. Explain how a message incorporates ethos, logos, and pathos.
   b. Evaluate the effectiveness of a speaker's nonverbal communication.

3. **Overcome barriers to listening and recollection.**
   a. Question a speaker for clarification or elaboration.
   b. Follow complex directions.
   c. Summarize a presentation accurately.
   d. Take concise notes that accurately reflect the presentation.

B. Listen effectively for diverse purposes and settings.

1. **Listen actively to presentations.**
   a. Note unfamiliar terms and questions raised by presentation.
   b. Annotate notes taken during a presentation to highlight areas for critical reflection.
   c. Critique a presentation.

2. **Listen effectively in one-on-one contexts.**
   a. Ask questions to check understanding.
   b. Paraphrase a conversation accurately.
   c. Revise a draft based on oral peer critique.

3. **Listen effectively in group discussions.**
   a. Take effective notes during group discussion.
   b. Participate in a productive deliberation.
   c. Work in small groups on an assignment.

V. Research

A. Formulate topic and question.

1. **Formulate research questions.**
   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.**
   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.**
   a. Adjust topic based on preliminary research.
   b. Develop a detailed and realistic schedule for researching and completing project.

B. Select information from a variety of sources.

1. **Gather relevant sources.**
   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.**
   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.**
   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.**
   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. **Integrate source material.**
   a. Introduce a source appropriately.

Note: *The Performance Indicators are examples of ways students demonstrate the performance expectation. They do not constitute an exhaustive list.*

b. Integrate source material into text by a combination of summarizing, paraphrasing, and quoting.
c. Balance use of source materials with relevant explanations.

3. Use source material ethically.
a. Paraphrase accurately.
b. Understand types of plagiarism.
c. Review own text to eliminate plagiarism.

4. Present final product.
a. Use appropriate media for public presentation of research results.
b. Cite sources appropriately.
c. Document sources using a standard format appropriate to the assignment.

Mathematics Standards

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Mathematics Standards

Introductory Narrative

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. In the physical and social sciences and in 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. 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.

Mathematics is a formal language and way of reasoning to understand phenomena of the natural world. These include both physical and social systems. Mathematical reasoning is key to solving an array of 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.

Understanding and Using These Standards

The standards were developed as a result of a collaborative effort between K-12 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, but when revisiting them in high school, the topics will be at a higher conceptual level, and the students should be computationally fluent and competent enough to become fluent in the concept.

These standards are designed to help students, parents, teachers, and counselors understand the specific content knowledge and academic skills necessary for college 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 CRS 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 knowledge and skills will be necessary. While College Readiness Standards (CRS) are not specifically di-

rected towards these fields, mastering the standards will help promote readiness to pursue majors that require significantly more mathematical knowledge.

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 readiness. In addition, students must develop ways of thinking about mathematics. These key cognitive strategies elevate mathematics from an exercise in rote memorization to a process of analysis and interpretation that enables the learner to grapple with a range of complex questions, topics, and issues. The standards contain frequent reference to these key cognitive strategies, but always in the context of challenging and appropriate content knowledge. Mathematical thinking never occurs in a vacuum; it is always embedded in appropriately challenging content.

Mathematics Standards

I. Numeric Reasoning

A. Number representation

1. **Compare real numbers.**
   a. Classify numbers as natural, whole, rational, irrational, real, imaginary, and/or complex.
   b. Use and apply the relative magnitude of numbers by using inequality symbols to compare them and by locating 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.**
   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. Describe a mathematical situation that requires a complex number.
   d. 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, and 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.**
   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 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 reasonability of solutions.**
   a. Identify the most reasonable solution for a given problem and 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. measuring paint).

II. Algebraic Reasoning

A. Expressions and equations

1. **Explain and differentiate between expressions and equations.**
   a. Define what an expression or equation represents.
   b. Distinguish among and apply different uses of equations: to state a definition, to represent an identity, to represent equivalence, and to represent a condition.

B. Manipulating expressions

1. **Recognize and use field properties, concepts, procedures, and algorithms to combine and transform expressions (e.g., polynomials, radicals, rational expressions).**
   a. Use the field properties (e.g., commutative, associative, distributive) and order of operations to transform expressions to equivalent expressions.
   b. Use the field properties and order of operations to evaluate variable expressions when given the value of the variables.

C. Solving equations, inequalities, and systems of equations

1. **Recognize and use field properties, concepts, procedures, and algorithms to solve equations, inequalities, and systems of linear equations.**
   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 field properties to solve an equation by constructing a sequence of equivalent equations.
   d. Use the elimination and/or substitution method to solve a linear system of equations with two variables.
   e. Use 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.**
   a. Describe the solution set of an equation or inequality (e.g., set notation including shading, graphical representation).
   b. Understand that the 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 in two variables and the graphs of the corresponding lines.
   d. Graph a function and understand the relationship between its real zeros and the x-intercepts of its graph.

D. Representations

1. **Interpret multiple representations of equations and relationships.**
   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.

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2. **Translate among multiple representations of equations and relationships.**
   a. Explain the common information presented in multiple representations of a relationship.
   b. Translate one given representation to another representation (e.g., table to graph, graph 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.**
   a. Construct and use drawings, models, and coordinate representations of plane and space figures in order to solve problems.
   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 and test conjectures about one-, two-, and three-dimensional figures and their properties.**
   a. Develop and verify attributes of lines and parts of lines in a plane and in space: parallel, intersecting, perpendicular, and skew lines; 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.

3. **Recognize and apply right triangle relationships including basic trigonometry.**
   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.**
   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 rigid 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).
   e. Apply transformations to solve problems (e.g., minimal path problems).

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2. **Identify the symmetries of a plane figure.**
   a. Recognize rotational symmetry as the composition of multiple reflections over intersecting lines (e.g., origin symmetry in the coordinate plane).
   b. Identify and distinguish between reflectional and rotational symmetry in an object.
   c. Identify congruent corresponding parts in a figure with reflectional or rotational symmetry.
   d. 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.**
   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.**
   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 a circle centered at (h, k) with radius (r) algebraically).
   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.**
   a. Compute probabilities using lengths of segments or areas of regions representing desired outcomes.
   b. Construct a regression line and use it to make predictions.

3. **Make connections between geometry and measurement.**
   a. Determine perimeter, area, and volume of two- and three-dimensional figures using measurements and formulas.
   b. Find the measures of lengths, area, and volume of similar figures.
   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.**
   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 bi-conditional statement and a true conditional statement with a true converse.

2. Understand the characteristics of an axiomatic system of Euclidean and non-Euclidean geometry.

a. Distinguish among theorems, properties, definitions, and postulates and use them to verify conjectures.
b. Compare and contrast characteristics of Euclidean and non-Euclidean geometries (e.g., variations of the Parallel Postulate).

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IV. Measurement Reasoning

A. Measurement involving physical and natural attributes

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

a. Determine appropriate units of measurement needed for the phenomena being measured in a given situation, i.e., unit analysis.
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.

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.

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.

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, and 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.

a. Describe the difference between surface area and volume of three-dimensional figures and the relationship in the units of measure 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, Pythagorean Theorem, and basic trigonometry.

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.**
   a. Select, compute, and justify measurements of center based on the data set, collection method, and other influential information.
   b. Select, compute, and justify measurements of variation based on the data set, collection method, and other influential information.
   c. Calculate weighted averages, indices, and ratings.
2. **Apply probabilistic measures to practical situations to make an informed decision.**
   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.**
   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.**
   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. Use the Law of Large Numbers to recognize that experimental probabilities converge to theoretical probability as the number of trials increases.
2. **Compute and interpret the probability of conditional and compound events.**
   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.

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VI. Statistical Reasoning

A. Data collection

1. **Plan a study.**
   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.**
   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.**
   a. Organize and construct graphical displays of data (e.g., line plots, bar graphs, histograms, scatterplots) to describe the distribution of data.
   b. Read and interpret graphical displays of data.

3. **Compute and describe summary statistics of data.**
   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 accuracy of the fit of a regression line based on data.
   c. Describe the effect of outliers on summary statistics.

4. **Describe patterns and departure from patterns in a set of data.**
   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. Describe observed variability influenced by various sampling methods within the context of the situation.
   d. Compare observed data to expected probability models in assessing chance variability.

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

1. **Make predictions and draw inferences using summary statistics.**
   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.**
   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 boxplots, back-to-back stem-leaf plots).

3. **Analyze relationships between paired data.**
   a. Describe relationship and trend of paired data observed from scatterplot 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.**
   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.

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VII. Problem Solving and Reasoning

A. Mathematical Problem Solving

1. Analyze given information.

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.

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.

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, and geometric) to support a solution.

4. Justify the solution.

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

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.

a. Use examples to formulate conjectures.
b. Use counterexamples to refute conjectures.
c. Determine the validity of a conditional statement, its converse, and its contrapositive.

2. Use various types of reasoning

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, and geometric) 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.

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

3. Evaluate the problem solving process.
a. Evaluate a real world solution for accuracy and effectiveness.
b. Compare and analyze various methods for solving a real-world problem.

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VIII. Functions

A. Recognition and representation of functions

1. **Recognize whether a relation is a function.**
   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.**
   a. Recognize general forms of linear, quadratic, rational, absolute value, square root, exponential, and logarithmic 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 addition, subtraction, multiplication, and division of two numbers as a function of two variables.
   e. Recognize the calculation of the Greatest Common Factor (GCF), Least Common Multiple (LCM), mean, and median as a function of two or more variables.
   f. Recognize a geometric transformation of the plane as a function of two variables.

B. Analysis of functions

1. **Understand and analyze features of a function.**
   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.**
   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 step and piece-wise defined 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.

C. Model real world situations with functions

1. **Apply known function models.**
   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., those for velocity and 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.

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 and map real-world situations that can be modeled as functions (e.g., diameter of a tree to its age).

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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.**
   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 interval].

2. **Use mathematical language to represent and communicate the mathematical concepts in a problem.**
   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.**
   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.**
   a. Make tables of inputs and outputs for mathematical ideas/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 slope.

2. **Summarize and interpret mathematical information provided orally, visually, or in written form within the given context.**
   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.**
   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., scatterplots).
   c. Recognize and explain the meaning of information presented using mathematical notation.

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

3. **Explain, display, or justify mathematical ideas and arguments using precise mathematical language in written or oral communications.**
   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., why a quadratic equation is put into standard form first when solving by factoring).
   c. Identify units associated with any variables and constants used in a problem solution.

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X. Connections

A. Connections among the strands of mathematics

1. **Connect and use multiple strands of mathematics in situations and problems.**
   a. Represent a geometric two-dimensional figure on the rectangular coordinate plane using a set of equations.
   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**
   a. Use mathematics to represent velocity and force in physics.
   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.**
   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.**
   a. Identify mathematical sequences, ratios, and patterns in nature (e.g., Fibonacci sequence, Golden Ratio).
   b. Explain 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.**
   a. Identify mathematics used in several careers and professions.
   b. Identify several careers or professions that are mathematically intensive fields.

Science Standards

epic
Educational Policy Improvement Center

Introductory Narrative

Science as a Way of Knowing

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, we regard the findings with increasing confidence. Findings that are repeatedly confirmed across a range of situations yield insights that can lead to explanatory models. Such explanatory models are sometimes also called theories. Throughout this process certain analytical procedures and practices are used in all science disciplines. These include specific mathematical procedures and techniques, standardized measurement methods, and several applications of formal logic.

These logical procedures are often called the scientific method. The scientific method is not usually a spontaneous, intuitive mode of thought, although science has room for such insights. The scientific method is the practice of testing hypotheses (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 foundational 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 ways that students learn skills for appropriately applying a wide variety of apparatus, equipment, techniques, and procedures for collecting, interpreting, and using data. While engaged in scientific inquiry, students utilize other foundation skills such as mathematics, communication, and social ethics, as well as personal skills such as time management, self-discipline, and organization.

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 the College Readiness Standards (CRS) in science that have been previously developed. In addition, the process drew from the variety of experiences and backgrounds VT members have acquired, 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 we call the scientific method.

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, to grapple with new ideas and divergent interpretations, and to master the powerful techniques of collecting, organizing, and analyzing information that we call the scientific method.

Although the standards are quite extensive and specific in their identification of important prerequisite knowledge that is valuable for success in entry-level college courses, they also emphasize in equal measure the importance of the key cognitive skills necessary to succeed on 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 strategies 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.**
   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. Suggest alternative explanations for data and criticize arguments in which data, explanations, or conclusions are represented as the only ones worth consideration.
   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.**
   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.**
   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.**
   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.**
   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. Advanced students are skilled at stating null and alternative hypotheses.
   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.
   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.**
   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.**
   a. Use Materials Safety Data Sheet (MSDS) information and demonstrate safe laboratory practices.
   b. Apply MSDS information to safely store chemicals after use.
   c. Apply safe handling procedures for live and preserved organisms.

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

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2. **Use computer models, applications and simulations.**
   a. Use computer models, simulations, data bases, 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 apparatus, equipment, techniques, and procedures for collecting quantitative and qualitative data.**
   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.**
   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.**
   a. Define and use a basic set of technical terms correctly for each discipline studied.

II. Foundation Skills: Scientific Applications of Mathematics

A. Basic mathematics conventions

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

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

4. Understand basic geometric principles.
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.
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.
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 deviation, and standard error.
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.

a. Know common SI prefixes (pico to tera), their abbreviations, and their associated powers of 10.
b. Use SI base units (e.g., grams, meters) and derived units (e.g., liters, joules, and grams per cubic centimeter).
c. Understand the relationship and usage of SI and standard English units in daily measurements.

2. Use appropriate significant digits

a. Know the rules for adding, subtracting, multiplying, and dividing measurements using the appropriate number of significant digits.
b. Understand the limitations of measurement devices, including the use of estimated digits.
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).

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.

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III. Foundation Skills: Scientific Applications of Communication

A. Scientific writing

1. **Use correct applications of writing practices in scientific communication.**
   a. Construct word (narrative) descriptions of apparatus, 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, apparatus, techniques or procedures, and data.**
   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 apparatus, carry out procedures, and collect specified data from a given set of appropriate instructions.**
   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.**
   a. Identify and define key scientific terminology from technical and scientific documents.

4. **Use specific strategies before, during, and after reading to improve comprehension.**
   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; 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.**
   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.**
   a. Use electronic tools to locate relevant information.

2. **Evaluate quality, accuracy, completeness, reliability, and currency of information from any source.**
   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.**
   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.**
   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. Students should consistently follow these practices.

2. **Understand how commonly held ethical beliefs impact scientific research.**
   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.**
   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.**
   a. Describe the contribution of selected individuals who have made major contributions to particular disciplines.

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V. Cross-Disciplinary Themes

A. Matter/states of matter

1. **Know modern theories of atomic structure.**
   a. Describe the characteristics and typical locations of subatomic particles such as protons, neutrons, and electrons.
   b. Describe what happens when a calcium atom becomes a calcium ion.

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

1. **Understand the Laws of Thermodynamics.**
   a. Express thermodynamic principles in mathematical or symbolic statements.

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

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VI. Biology

A. Structure and function of cells

1. **Know that although all cells share basic features, cells differentiate to carry out specialized functions.**
   a. Identify different cell types based on function. Examples: nervous, epithelial, and muscle.
   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. **Know that cells can be categorized into two major types: prokaryotic and eukaryotic, and describe major features that distinguish one from the other.**
   a. Describe or recognize major features that distinguish prokaryotic from eukaryotic cells.

3. **Describe the structure and function of major subcellular organelles.**
   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.**
   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.**
   a. Describe the major features and events of cytokinesis with pictures or word descriptions.

6. **Know the structure of membranes and how this is related to permeability.**
   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.**
   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.**
   a. Describe the environmental effects (e.g., pH, temperature) on enzyme activity and explain why these affect the 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.
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.
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.
a. Conduct lab experiments regarding fermentation in yeast and bacteria.
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 between fermentation and cellular respiration.

6. Understand coupled reaction processes and describe the role of ATP in energy coupling and transfer.
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.
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.
a. Describe mechanisms that produce variations in population sizes.
b. Recognize, describe, and explain typical patterns of changes 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 extinction, Cretaceous dinosaur extinction, 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).

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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.

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.

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 the functions of nucleic acids.

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, 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."

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.

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.**
   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.**
   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.**
   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 present in each.**
   a. Name and describe Earth's major biomes including tundra, boreal forest, temperate deciduous forest, 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.

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2. **Know patterns of energy flow and material cycling in Earth's ecosystems.**
   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.

3. **Understand typical forms of organismal behavior.**
   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.**
   a. Describe events and processes that occur during 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.**
   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.**
   a. Describe separation techniques for both mixtures and compounds.
   b. Distinguish between homogeneous and heterogeneous mixtures.

B. Atomic structure

1. **Summarize the development of atomic theory. Understand that models of the atom are used to help us understand the properties of elements and compounds.**
   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; 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 distribution in atoms (Aufbau principle, the Pauli exclusion principle, Hund's rule) and their connection to the periodic table.

C. Periodic table

1. **Know the organization of the periodic table.**
   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.**
   a. Define each 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.

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D. Chemical bonding

1. **Characterize ionic bonds, metallic bonds, and covalent bonds. Describe the properties of metals and ionic and covalent compounds.**
   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.**
   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 falls 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.**
   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 Bronsted 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.**
   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.**
   a. Identify the factors that cause a shift in equilibrium (e.g., temperature, concentration, volume, and 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.**
   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.**
   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.**
   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.**
   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.**
   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.**
   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.**
   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.**
   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, gas.**
   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.**
   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.

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3. **Understand principles of ideal gas behavior and kinetic molecular theory.**
   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.**
   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.**
   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.**
   a. Define boiling, freezing, sublimation, etc.
   b. Explain heating curves and phase diagrams.

7. **Describe intermolecular forces.**
   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, nucleic acids

1. **Understand the major categories of biological molecules: lipids, carbohydrates, proteins, and nucleic acids.**
   a. Recognize each type 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.**
   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.**
   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.**
   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.**
   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.**
   a. Define density as 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.**
   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.**
   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.**
   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.**
   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.**
   a. State the definitions for displacement, distance, velocity, speed, and acceleration.

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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.

2. Understand forces and Newton's Laws.
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.
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.
a. Calculate potential energy values for various types of potential energy (gravitational, elastic, and electrical).
b. Calculate kinetic energy values (translational and rotational).
c. Using a diagram of a pendulum, identify where potential and kinetic energy occur.

2. Understand conservation of energy.
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.
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.
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.**
   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 2nd Law of Motion as applied to rotation.

3. **Apply the concept of static equilibrium.**
   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.**
   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.**
   a. Define pressure and make basic pressure computations using pressure=force/area and 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.**
   a. Describe and calculate changes in fluid pressure when external pressure is applied, especially as observed in hydraulic systems.

3. **Understand buoyancy.**
   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.

G. Oscillations and waves

1. **Understand basic oscillatory motion and simple harmonic motion.**
   a. Identify examples of oscillatory motion.
   b. Recognize examples of simple harmonic motion.

2. **Understand the difference between transverse and longitudinal waves.**
   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, amplitude.**
   a. Perform computations using the formula (wave speed) = (wavelength) * (frequency).
   b. Describe wavelength, frequency, amplitude, and period, and identify each from various wave graphs.

4. **Understand the properties and behavior of sound waves.**
   a. Describe the properties and behavior of sound including compressions, rarefactions, travel through various media.
   b. Compare and contrast sound and electromagnetic waves in terms of wave speed, wave type, wavelength, frequency, and medium.

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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.

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.

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.

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.

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.

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

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.

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.

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.**
   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.**
   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.**
   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.**
   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.**
   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).

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IX. Earth and Space Sciences

A. Earth systems

1. **Know the major features and characteristics of atmosphere, geosphere, hydrosphere, and biosphere.**
   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.**
   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).

3. **Possess a scientific understanding of the history of Earth's systems.**
   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.

4. **Utilize the tools scientists use to study and understand the Earth's systems.**
   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.**
   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.**
   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.**
   a. Identify and describe the major components of the solar system (e.g., star, planets, comets, dwarf planets, keiper objects, asteroids).

2. **Possess a scientific understanding of the formation of the solar system.**
   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.**
   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.**
   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.**
   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.**
   a. Locate and identify the major tectonic plates and plate boundaries on a map.

3. **Describe the motions and interactions of tectonic plates.**
   a. Describe the geologic features that result from convergent, divergent, and transform plate boundaries.

4. **Describe the rock cycle and its products.**
   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. **Matter and energy in the Earth system.**
   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.**
   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.

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X. Environmental Science

A. Earth systems

1. **Recognize the Earth's systems.**
   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.**
   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.**
   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.**
   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.**
   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.**
   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, physical, and biological factors that transform these from one form to another.

B. Energy

1. **Understand energy transformations.**
   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.**
   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.**

a. Describe and explain carrying capacity, cultural and economic influences, urbanization, distribution, loss of biodiversity, endangered plants and animals, and deforestation.
b. Explain how 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.**
   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.**
   a. Name the major US 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).**
   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.**
   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.**
   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.**
   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.**
   a. Describe the formation and effects of acid deposition, ozone depletion, green house 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.

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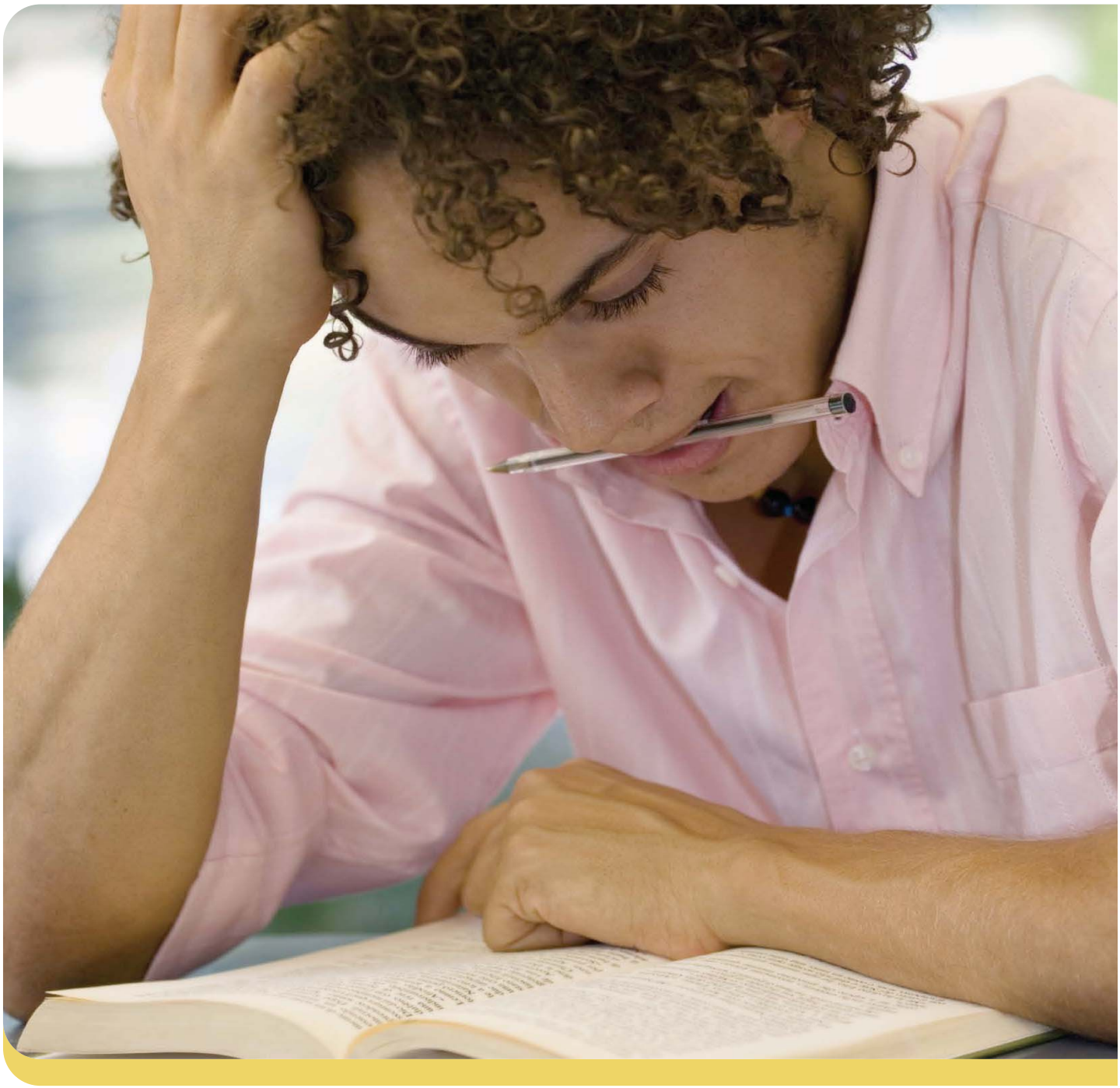
Social Science Standards



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Social Science Standards

Social Sciences as a Way of Knowing

The social sciences use an interdisciplinary approach to understand human behavior, organizations, institutions, beliefs, and attitudes across time and space. Social sciences encompass a wide variety of disciplines including history, geography, political science, sociology, psychology, anthropology, economics, philosophy, and archaeology as well as several fields of specialization within those 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 strategies from the sciences, mathematics, and English.

The goal and the focus of the social sciences is to promote a deeper and richer understanding of the human experience from multiple perspectives and frameworks. Together, they impart particular knowledge and skills that equip students to engage actively, thoughtfully, and responsibly with their community, be it at the local, national, or global level.

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Social sciences 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 spatial influences on their behavior and to connect their lives and decisions to the world around them, both past and present.

Understanding and Using These Standards

The social sciences as taught at the college level require mastery of key cognitive strategies that are utilized to process a broad body of factual information and concepts. Simply memorizing facts and data is not sufficient to succeed in a college-level social science course. These thinking processes are the method by which students develop a greater understanding of the historical, political, economic, 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.

To succeed at the college level, students in the social sciences 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 sciences including history, geography, political science, economics, and sociology. While it is not necessary for high school students to take courses

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in many of these subject areas, they do need to understand something about the tools that scholars in these subject areas use to formulate and investigate major problems in these 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 science 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 science courses.

The Vertical Teams (VTs) chose deliberately not to identify lists of facts that students must master to be ready for college. This should not be interpreted to mean that students should not be mastering a range of specific information about social systems and phenomena. Instead, the standards assume that students will utilize 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 into 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 science standards from other states and national organizations that were reviewed in the process of developing these standards.

Social Science Standards

I. Interrelated Disciplines and Skills

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

1. **Understand the tools and concepts of geography.**
   a. Identify features of the Earth's cultural and physical regions (e.g., landforms, water bodies, 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 information from a spatial perspective.

2. **Understand the interaction between human communities and their environment.**
   a. Compare and contrast agricultural and pastoral societies.
   b. Evaluate the impact of the Industrial Revolution and rapid urbanization on the environment.
   c. Trace and explore the influence of the global environmental movement.
   d. Describe the impact of western expansion during the nineteenth and twentieth centuries on the environment of the United States.

3. **Understand major cultural and physical processes that have shaped the world and its people over time.**
   a. Explain how monsoon patterns have shaped human communities in the Indian Ocean basin over time.
   b. Identify physical barriers to human exchange (e.g., trade, cultural, biological) in the past and explain efforts by human communities to overcome them.
   c. Identify how human activities (e.g., irrigation, land use management policies) have altered the Earth's physical landscape.

4. **Understand the causes and consequences of human migration patterns over time.**
   a. Identify and explain shifts in urban population centers over time and space.
   b. Trace the influence of human migration in Eurasia upon domesticated plant and animal distribution.
   c. Identify the economic forces (e.g., industrialization, the mechanization of agriculture, the transportation revolution) that account for the changing patterns of migration and population distribution in United States' history.

5. **Understand the concept of cultural regions and how they change over time.**
   a. Define borderland regions and explain their impact on human interaction.
   b. Create maps to show the spatial dimensions of the world's major cultural regions today (e.g., language, ethnicity, race, religion).

6. **Apply geography to interpret the past and present, and to predict the future.**
   a. Write an analytical essay that predicts how climate change might affect the economy of the United States.
   b. Create a map that demonstrates the process of desertification and deforestation and its impact on human settlement in Africa.
   c. Explain how the physical geography has influenced the culture, history, and geo-political boundaries of regions (e.g., the Balkan Peninsula, the Arabian Peninsula, Mesoamerica, North America).

B. Periodization and chronological reasoning

1. Understand how and why historians divide the past into eras.

a. Describe the basis for dividing U.S. history before and after 1877.
b. Create a chart or timeline that identifies key events in the Cold War.
c. Compare and contrast the political and legal status of African-Americans in 1900 and 2000.
d. Explain the impact of the fourteenth century Bubonic Plague on global history.

2. Identify patterns of change and continuity across time and place.

a. Compare and contrast the impact of the Internet on various countries (e.g., the United States, China, India).
b. Analyze the economic impact of British Imperialism on regional economies (e.g., South Asia, sub-Saharan Africa, Southeast Asia) in the nineteenth and twentieth centuries.
c. Explain the impact of Mexican immigration to the U.S. Southwest between 1890 and 1980.
d. Compare and contrast the political and economic changes in Russia as a result of the Communist Revolution in the early twentieth century to the shift to a more open political system and free market economy at the end of the twentieth century.

3. Analyze causes and effects of major political, economic, and social changes in U.S. and world history.

a. Explain the impact of the end of slavery on the economy of the American South.
b. Create a chart that lists several technologies that diffused from one region to another along the Silk Road during the first millennium of the Common Era.
c. Compare and contrast how different countries' governments responded to the Great Depression of the 1930s.
d. Explain the impact of World War II on the African-American and Mexican-American Civil Rights Movements.

4. Understand the economic, social, and political ramifications of migration and immigration.

a. Compare and contrast immigration to the United States between 1877 and 1920, and 1965 and the present.
b. Evaluate the impact of migration on cultural diffusion (e.g., distribution of languages, religions, food or goods) throughout the world.
c. Analyze the impact of the partitioning of India in 1947 on the religious distribution of populations in South Asia.
d. Provide a historical perspective of xenophobia and its impact on immigration policies in the United States.

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

1. Understand different governmental systems and functions.

a. Compare and contrast federal, unitary and confederal systems of government.
b. Describe libertarian, conservative, and authoritarian views on the purpose, structure, and functions of government.
c. Distinguish between democratic, communist, and socialist governmental systems. Give examples of each.

2. Understand the nature and source of various types of political authority and power.

Note: *The Performance Indicators are examples of ways students demonstrate the performance expectation. They do not constitute an exhaustive list.*

a. Explain the major characteristics of different political systems and regime types (e.g., democracy, monarchy, oligarchy, dictatorship).
b. Diagram and explain the differences between the various governmental systems (e.g., United States, Japan, Mexico).
c. Compare and contrast the relationship between the executive and legislative branches of government in presidential and parliamentary forms of government.

3. Understand changes in the functions and structure of governments across time.
a. Identify how revolutions such as the American, Cuban, French, Russian, and Iranian Revolutions affected the functions and structure of government in those countries.
b. Identify changes in the structures and function of the United States federal government since the Great Depression and World War II.

4. Understand how political and social movements bring about significant changes in the scale and scope of government structures.
a. List and explain several changes to the Texas Constitution and the U.S. Constitution during the Progressive Era.
b. Explain the impact of the African-American Civil Rights Movement on the U.S. federal government.
c. Explain the influence of political activism upon government policy regarding alcohol consumption over time (e.g., the nineteenth century Temperance Movement, the twentieth century Prohibition Movement, the Mothers against Drunk Driving).

5. Understand how political ideology shapes the structures and functions of the American federal system.
a. Create a visual presentation that demonstrates how and why the U.S. Constitution is amended, using several historical examples.
b. Identify and explain the role and impact of third parties in American political history.
c. Explain how political ideology influences Supreme Court appointments and decisions.

6. Understand the importance of civic responsibility.
a. List and describe various ways individuals can influence political decisions in the United States.
b. Evaluate potential consequences of declining levels of civic participation in democratic societies.
c. Analyze the concept and impact of civil disobedience and provide historical examples.

D. Change and continuity of economic systems and processes

1. Identify and understand the major characteristics of different economic systems and economic institutions.
a. Define a "mixed economy" and evaluate to what extent it describes the U.S economy today.
b. Distinguish between a traditional, command, and market economy. Give examples of each.
c. Define and explain the role of mercantilism in European colonization of the Americas after 1500.

2. Understand basic functions and structures of international economics.
a. Using graphs, demonstrate how changes in a country's economic situation affect its foreign exchange rate.

b. Explain the benefits and drawbacks of free trade between countries.
c. Explain how a country develops a trade surplus or trade deficit with other countries.
d. Explain the functions of the World Bank, the International Monetary Fund, and the World Trade Organization.

3. Understand the conflicts and compromises inherent in any economic system.
a. List several examples of the U.S. government's intervention in the marketplace to ensure fair competition.
b. Define and describe the strengths and weaknesses of different economic systems.

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

1. Understand what a social group is and the way it functions.
a. Define "social group" (e.g., clubs, families, religious organizations, gangs), reasons for group formation, and strategies to maintain the group.
b. Identify various ways that social groups in your community interact and the roles they play in social relations.

2. Understand how cultural socialization contributes to human development and behavior.
a. Identify the major agents of socialization and how they influence individual identity.
b. Explain how social groups influence individual attitudes, beliefs, and behavior.
c. Analyze how racial, gender, and ethnic stereotypes expressed in popular culture shape an individual's identity.

3. Understand how social institutions (e.g., marriage, family, religion, government, economic, educational institutions) function and meet the needs of society.
a. Compare and contrast the functions of marriage in different societies (e.g., Western and Islamic societies).
b. Compare and contrast the present-day function of religious institutions in different societies (e.g., religious institutions in the United States) with those in one or more Asian society (e.g., China, Japan, India).
c. Compare and contrast role of the family in different cultures (e.g., Chinese vs. Western).

4. Understand the sources and consequences of social conflict.
a. Analyze how conflicting religious values create social conflict in local communities.
b. Explain how the U.S. government has attempted to ameliorate racial tension in the past and evaluate the effectiveness of these policies.

F. Problem-solving and decision-making skills

1. Use multiple strategies to explore questions or issues.
a. Design a research project that analyzes various points of view on the United States' policy towards immigration in the early 21st Century (e.g., guest worker programs, promoting or discouraging immigration, English-only laws).
b. Devise a proposal that suggests the best way to spend $1 billion on preventing the spread of communicable diseases in the developing world (e.g., sub-Saharan Africa, Southeast Asia, South Asia).

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2. **Use critical thinking skills to explore questions and issues.**
   a. Distinguish benefits and drawbacks of continued American space exploration.
   b. Identify key strengths and weaknesses in proposals to improve public education in the United States such as school vouchers or the No Child Left Behind Act, and develop a position paper based on this evidence.
   c. Using primary and secondary sources, analyze American military strategy and decision making (e.g., President Truman's decision to use atomic weapons on Japan and timetables for invading Europe and Japan).

3. **Use social science skills and tools to collect, analyze, and interpret data.**
   a. Evaluate to what extent current political boundaries in the Middle East reflect ethnic and religious divisions in the region.
   b. Design a chart that demonstrates the spread of the use of languages such as English, Spanish, or French over time.
   c. Create a graph that compares infant mortality rates in various countries such as the United States, India, China, Russia, or Sweden.
   d. Collect and present visual images that depict shifting attitudes towards women in the United States over time.

4. **Identify and recognize the complexity of ethical issues.**
   a. Explain the ethical problems posed by tolerating discrimination against others.
   b. Identify ethical guidelines for the use of human and animal participants in psychological research.
   c. Recognize the ethical issues posed by white-collar crime in the business sector.

5. **Explore the impact of changes in science and technology on moral and ethical issues.**
   a. Examine the impact of increased life expectancy on American society.
   b. Evaluate how chemical weapons changed warfare in the twentieth century.

6. **Understand how states address ethical issues.**
   a. Evaluate the effectiveness of government-imposed trade sanctions as a means to encourage greater adherence to global human rights standards in other countries.
   b. Identify and explain the effectiveness of international human rights treaties.

II. Diverse Human Perspectives and Experiences

A. Multicultural societies

1. Evaluate to what extent a society is multicultural.

a. Identify the different racial and ethnic classifications used by the U.S. Census Bureau.
b. Identify racial and ethnic classifications used in countries other than the U.S.
c. Compare and contrast the ethnic and racial makeup of the United States to other countries such as Canada, South Africa, or Russia.
d. Identify several countries in the world where cultural differences have produced violent conflict since 1945, and explain the sources of these conflicts.

2. Experiences and contributions of diverse groups to multicultural societies.

a. Analyze the impact of the African-American Civil Rights Movement on the United States and other places (e.g., South Africa, Great Britain).
b. Describe and list several examples of Latino contributions to U.S. popular culture since 1980.
c. Trace the growth of the Muslim population in Western Europe after World War II and explain its impact.
d. Explain settlement patterns of Asian migrants to the United States over time and their contributions to American society.

B. Understand that multiple factors influence personal and group identities including race, ethnicity, gender, nationality, institutional affiliations, and socioeconomic status, among others

1. Understand the concept of race.

a. Explain concept of race and analyze the advantages and disadvantages associated with various racial classifications.
b. Explain how race has been socially constructed over time.
c. Trace how African-American identity evolved over time in the United States.
d. Analyze to what extent racial stereotypes in popular culture shape contemporary views of sub-Saharan Africa among the American public.

2. Understand the concept of ethnicity.

a. Describe the role of ethnic identity in the violent disintegration of Yugoslavia in the 1990s.
b. Distinguish between racial, ethnic, and national identities.
c. Assess how concepts of ethnicity have been used to allow one group to dominate another.
d. Explore the meaning and significance of the following terms: Hispanic, Latino/a, Chicano/a, Mexican-American, Tejano/a.

3. Understand the concept of gender.

a. Identify examples of how gender is socially constructed.
b. Debate the impact of increased female participation in the workforce in Western countries since 1970.
c. Compare and contrast the Women's Rights Movements of the nineteenth and twentieth centuries.

4. Understand the concept of nationality.

a. Explain how national identities have formed over time.
b. Examine the political and historical roots of nationalism as an identity for individuals.
c. Examine how national identities are affected by patterns of globalization today.

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5. **Understand diverse religious concepts, structures, and institutions around the world.**
   a. Explain similarities and differences between the Abrahamic religions of Judaism, Christianity, and Islam.
   b. Use a map to show how religious affiliations (e.g., Buddhism, Christianity, Islam) have diffused across time and space.
   c. List and explain several examples of diversity within the religious communities today (e.g., Sunni/Shia, Protestant/Catholic).

6. **Recognize major philosophical and intellectual concepts that influence human behavior or identity.**
   a. Analyze the Enlightenment and its impact upon political revolutions in the eighteenth and nineteenth centuries (e.g., the French, American, and Haitian Revolutions).
   b. Explain how Confucianism is an organizing system of Chinese and other East Asian societies.
   c. Examine the influence of social Darwinism on the American foreign and economic policy in the late nineteenth century.

7. **Understand socioeconomic status and stratification.**
   a. Define the concept of class and give examples from multiple societies.
   b. Describe the impact of poverty on various measures of economic and social success (e.g., education, social mobility, access to health care) in the United States.
   c. Define the concept of caste and its legacy in various societies (e.g., South Asia, Latin America).

8. **Understand that individual and group identities are learned and ascribed and change over time.**
   a. Explain how the spread of religions such as Islam, Buddhism, and Christianity have shaped group identities over time.
   b. Create a visual presentation that demonstrates the changing depiction of race and gender in media in the United States since 1950.
   c. Analyze how various Supreme Court decisions or federal government initiatives have shaped individual or group identities over time (e.g., Plessy v. Ferguson, Brown v. Board of Education, the Americans with Disabilities Act, the Civil Rights Act of 1964, Lawrence v. Texas).

III. Interdependence of Global Communities

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

1. Recognize spatial patterns of human communities that exist between or within contemporary political boundaries.

a. Create a map that identifies areas and regions around the world where major world religions (e.g., Buddhism, Christianity, Islam) have a significant following.

b. Create a map that demonstrates the linguistic diversity of multilingual countries such as India, Nigeria, Switzerland, or Afghanistan.

2. Connect local developments to global ones.

a. Make a list and explain the significance of various technologies developed in China that shaped world history.

b. Explain how the Cold War influenced American politics and American popular culture.

c. Create a visual presentation to reflect your local area's global economic connections (e.g., worldwide distribution of local products).

d. Explain how decisions made by multinational institutions (e.g., OPEC, the International Monetary Fund, the United Nations) affect one's life.

3. Understand how and why diverse communities interact and become dependent on each other.

a. Describe the legacy of the Columbian Exchange and how it altered multiple societies around the world in the sixteenth and seventeenth centuries.

b. Explain the reasons for and analyze the long-term impact of immigration to the United States from Latin America during the twentieth century.

B. Global Analysis

1. Identify similarities and differences between societies, countries, and regions.

a. Compare and contrast the governing policies of large empires over time (e.g., the Roman Empire, the Tang Dynasty, the Abbasid Caliphate), explaining how each promoted order and stability.

b. Compare and contrast the use of forced labor in British and Spanish colonies in North American colonies from the sixteenth through eighteenth centuries.

c. Compare and contrast the decolonization process after 1945 in multiple regions (e.g., India, Belgian Congo, Indonesia, Algeria).

d. Compare and contrast business practices within the industrialized world.

2. Apply the social sciences to understand past and present conditions and world events.

a. Analyze to what extent colonial powers' actions (e.g., the Berlin Conference of 1884-1885) contributed to the modern regional conflicts in Africa.

b. Identify arguments and counter arguments for contemporary economic globalization (e.g., outsourcing, monetary exchange rates, capital markets) to write a position paper.

c. Create charts and graphs that use statistics to project the distribution of the world's population in the year 2100.

d. Develop a policy paper that suggests ways of reducing infant mortality in Africa.

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IV. Analysis, Synthesis and Evaluation of Information

A. Critical reading of texts, images, and other artifacts

1. **The ability to identify the main idea(s) and point(s) of view in sources.**
   a. Read an editorial or opinion column from a major newspaper, periodical, or Internet blog and make a list of the author's main ideas and point of view.
   b. Collect and evaluate a variety of visual artifacts (e.g., editorial cartoons, propaganda posters). Identify the message and the techniques used to influence public opinion.

2. **The ability to situate a source in its appropriate contexts (contemporary, historical, cultural).**
   a. Watch a film that incorporates historical events and developments (e.g., *Casablanca*, *On the Waterfront*, *Salt of the Earth*, *Glory*) and evaluate how it portrays historical developments.
   b. Read a literary work (e.g., *The Grapes of Wrath*, *The Iliad*, *The Crucible*) and describe the historical events and factors influencing its content.
   c. Identify news stories on global issues in national newspapers that relate to your city or state.

3. **Evaluate sources from multiple perspectives.**
   a. Analyze the Declaration of Independence from the perspective of men and women, and people of Native American, European, and African descent.
   b. Analyze the Equal Rights Amendment and explain why it generated controversy in the United States.
   c. Evaluate the idea of conservation from a variety of points of view.

4. **Understand the difference between a primary and secondary source.**
   a. Identify primary and secondary sources from a set of provided references.
   b. Identify and collect credible and high quality primary and secondary sources that are germane to a given topic.
   c. Create an argument (e.g., an essay, letter to the editor, verbal presentation) that uses relevant primary sources.

5. **Critical reading of narrative texts.**
   a. Preview a chapter in a textbook by reading introductory passages, examining organization strategies, headings, images, and maps in order to determine key questions and issues explored.
   b. Make a list of key terminology and other key concepts necessary to understand the text at hand.
   c. Write a critical review of a non-fiction book or chapter in a textbook that states the main argument and key supporting evidence. Conclude with any questions and points of clarification needed to understand the argument.

6. **Critical reading of research data.**
   a. Critically examine the results of a public opinion poll noting the size of the polling sample, the phrasing of the questions asked, and the demographic composition of the polling sample. Determine what conclusions can and cannot be fairly assumed by the poll results.
   b. Use data provided by the U.S. Census Bureau to create a visual presentation that demonstrates the demographic composition of your county.

B. Research and methods

1. **Use of scientific method in research.**
   a. Propose a theory that explains fluctuations in voter turnout since 1968.
   b. Identify the independent and dependent variables in a variety of hypotheses that suggest explanations for social phenomena (e.g., juvenile crime, divorce rates, rates of population growth).

2. **Understand how historians develop new and competing views of past phenomena.**
   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. Read two historians' interpretations of an event noting their research methods. Explain how different research methods determine different points of view and emphasis.

3. **The ability to gather, organize, and display data and research results.**
   a. Display relative quantitative or cartographic information when presenting research analysis using, when appropriate, 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 your city or town in the past three city council elections and determine which precincts showed more voter activity.

4. **Ability to identify and collect sources**
   a. Collect five 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 relative to the research question at hand.
   c. Create an annotated bibliography on a specific topic.

C. Critical listening

1. **Critically understand/interpret presentations (e.g., speeches, lectures, less formal presentations).**
   a. Listen to Martin Luther King, Jr's "I Have a Dream" speech and summarize five main points.
   b. After listening to a lecture, write down three questions to pose to the lecturer in order to gain further insight into the topic.
   c. Listen to a lecture and connect the new information with three previously studied topics.
   d. Compare and contrast notes after a lecture with a fellow student noting points of clarity, confusion, and disagreement.

D. Reaching conclusions

1. **Constructing a thesis that is supported by evidence.**
   a. Develop a thesis statement, outline, and organizational strategy that will be used to support the thesis in a written paper.
   b. Utilizing the conventions of the discipline and a variety of sources, write a research paper (5 to 10 pages) on a topic germane to a given course.

2. **Recognizing counterarguments.**
   a. Identify and summarize relevant primary or secondary sources that pose contradictory arguments on an issue.
   b. Write a short paper advocating a specific cause or action. Acknowledge a counterargument and explain how the position asserted is preferable in the face of the counterargument. Use evidence appropriate to the assignment to strengthen the argument.
   c. Write a short paper advocating a public policy; write a counterargument.

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V. Effective Communication

A. Engage in clear and coherent dialogue

1. **Use appropriate communication techniques depending on the context or nature of the interaction.**
   a. Present orally a summary of conclusions on a research question.
   b. Prepare for and actively participate in a class discussion on a historical conflict.

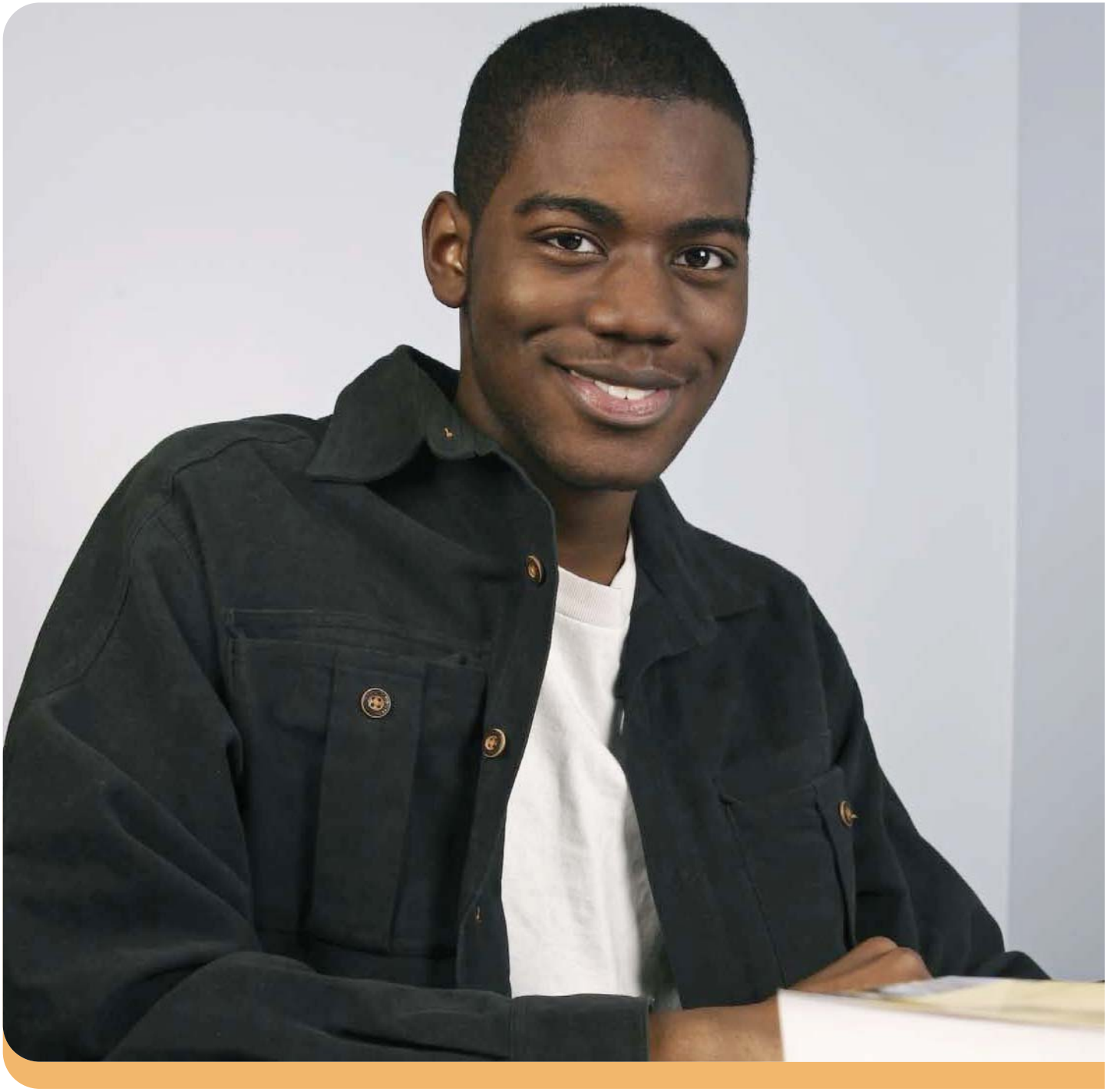
B. Write clearly and coherently

1. **Use conventions of standard written English.**
   a. Utilize standard written English in formal writing assignments with minimal grammar, spelling, and punctuation errors.
   b. Turn in a writing assignment to be proofread by a teacher, parent, or other student. Revise the paper, considering their constructive criticism when appropriate.

C. Academic integrity

1. **Attribute ideas and information to source materials and people.**
   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., MLA, APA, Turabian, Chicago).
   d. Explain why an academic integrity standard is necessary and the consequences of violating it.
   e. Write an essay that includes citations of both paraphrased material and directly quoted material.
   f. 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.

Cross-Discipline Standards



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Cross-Discipline Standards

Foundations of Learning and Knowing

Although the College Readiness Standards (CRS) are organized into four distinct disciplinary areas, English/Language Arts, Mathematics, Science, and Social Sciences, this does not mean that they have no 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 inclusion of this section that enumerates these skills as a separate and distinct set of standards.

The cross-discipline standards in this section can be thought of as being tools that college instructors in all areas utilize to challenge, engage, and evaluate students in each specific subject area. They include key cognitive strategies, such as reasoning, problem solving, and conducting research, in addition to foundational skills for processing and creating content knowledge, such as reading, writing, and data analysis.

Many of these skills are also taught within the context of a single subject area as well. Reading and writing are excellent examples of subject areas where this occurs. While the primary responsibility for developing reading and writing skills in high 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 likely be required to write a lab report in a biology class or read primary source documents in a history class.

The importance of being able to apply these skills across a variety of contexts and to a range of subject matter has been stressed by academic and business leaders. 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 application of knowledge across disciplines and subject areas and the mastery of a base set of communication and analysis skills that span subject areas.

Research on what it takes to succeed in entry-level college courses has also documented the importance of these foundational cognitive skills. The key finding from this research is that students not only need to possess content knowledge, but to be able to apply key cognitive strategies to the academic tasks presented to them, most of which require much more than simple recall of factual knowledge.

These cross-discipline standards enable students to engage in deeper levels of thinking across a range of subject matter. 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 a deeper understanding of the content and gain a greater insight into the way experts in the subject area think.

Understanding and Using The Cross-Discipline Standards

The cross-discipline standards are organized into two major areas. 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, works habits, and academic integrity. The second area, Foundational Skills, consists of proficiencies students need to be able to transfer and apply across the curriculum. These include reading, writing, conducting research, understanding and using data, and using technology.

The first three levels of the cross-discipline standards, the key content, the organizing components, and the performance expectations, are written to apply across subject areas. The performance indicators, however, illustrate how the cross-discipline 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.

Cross-Discipline Standards

I. Key Cognitive Skills

A. Intellectual Curiosity

1. **Engage in scholarly inquiry and dialogue.**
   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.**
   a. Articulate own 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.**
   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.**
   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.
   d. Recognize and apply techniques of statistical and 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.**
   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 refine claims based on the results of an inquiry.**
   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 the situation to identify the problem to be solved.**
   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.

Note: *The Performance Indicators are examples of ways students demonstrate the performance expectation. They do not constitute an exhaustive list.*

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 problems.**
   a. Use a range of standard apparatus, techniques, and strategies to gather and analyze information.
   b. Use knowledge gained from other subject areas to solve a given problem.

3. **Systematically collect evidence and data directly related to solving the problem.**
   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.**
   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.**
   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.**
   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.**
   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.**
   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.**
   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.

Cross-Discipline Standards

F. Academic Integrity

1. **Attribute ideas and information to source materials and people.**
   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.**
   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, issues, or problem.**
   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.**
   a. Follow copyright laws and restrictions.
   b. Use technology responsibly (e.g., avoiding malice, misrepresentation, or misleading use of information).

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II. Foundational Skills

A. Reading Across the Curriculum

1. **Use effective prereading strategies.**
   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 sidebards to form an overview of a text.

2. **Use a variety of strategies to understand the meanings of new words.**
   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.**
   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.**
   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. **Critically analyze textual information.**
   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.**
   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.**
   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 reexamine 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.

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.

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 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.

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.

a. Submit a writing assignment to be proofread by a teacher, parent, or other student. Revise the paper, incorporating the 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.

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 research topic.

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. Plan an investigative study.
d. Explain reasons for valid competing points of view of a given topic.

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3. **Refine research topic based on preliminary research and devise a timeline for completing work.**
   a. Gather relevant sources and information from a variety of 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 apparatus, identifying controls and variables, tentatively predicting the outcome of the procedure, 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.**
   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.**
   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 that the student has gathered.
   d. Determine the best order for presenting evidence that supports conclusions.

6. **Design and present an effective product.**
   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 citation system specified by or appropriate to the assignment.

7. **Integrate source material.**
   a. Integrate source material into text by a combination of accurately summarizing, paraphrasing, and quoting.
   b. Balance use of source materials with relevant explanations.
   c. Use source material ethically.
   d. Understand and avoid all types of plagiarism.

8. **Present final product.**
   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.**
   a. Identify patterns from multiple representations of data such as graphical and tabular forms.
   b. Review current news events and evaluate possible connections, such as linking economic data with political events.

2. **Use statistical and probabilistic skills necessary for planning an investigation, and collecting, analyzing, and interpreting data.**
   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 misuses of data.

3. **Present analyzed data and communicate findings in a variety of formats.**
   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.**
   a. Use the Internet 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.**
   a. Use data analysis software to analyze survey results.
   b. Use spreadsheets to manage and organize statistical data.
   c. Manage references using citation software.

3. **Use technology to communicate and display findings in a clear and coherent manner.**
   a. Create spreadsheets and graphs to communicate findings in a slide presentation.
   b. Utilize technology to present information and/or data in a variety of ways.

4. **Use technology appropriately.**
   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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Glossary of Terms

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

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

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

Constructions
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.

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.

Function
The action for which a person or thing is specially fitted or used or for which a thing exists.

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

Global Communities
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 Readiness Standards (CRS). 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 diverse 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 College Readiness Standards (CRS). 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 College Readiness Standards (CRS). 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 College Readiness Standards (CRS). Designated in this document by lower-case letters.

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

Primary Sources
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.

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

Qualitative
Descriptions or distinctions based on some quality rather than on some quantity.

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

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

Recursive
Of, relating to, or constituting 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 exist in the present and the past).

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

Secondary Sources
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 text).

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 "deka" 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 on a page.

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 post-secondary faculty, established to develop College Readiness Standards (CRS) 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 Readiness Standards contained in this document.

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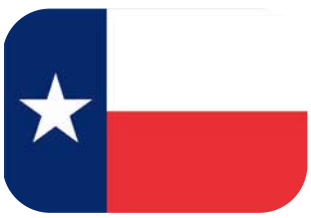

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