STATE MATCH

Texas
College Readiness
Standards

English/Language Arts,
Mathematics, and Science

and

the ACT®

August 2008

ACT®

About This Report

EXECUTIVE SUMMARY
(pp. 1–1)

This portion summarizes the findings of the alignment between the Texas College Readiness Standards and the ACT®.

SECTION A
(pp. 3–6)

This section provides tables by content area (English/Language Arts, Mathematics, and Science), listing the precise number of Texas College Readiness Standards measured by the ACT.

SECTION B
(pp. 7–40)

All Texas College Readiness Standards are listed here; each one highlighted is measured by the ACT. Texas standards listed here are from the Texas College Readiness Standards adopted by the Texas Higher Education Coordinating Board in 2008. Underlined science content indicates that the content topics are included in, but not directly measured by, the ACT Science Test.

SECTION C
(pp. 41–50)

ACT's College Readiness Standards appear here. Highlighting indicates that a statement reflects one or more statements in the Texas College Readiness Standards. ACT College Readiness Standards not highlighted are not addressed in the Texas College Readiness Standards.

A supplement is available that identifies the specific ACT College Readiness Standard(s) corresponding to each Texas College Readiness Standard in a side-by-side format. To request this supplement, please e-mail ACT at **statematch@act.org**.

ACT

Executive Summary

We believe the ACT® offers many advantages to Texas students and educators in assessing the Texas College Readiness Standards, and this report offers strong evidence for this belief.

Comparisons conducted by our content specialists show that the ACT Reading, English, Writing, Mathematics, and Science tests measure most Texas English/ Language Arts, Mathematics, and Science College Readiness Standards:

THE ACT MEASURES MOST TEXAS COLLEGE READINESS STANDARDS IN ENGLISH/LANGUAGE ARTS, MATHEMATICS, AND SCIENCE.

- English/Language Arts: 2 out of 5 Key Contents

  Almost all Texas English/Language Arts College Readiness Standards in Writing and Reading are covered by the ACT English, Reading, and/or Writing tests. The ACT does not assess Speaking, Listening, or Research skills.

- Mathematics: 10 out of 10 Key Contents

  Almost all Texas Mathematics College Readiness Standards are covered by the ACT Mathematics Test.

- Science: Process Key Contents: 2 out of 4
  (Content Key Contents: 6 out of 6)

  Most Texas Science College Readiness Standards are covered by the ACT Science Test.

  (A note about science content: ACT's Science tests present content from biology, chemistry, physics, and Earth/space sciences. Although content knowledge in these content areas is needed to answer some of the test questions, the test questions emphasize scientific reasoning and are based in experimental science contexts. Factual content knowledge, although needed to answer some of the test questions, is not systematically sampled from the full content knowledge domain. Therefore, each ACT Science Test covers some, but not all, of the discrete science content knowledge specifically described in the Texas Science College Readiness Standards.

  To emphasize the point that content is included, but not necessarily covered in its entirety, on every test form, science content match results appear in parentheses in Section A of this document (which describes the number of Texas standards measured by ACT's tests), and are underlined rather than highlighted in Section B. Our goal here is to clearly communicate that science content will be included, but each specific content topic will not be covered consistently enough for inferences to be made about student proficiency in all areas.)

Most exceptions to a match between the ACT and the Texas College Readiness Standards arise from standards not being assessable in group settings, standards that are personal in nature, and standards requiring measurement over extended time.

In sum, test results from the ACT can help Texas educators and students make well-informed decisions in planning students' career and academic goals.

Section A: Number of Texas College Readiness Standards Measured by the ACT

Table A-1. Number of Texas English/Language Arts College Readiness Standards Measured by the ACT

Texas College Readiness Standards Key Contents*	Number of Texas College Readiness Standards Measured by the ACT	Aspects of Texas College Readiness Standards that are Not Measured
I. Writing	1 out of 1	Utilize effective prewriting strategies Revise drafts of functional texts (e.g., application, resume, operations manual) Consult reference guides for citation conventions, grammar, mechanics, and punctuation
II. Reading	3 out of 4	Use text features and graphics to form an overview of informational texts Evaluate similarities and differences in how multiple texts present information, argue a position, or relate a theme Explain how literary and other texts evoke personal experience
III. Speaking	0 out of 2	Understand the elements of communication both in informal group discussions and formal presentations Develop effective speaking styles for both group and one-on-one situations
IV. Listening	0 out of 2	Apply listening skills as an individual and as a member of a group in a variety of settings
V. Research	0 out of 3	Formulate topic and questions Select information from a variety of sources Produce and design a document
TOTALS 2 out of 5 Key Contents	4 out of 12	

*Refer to Texas English/Language Arts College Readiness Standards on pages 7–11

Table A-2. Number of Texas Mathematics College Readiness Standards Measured by the ACT		
Texas College Readiness Standards Key Contents*	**Number of Texas College Readiness Standards Measured by the ACT**	**Aspects of Texas College Readiness Standards that are Not Measured**
I. Numeric Reasoning	3 out of 3	
II. Algebraic Reasoning	4 out of 4	
III. Geometric Reasoning	4 out of 4	
IV. Measurement Reasoning	4 out of 4	
V. Probabilistic Reasoning	2 out of 2	
VI. Statistical Reasoning	2 out of 3	Plan a study Determine types of data
VII. Functions	3 out of 3	
VIII. Problem Solving and Reasoning	3 out of 3	
IX. Communication and Representation	3 out of 3	
X. Connections	2 out of 2	
TOTALS 10 out of 10 Key Contents	30 out of 31	

*Refer to Texas Mathematics College Readiness Standards on pages 12–20

Table A-3. Number of Texas Science College Readiness Standards Measured by the ACT			
Texas College Readiness Standards Key Contents*		**Number of Texas College Readiness Standards Measured by the ACT**	**Aspects of Texas College Readiness Standards that are Not Measured**
I.	Nature of Science	3 out of 5	Collaborate on joint projects Understand and apply safe procedures in the laboratory and field Demonstrate literacy in computer use
II.	Foundation Skills: Scientific Applications of Mathematics	3 out of 6	Use dimensional analysis in problem solving Understand descriptive statistics Select and use appropriate Standard International (SI) units and prefixes to express measurements for real-world problems
III.	Foundation Skills: Scientific Applications of Communication	1 out of 4	Use correct applications of writing practices in scientific communication Prepare and present scientific/technical information in appropriate formats for various audiences Use search engines, databases, and other digital electronic tools effectively to locate information Evaluate quality, accuracy, completeness, reliability, and currency of information from any source
IV.	Science, Technology, and Society	0 out of 3	Recognize how scientific discoveries are connected to technological innovations Understand how scientific research and technology have an impact on ethical and legal practices Recognize the role of people in important contributions to scientific knowledge
TOTALS 2 out of 4 Process Key Contents		10 out of 18	

Table A-3. Number of Texas Science College Readiness Standards Measured by the ACT		
Texas College Readiness Standards Key Contents*	**Number of Texas College Readiness Standards Measured by the ACT**	**Aspects of Texas College Readiness Standards that are Not Measured**
V. Cross-Disciplinary Themes	(5) out of (5)	
VI. Biology	(7) out of (7)	
VII. Chemistry	(11) out of (11)	
VIII. Physics	(10) out of (10)	
IX. Earth and Space Science	(6) out of (6)	
X. Environmental Science	(5) out of (5)	
TOTALS 6 out of 6 Content Key Contents	(33) out of (33)	

*Refer to Texas Science College Readiness Standards on pages 21–40

Section B: Texas College Readiness Standards Measured by the ACT

English/Language Arts

Texas English/Language Arts
College Readiness Standards

I. Writing

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

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

Examples:

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

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

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

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

Examples:

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

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

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

Examples:

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

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

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

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

Examples:

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

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

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

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

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

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

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

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

Examples:

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

b. Edit for subject-verb agreement.

c. Edit for pronoun reference and agreement.

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

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

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

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

II. Reading

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

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

Examples:

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

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

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

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

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

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

Examples:

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

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

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

Examples:

a. Analyze connections between main ideas and supporting details.

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

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

Examples:

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

b. Summarize key points in important historical documents.

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

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

Examples:

a. Evaluate the logical effectiveness of arguments.

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

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

6. Analyze imagery in literary texts.

Examples:

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

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

Examples:

a. Analyze a passage for word choice and voice.

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

c. Explain how authors use dialect to convey character.

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

Examples:

a. Explain how form or genre communicates meaning.

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

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

Examples:

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

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

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

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

Examples:

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

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

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

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

Examples:

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

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

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

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

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

Examples:

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

b. Explain how connotation determines meaning.

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

Examples:

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

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

Examples:

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

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

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

Examples:

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

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

Examples:

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

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

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

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

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

Examples:

a. Analyze how significant historical events influence authors.

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

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

Examples:

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

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

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

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

Examples:

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

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

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

Examples:

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

III. Speaking

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

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

Examples:

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

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

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

   Examples:

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

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

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

   Examples:

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

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

2. Participate actively and effectively in group discussions.

   Examples:

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

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

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

   Examples:

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

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

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

   d. Use appropriate media for public presentations.

IV. Listening

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

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

   Examples:

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

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

   c. Identify subtle uses of language.

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

   Examples:

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

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

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

   Examples:

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

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

   c. Paraphrase or summarize information.

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

B. Listen effectively in informal and formal situations.

1. Listen critically and respond appropriately to presentations.

   Examples:

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

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

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

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

   Examples:

   a. Accurately paraphrase what has been heard.

   b. Revise a draft based on oral peer critique.

3. Listen actively and effectively in group discussions.

   Examples:

   a. Take effective notes during group discussion.

   b. Participate in a productive deliberation.

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

V. Research

A. Formulate topic and questions.

1. Formulate research questions.

Examples:

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

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

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

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

2. Explore a research topic.

Examples:

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

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

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

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

Examples:

a. Adjust topic based on preliminary research.

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

B. Select information from a variety of sources.

1. Gather relevant sources.

Examples:

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

b. Locate electronic sources using advanced search strategies.

c. Select an appropriate range of source materials.

2. Evaluate the validity and reliability of sources.

Examples:

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

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

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

3. Synthesize and organize information effectively.

Examples:

a. Manage sources appropriately.

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

c. Select quotations that support the thesis.

d. Determine what evidence best supports the major points.

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

4. Use source material ethically.

Examples:

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.

C. Produce and design a document.

1. Design and present an effective product.

Examples:

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

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

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

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

2. Use source material ethically.

Examples:

a. Paraphrase accurately.

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

c. Cite sources appropriately.

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

Texas Mathematics
College Readiness Standards

I. Numeric Reasoning

A. Number representation

1. Compare real numbers.

Examples:

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

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

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

d. Represent any rational number in scientific notation.

2. Define and give examples of complex numbers.

Examples:

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

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

c. Understand that to solve certain problems and equations, number systems need to be extended from whole numbers to the set of all integers (positive, negative, 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.

Examples:

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

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

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

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

C. Number sense and number concepts

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

Examples:

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

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

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

II. Algebraic Reasoning

A. Expressions and equations

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

Examples:

a. Define what an expression or equation represents.

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

B. Manipulating expressions

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

Examples:

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

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

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

C. Solving equations, inequalities, and systems of equations

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

   Examples:

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

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

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

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

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

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

   Examples:

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

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

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

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

D. Representations

1. Interpret multiple representations of equations and relationships.

   Examples:

   a. Interpret graphical representations of equations.

   b. Understand how variables can be used to express generalizations and represent situations.

   c. Recognize the solution(s) to an equation from a table of values.

   d. Describe numerical patterns using algebraic expressions and equations in closed or recursive forms, such as arithmetic sequences.

2. Translate among multiple representations of equations and relationships.

   Examples:

   a. Explain the common information presented in multiple representations of a relationship.

   b. Translate one given representation to another representation (e.g., tabular to graphic, graphic to symbolic).

   c. Use multiple representations to determine rate of change.

   d. Determine if a relationship given in graphical, tabular, or symbolic form is linear or nonlinear.

III. Geometric Reasoning

A. Figures and their properties

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

   Examples:

   a. Construct and use drawings, models, and coordinate representations of plane and space figures in order to solve problems by hand and using technology.

   b. Recognize and describe the plane-figure components of three-dimensional figures, such as prisms, pyramids, cylinders, and cones.

   c. Describe and use cross-sections and nets of three-dimensional figures to relate them to plane figures.

   d. Describe the conic sections as intersections of a plane with a cone.

   e. Recognize and describe orthographic (top, front, side) and isometric views of three-dimensional geometric figures.

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

   Examples:

   a. Develop and verify attributes of lines and parts of lines in a plane and in space: parallel, intersecting, perpendicular, and skew lines; angle relationships associated with transversals on parallel lines.

   b. Develop and verify angle relationships: vertical, complementary, supplementary, angles on parallel lines, angle-side relations in a triangle, interior/exterior angles on polygons, and angles on circles.

   c. Develop, verify, and extend properties of circles, including properties of angles, arcs, chords, tangents, secants, and spheres.

   d. Develop and verify properties of triangles and quadrilaterals (e.g., triangle congruence conditions, properties of a parallelogram).

   e. Develop and verify properties of parts of prisms, cylinders, pyramids, and cones.

   f. Apply properties of geometric figures to solve problems.

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

   Examples:

   a. Apply the Pythagorean Theorem and its converse to solve real-life situations in two and three dimensions.

   b. Apply Pythagorean triples and special right triangle relationships to solve problems.

   c. Solve right triangle situations using sine, cosine, and tangent.

B. Transformations and symmetry

1. Identify and apply transformations to figures.

   Examples:

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

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

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

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

2. Identify the symmetries of a plane figure.

   Examples:

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

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

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

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

   Examples:

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

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

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

C. Connections between geometry and other mathematical content strands

1. Make connections between geometry and algebra.

   Examples:

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

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

   c. Relate geometric and algebraic representations of lines, segments, simple curves, and conic sections [e.g., describe 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.

   Examples:

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

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

3. Make connections between geometry and measurement.

   Examples:

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

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

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

D. Logic and reasoning in geometry

1. Make and validate geometric conjectures.

   Examples:

   a. Use drawings, manipulatives (e.g., paper folding, transformations) and constructions (e.g., compass/straightedge, 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 that Euclidean geometry is an axiomatic system.

Examples:

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

b. Understand that non-Euclidean geometries exist.

IV. Measurement Reasoning

A. Measurement involving physical and natural attributes

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

Examples:

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

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

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

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

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

B. Systems of measurement

1. Convert from one measurement system to another.

Examples:

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.

Examples:

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

C. Measurement involving geometry and algebra

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

Examples:

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

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

Examples:

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

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

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

Examples:

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

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

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

D. Measurement involving statistics and probability

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

Examples:

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

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

c. Calculate weighted averages, indices, and ratings.

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

Examples:

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

b. Interpret given probability measures in a problem.

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

V. Probabilistic Reasoning

A. Counting principles

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

   Examples:

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

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

B. Computation and interpretation of probabilities

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

   Examples:

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

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

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

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

   Examples:

   a. Distinguish between independent and dependent events.

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

   c. Compute conditional probability.

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

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

VI. Statistical Reasoning

A. Data collection

1. Plan a study.

   Examples:

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

   b. Explain the difference between observational and experimental studies.

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

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

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

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

B. Describe data

1. Determine types of data.

   Examples:

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

   b. Recognize and describe univariate and bivariate data.

2. Select and apply appropriate visual representations of data.

   Examples:

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

   b. Read and interpret graphical displays of data.

3. Compute and describe summary statistics of data.

   Examples:

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

   b. Describe the effect of outliers on summary statistics.

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

   Examples:

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

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

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

1. Make predictions and draw inferences using summary statistics.

   Examples:

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

   b. Draw conclusions from analyzing a set of data.

2. Analyze data sets using graphs and summary statistics.

   Examples:

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

   b. Analyze and describe similarities and differences by comparing graphical distributions (e.g., parallel boxplots, back-to-back stem-leaf plots).

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

   Examples:

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

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

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

4. Recognize reliability of statistical results.

   Examples:

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

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

   c. Identify and explain misleading uses of data.

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

VII. Functions

A. Recognition and representation of functions

1. Recognize whether a relation is a function.

   Examples:

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

2. Recognize and distinguish between different types of functions.

   Examples:

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

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

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

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

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

B. Analysis of functions

1. Understand and analyze features of a function.

   Examples:

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

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

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

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

2. Algebraically construct and analyze new functions.

   Examples:

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

   b. Formulate the composition of two functions.

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

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

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

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

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

C. Model real world situations with functions

1. Apply known function models.

   Examples:

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

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

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

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

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

2. Develop a function to model a situation.

   Examples:

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

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

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

VIII. Problem Solving and Reasoning

A. Mathematical problem solving

1. Analyze given information.

Examples:

a. Extract needed facts and relationships from given information.

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

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

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

e. Identify additional information needed to reach a solution.

f. Test ideas with specific cases.

2. Formulate a plan or strategy.

Examples:

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

b. Identify needed algorithms or formulas.

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

3. Determine a solution.

Examples:

a. Make and test conjectures.

b. Find an approximate solution with or without technology.

c. Identify and solve sub-problems.

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

4. Justify the solution.

Examples:

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

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

c. Verify a general solution in special cases.

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

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

5. Evaluate the problem solving process.

Examples:

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

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

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

B. Logical reasoning

1. Develop and evaluate convincing arguments.

Examples:

a. Use examples to formulate conjectures.

b. Use counterexamples to refute conjectures.

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

2. Use various types of reasoning.

Examples:

a. Use inductive reasoning to formulate a conjecture.

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

c. Use geometric and visual reasoning.

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

C. Real world problem solving

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

Examples:

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

b. Convert given information into an appropriate mathematical model.

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

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

Examples:

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

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

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

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

3. Evaluate the problem solving process.

Examples:

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

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

IX. Communication and Representation

A. Language, terms, and symbols of mathematics

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

Examples:

a. Use variables to represent quantities in contextual situations.

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

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

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

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

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

Examples:

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

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

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

Examples:

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

b. Write the converse, inverse, and contrapositive of any given conditional statement.

B. Interpretation of mathematical work

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

Examples:

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

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

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

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

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

f. Use multiple representations of rate of change.

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

Examples:

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

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

C. Presentation and representation of mathematical work

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

Examples:

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

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

Examples:

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

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

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

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

Examples:

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

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

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

X. Connections

A. Connections among the strands of mathematics

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

   Examples:

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

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

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

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

2. Connect mathematics to the study of other disciplines.

   Examples:

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

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

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

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

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

   Examples:

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

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

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

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

   Examples:

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

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

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

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

   Examples:

   a. Identify mathematics used in several careers and professions.

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

Texas Science
College Readiness Standards

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

A. Cognitive skills in science

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

Examples:

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

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

- Premises of the argument are not made explicit.
- Conclusions do not follow logically from the evidence.
- Argument is based on analogy but the comparison is faulty.
- Fact and opinion intermingle, opinions are presented as fact, or it is not clear which is which.
- Celebrity is used as authority.
- Vague attributions are used in place of specific references or citations.
- Reports of experimental results fail to describe appropriate controls.
- Faulty graphs distort appearance of results by omitting data, omitting part of the scale, using no scale at all, etc.
- Average (mean) results are reported, but not the amount of variation around the mean.
- Absolute and proportional quantities or percentages are mixed together without clarification.
- Other incorrect, misleading, or shoddy practices are used, as described in more detail in *Science for All Americans*, a report from Project 2061, AAAS, 1990.

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

d. Demonstrate ability to review and evaluate articles from a variety of sources, including scientific journals, websites, and popular publications to identify examples of proper statements and arguments, as well as examples where good practices were not exhibited.

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

Examples:

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

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

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

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

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

Examples:

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

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

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

Examples:

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

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

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

B. Scientific inquiry

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

Examples:

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

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

c. Identify appropriate controls and variables in the investigation.

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

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

f. Present results and seek critiques from others.

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

C. Collaborative and safe working practices

1. Collaborate on joint projects.

Examples:

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

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

Examples:

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

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

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

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

Examples:

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.

Examples:

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

2. Use computer models, applications and simulations.

Examples:

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 apparatuses, equipment, techniques, and procedures for collecting quantitative and qualitative data.

Examples:

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.

Examples:

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.

Examples:

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

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II. Foundation Skills: Scientific Applications of Mathematics

A. Basic mathematics conventions

1. Understand the real number system and its properties.

   Examples:

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

   b. Determine rates from magnitudes (e.g., speed from time and distance) and magnitudes from rates (e.g., the expected number of births if the birth rate and population size are known; 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.

   Examples:

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

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

   Examples:

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

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

   c. Find the reciprocal of any number.

4. Use proportional reasoning to solve problems.

   Examples:

   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.

   Examples:

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

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

   Examples:

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

   b. Estimate distances and travel times from maps.

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

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

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

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

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

   Examples:

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

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

   c. Report the appropriate units with the numerical answer.

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

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

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

B. Mathematics as a symbolic language

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

   Examples:

   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.

   Examples:

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

C. Understand relationships among geometry, algebra, and trigonometry

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

   Examples:

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

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

c. Perform graphical vector addition and subtraction.

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

Examples:

a. Construct graphs from given equations.

b. Predict the shape of a curve without graphing.

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

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

Examples:

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

4. Understand basic geometric principles.

Examples:

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

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

D. Scientific problem solving

1. Use dimensional analysis in problem solving.

Examples:

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

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

E. Scientific application of probability and statistics

1. Understand descriptive statistics.

Examples:

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

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

c. Use appropriate statistical tests to evaluate hypotheses.

F. Scientific measurement

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

Examples:

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

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

Examples:

a. Know the rules for adding, subtracting, multiplying, and dividing measurements using the appropriate number of significant digits.

b. Apply an understanding of significant digits and estimated digits to evaluate and guide selection of appropriate measuring devices.

c. Make measurements using various devices and record data with the correct number of significant figures.

d. Distinguish between accuracy (i.e., closeness to true value), and precision (i.e., reproducibility).

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

Examples:

a. Using log tables or calculators, determine the log of a number between 1 and 10, and determine the value of a number from its logarithm (base 10).

b. Express the value of the log (base 10) of a number greater than 10 or less than 1, using scientific notation.

c. Recognize, without the help of log tables or calculators, the log (base 10) of any power of 10.

d. Add or subtract numbers expressed as logs accurately to determine values represented.

e. Use logarithms for calculations involving numbers less than one or greater than 10, i.e., numbers expressed with exponents of ten in scientific notation.

f. Calculate the pH of a given molar concentration of an acid or alkaline (basic) solution.

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III. Foundation Skills: Scientific Applications of Communication

A. Scientific writing

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

   Examples:

   a. Construct word (narrative) descriptions of apparatuses, equipment, techniques and procedures, data, and other features of scientific investigations with sufficient clarity that a layman reader can comprehend and replicate the items or arrangements being described.

   b. Write accurate and understandable lab reports and technical documents.

   c. Prepare a summary or abstract of a technical article or report, extracting in brief form the pertinent information.

   d. Use appropriate terminology and data expression to communicate information in a concise manner.

   e. Give credit to original authors including online or electronic sources and never take credit for words that are not one's own.

   f. Write a technical report including a bibliography and proper documentation of sources using a standard style.

B. Scientific reading

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

   Examples:

   a. Describe the contents of a technical or scientific article.

   b. Explain the importance of a technical or scientific article.

   c. Make reasonable conclusions or predictions from given scientific article data.

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

   Examples:

   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.

   Examples:

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

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

   Examples:

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

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

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

C. Presentation of scientific/technical information

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

   Examples:

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

   b. Present data or explanations extemporaneously without word-byword 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.

   Examples:

   a. Use electronic tools to locate relevant information.

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

   Examples:

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

   b. Develop referencing skills to find needed background information.

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IV. Science, Technology, and Society

A. Interactions between innovations and science

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

   Examples:

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

B. Social ethics

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

   Examples:

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

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

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

   Examples:

   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.

   Examples:

   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.

   Examples:

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

V. Cross-Disciplinary Themes

A. Matter/states of matter

1. Know modern theories of atomic structure.

   Examples:

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

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

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

   Examples:

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

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

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

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

1. Understand the Laws of Thermodynamics.

   Examples:

   a. Express thermodynamic principles in mathematical or symbolic statements.

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

2. Know the processes of energy transfer.

   Examples:

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

   b. Compare and contrast kinetic and potential energy.

C. Change over time/equilibrium

1. Recognize patterns of change.

   Examples:

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

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

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

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

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

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

D. Classification

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

Examples:

a. Correctly use nomenclature for classification.

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

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

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

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

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

g. Distinguish among elements, compounds, and mixtures.

E. Measurements and models

1. Use models to make predictions.

Examples:

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.

Examples:

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.

Examples:

a. Compare the order of magnitude estimates for metric sizes of a variety of objects (e.g., atomic nucleus, atom, molecule, grain of sand, pinhead, fingernail, baseball, city, state, country, planet, star).

VI. Biology

A. Structure and function of cells

1. Know that although all cells share basic features, cells differentiate to carry out specialized functions.

Examples:

a. Describe criteria for recognizing different functional cell types and give examples of such types including nervous, epithelial, muscle and other cells.

b. Name and describe basic cell types found in living organisms.

c. Give examples of particular modifications of cells, and explain how these modifications are related to each type's function in an organism.

d. Recognize and describe major features that distinguish plant, animal and fungal cells.

2. Explain in your own words how cells can be categorized into two major types: prokaryotic and eukaryotic, and describe major features that distinguish one from the other.

Examples:

a. Describe or recognize major features that distinguish prokaryotic from eukaryotic cells.

3. Describe the structure and function of major subcellular organelles.

Examples:

a. Describe or recognize the appearance or structure of ribosomes, cytoplasmic membrane, chromosomes, cell wall, eukaryotic nucleus, nucleolus, lysosomes, vacuoles, cytoskeleton, centrioles, cilia, flagella, Golgi apparatus, chloroplasts, mitochondria, and endoplasmic reticulum, and describe important functions of each.

4. Describe the major features of mitosis and relate this process to growth and asexual reproduction.

Examples:

a. Draw, describe, and place in sequence the various stages of mitosis.

b. Identify the stages of mitosis when presented on a microscope slide, computer animation, or drawing during a practical lab exam.

c. Arrange pictures or word descriptions of the stages of mitosis into correct sequence and describe or explain any significant events occurring in each stage.

5. Understand the process of cytokinesis in plant and animal cells and how this process is related to growth.

Examples:

a. Describe the major features and events of cytokinesis with pictures or word descriptions.

6. Know the structure of membranes and how this relates to permeability.

Examples:

a. Describe and explain the processes of osmosis and diffusion, and explain how the structure of plasma membranes permits and influences these events.

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B. Biochemistry

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

   Examples:

   a. Describe the role of each type of biological molecule within a living system.
   b. Identify a biological molecule based on its formula and structure.
   c. Describe the major role of each biological molecule in biological structure and metabolism.

2. Describe the structure and function of enzymes.

   Examples:

   a. Describe the environmental effects (e.g., pH, temperature) on enzyme activity and explain why these affect 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.

   Examples:

   a. Explain the importance of chlorophyll.
   b. Describe patterns of electron flow through light reaction events.
   c. Describe significant features of the Calvin cycle.

4. Describe the major features and chemical events of cellular respiration.

   Examples:

   a. Describe what Adenosine Triphosphate (ATP) is and its importance as an energy carrier molecule.
   b. Describe major features of glycolysis, Krebs cycle, electron transport system, and chemiosmosis.

5. Know how organisms respond to presence or absence of oxygen, including mechanisms of fermentation.

   Examples:

   a. Conduct lab experiments regarding fermentation, respiration, and photosynthesis.
   b. Describe the role of oxygen in respiration, and describe pathways of electron flow in the absence of oxygen.
   c. Explain the advantages and disadvantages between fermentation and aerobic respiration.

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

   Examples:

   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.

   Examples:

   a. Describe features of biogeography/ plate tectonics, fossil record, metabolism, DNA/protein sequences, homology, embryology, artificial selection/agriculture, and antibiotic resistance that contribute to our understanding of evolutionary change.

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

   Examples:

   a. Describe mechanisms that produce variations in population sizes.
   b. Recognize, describe, and explain typical patterns of change in population size (e.g., the logistic growth curve).
   c. Describe particular examples of extinction and describe conditions that produced these extinctions (e.g., Permian 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).
   g. Describe and explain processes and major events in natural selection, genetic drift, mutation, etc., and distinguish these processes from each other.

D. Molecular genetics and heredity

1. Understand Mendel's laws of inheritance.

   Examples:

   a. Describe the laws of Mendelian genetics.

b. Predict outcomes of a variety of test crosses and be able to predict parental genotypes for offspring.

c. Use the laws of inheritance to carry out numerical calculations analyzing and predicting genetic characteristics of parents and offspring.

d. Read a "genetics problem" and identify the information needed to complete a Punnett square.

e. Determine phenotypes and genotypes of offspring from a given set of data about parental phenotypes and/or genotypes, expressing these features in numerical terms for cases of monohybrid and dihybrid crosses and other typical cases.

f. Determine phenotypes and genotypes of parents from a given set of data about offspring phenotypes and/or genotypes, expressing these features in numerical terms.

2. Know modifications to Mendel's laws.

Examples:

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.

Examples:

a. Research a genetic disorder and describe the cause of the disorder.

b. Describe in words or pictures the molecular structure of DNA, RNA, and proteins.

c. Describe in words or pictures the molecular events of replication, transcription, translation, and mutation.

d. Describe the events and processes of molecular genetics: DNA controls synthesis of several types of RNA; RNA molecules plus proteins cooperate to synthesize new proteins; and proteins control structure and metabolism of cells.

e. Describe the processes of electrophoresis and polymerase chain reaction, and explain their function in identifying DNA, RNA, and proteins.

4. Understand simple principles of population genetics and describe characteristics of a Hardy-Weinberg population.

Examples:

a. Calculate phenotypes and genotypes of offspring populations from a given set of data about phenotypes and/or genotypes present in a population, using the Hardy-Weinberg equations.

b. Describe and explain features of a population that must be present in order for Hardy-Weinberg calculations to be accurate.

5. Describe the major features of meiosis and relate this process to Mendel's Laws of Inheritance.

Examples:

a. Explain the events of meiosis and the significance of these events to maintain chromosomal numbers.

b. Explain how the events of meiosis produce the genetic effects described by Mendel's Laws of Inheritance.

c. Arrange pictures or word descriptions of the stages of meiosis into their correct sequence and describe or explain any significant events occurring in each stage.

d. Compare and contrast mitosis and meiosis.

E. Classification and taxonomy

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

Examples:

a. Explain the relationship between DNA sequences and physical characteristics.

b. Describe the characteristics of each taxon and explain the significance in separating organisms.

c. Distinguish similarities and differences among a given set of pictures or drawings of vertebrates during their development.

d. Describe species diversity and cladistics, including the types of evidence and procedures that can be used to construct diagrams (e.g., phylogenetic trees).

e. Construct cladograms and/or phylogenetic trees from simple data sets for major groups of organisms.

f. Determine the correct classification and taxonomy of organisms from narrative or pictorial descriptions.

F. Systems and homeostasis

1. Know that organisms possess various structures and processes (feedback loops) that maintain steady internal conditions.

Examples:

a. Describe examples of organisms that possess various structures and processes (feedback loops) that maintain steady internal conditions.

b. Describe examples of homeostasis (e.g., temperature regulation, osmotic balance, glucose levels) and describe the major features of feedback loops that produce such homeostasis.

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2. Describe, compare, and contrast structures and processes that allow gas exchange, nutrient uptake and processing, waste excretion, nervous and hormonal regulation, and reproduction in plants, animals, and fungi; give examples of each.

Examples:

a. Describe common gas exchange systems in plants and animals including anatomical features and functions.

b. Describe common nutrient acquisition systems in plants, animals, and fungi, including anatomical features and functions.

c. Describe common waste excretion systems in plants and animals, including anatomical features and functions.

d. Describe common nervous/hormonal control systems in plants and animals, including anatomical features and functions.

e. Describe common reproductive systems in plants, animals, and fungi including anatomical features and functions.

G. Ecology

1. Identify Earth's major biomes, giving their locations, typical climate conditions, and characteristic organisms present in each.

Examples:

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.

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

Examples:

a. Describe patterns of energy flow and nutrient cycling through ecosystems.

b. Describe and explain a trophic pyramid, including descriptions of typical organisms to be found at each trophic level in an ecosystem.

c. Describe patterns of energy flow and nutrient cycling through ecosystems including the role of microorganisms.

3. Understand typical forms of organismal behavior.

Examples:

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.

Examples:

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.

Examples:

a. Distinguish between physical properties (e.g., density, melting point) and chemical properties (e.g., ability to react, combustibility). Know that chemical changes create new substances (e.g., rusting), while physical changes do not (e.g., boiling).

b. Understand that, as an intrinsic property, density does not change as sample size is changed, and be able to perform density calculations.

2. Recognize and classify pure substances (elements, compounds) and mixtures.

Examples:

a. Describe separation techniques for both mixtures and compounds.

b. Distinguish between homogeneous and heterogeneous mixtures.

c. Understand that, as an intrinsic property, density does not change as sample volume is changed, and be able to perform density calculations.

B. Atomic structure

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

Examples:

a. Describe the discoveries of Dalton (atomic theory), Thomson (the electron), Rutherford (the nucleus), and Bohr (planetary model of the atom); understand how each discovery contributed to modern atomic theory.

b. Identify the masses, charges, and locations of the major components of the atom (protons, neutrons, and electrons); describe Rutherford's "gold foil" experiment that led to the discovery of the atomic nucleus; 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.

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d. Explain the importance of quantized electron energy and its relationship to atomic emission spectra.

e. Understand the electron configuration in atoms (Aufbau principle, the Pauli exclusion principle, Hund's rule) and their connection with the periodic table.

C. Periodic table

1. Know the organization of the periodic table.

Examples:

a. Identify periods and groups on the periodic table.

b. Identify metals, metalloids, and nonmetals on the periodic table.

c. Distinguish between and describe patterns in electron configurations for representative elements, transition elements, inner-transition elements, and noble gases. Predict the common charges on the representative elements from the periodic table.

2. Recognize the trends in physical and chemical properties as one moves across a period or vertically through a group.

Examples:

a. Define 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.

D. Chemical bonding

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

Examples:

a. Draw Lewis dot structures for simple molecules, including simple hydrocarbons.

b. Use Valence Shell Electron Pair Repulsion (VSEPR) model to predict molecular shapes.

c. Describe non-polar and polar covalent bonds. Use a chart of electronegativities to determine bond polarity.

d. Determine if a molecule is polar (contains a dipole moment).

E. Chemical reactions

1. Classify chemical reactions by type. Describe the evidence that a chemical reaction has occurred.

Examples:

a. Write equations for chemical reactions using appropriate symbols and balance the equations by applying the Law of Conservation of Mass. Write net ionic equations.

b. Predict the products of a reaction that fall within the five general types of chemical reactions (synthesis, decomposition, single replacement, double replacement, and combustion).

c. Use an activity series to predict whether a single replacement reaction will occur.

d. Use solubility rules to determine the precipitate formed in a double replacement precipitation reaction.

2. Describe the properties of acids and bases, and identify the products of a neutralization reaction.

Examples:

a. Define pH and describe acid and base solutions in terms of pH. Use hydrogen ion or hydroxide ion concentrations to determine the pH of an acid or base solution.

b. Use both commercial and noncommercial 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.

Examples:

a. Differentiate between oxidation and reduction, and between oxidizing agent and reducing agent.

b. Understand the consequences of corrosion processes and define and describe the electroplating process.

c. Determine the oxidation number of any atom in an element, ion, or compound.

4. Understand chemical equilibrium.

Examples:

a. Identify the factors that cause a shift in equilibrium (e.g., temperature, concentration, volume, 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.

Examples:

a. Distinguish between endothermic and exothermic reactions. Draw energy diagrams for endothermic and exothermic reactions.

b. Describe the Law of Conservation of Energy.

6. Understand chemical kinetics.

Examples:

a. Describe collision theory and use this theory to explain effects of concentration, temperature, and nature of reactants on reaction rate.

b. Define catalyst and describe how a catalyst affects a reaction rate.

F. Chemical nomenclature

1. Know formulas for ionic compounds.

Examples:

a. Name and write formulas for binary and ternary ionic compounds, using Group A (representative) metals and Group B (transition) metals, including those containing common polyatomic ions, (e.g., nitrate, sulfate, carbonate, ammonium, phosphate, hydroxide).

2. Know formulas for molecular compounds.

Examples:

a. Name and write formulas for binary molecular compounds and acids.

b. Categorize a compound as ionic or molecular.

G. The mole and stoichiometry

1. Understand the mole concept.

Examples:

a. Use Avogadro's number and molar mass to convert to moles of a substance. Determine the percent composition of a compound. Calculate the empirical formula of a compound from mass or percent composition data.

2. Understand molar relationships in reactions, stoichiometric calculations, and percent yield.

Examples:

a. Construct mole ratios for a reaction to calculate the reactant amounts needed or product amounts formed in terms of moles or mass.

b. Calculate percent yield, theoretical yield, or actual yield for a reaction.

H. Thermochemistry

1. Understand the Law of Conservation of Energy and processes of heat transfer.

Examples:

a. Distinguish among radiation, convection, and conduction as means of heat transfer.

b. Describe processes of heat transfer.

c. Perform calculations involving heat transfer, using specific heat and latent heat (phase changes).

2. Understand energy changes and chemical reactions.

Examples:

a. Describe and give examples of renewable and non-renewable energy resources.

b. Describe endothermic and exothermic reactions.

c. Know that systems naturally tend to move in a direction that increases disorder or randomness (entropy).

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

1. Understand the behavior of matter in its various states: solid, liquid, gas.

Examples:

a. Describe how gas pressure is affected by volume, temperature, and the addition of gas.

b. Describe the behavior of solids, liquids, and gases under changes in pressure.

2. Understand properties of solutions.

Examples:

a. Describe factors affecting solubility, units of concentration, colligative properties, and colloids.

b. Calculate the molarity and molality of solutions.

c. Determine boiling point elevation and freezing point depression for a solution.

3. Understand principles of ideal gas behavior and kinetic molecular theory.

Examples:

a. Use kinetic molecular theory to explain how gas pressure is affected by volume, temperature, and the addition of gas.

b. Distinguish between real and ideal gas behavior, and identify the criteria in the kinetic molecular theory that conflict with the properties of real gases.

4. Apply the concept of partial pressures in a mixture of gases.

Examples:

a. Use Dalton's Law to determine the partial pressure of a gas in a mixture of gases.

5. Know properties of liquids and solids.

Examples:

a. Describe the properties of liquids (e.g., surface tension, capillary action).

b. Describe the structure of solids (e.g., crystal lattice structure, unit cell, amorphous solids).

6. Understand the effect of vapor pressure on changes in state; explain heating curves and phase diagrams.

Examples:

a. Define boiling, freezing, sublimation, etc.

b. Explain heating curves and phase diagrams.

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7. Describe intermolecular forces.

Examples:

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: proteins, carbohydrates, lipids, and nucleic acids.

Examples:

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.

Examples:

a. Identify the types of radioactive decay particles that occur, compare their properties (e.g., mass, charge, composition, penetrating ability), and write equations representing the decay processes.

b. Explain the concept of half-life for a radioisotope, and use this concept to determine the amount of a certain sample of radioisotope remaining after a period of time, given the length of the half-life.

c. Determine the length of time that has passed, given the remaining amount of radioisotope, the original amount of radioisotope, and the length of the half-life.

d. Explain how carbon-14 is used to date artifacts.

e. Compare and contrast the nuclear processes of fission and fusion.

VIII. Physics

A. Matter

1. Demonstrate familiarity with length scales from sub-atomic particles through macroscopic objects.

Examples:

a. Compare order of magnitude estimates for metric sizes of a variety of objects (e.g., atomic nucleus, atom, molecule, grain of sand, pinhead, fingernail, baseball, city, state, country, planet, star).

2. Understand states of matter and their characteristics.

Examples:

a. Describe the states of matter in terms of volume, shape, and cohesive strength.

b. State the physical changes associated with a change in phase.

3. Understand the concepts of mass and inertia.

Examples:

a. Describe the concept of mass as a measurement of inertia.

b. Compare order of magnitude estimates for masses of a variety of objects (e.g., electron, grain of sand, pebble, baseball, person, car, planet, star).

4. Understand the concept of density.

Examples:

a. Define density as ratio of mass to volume. Apply the definition to calculate mass, volume, or density, given two of the three quantities.

b. Calculate density of a homogeneous material and use it to identify the material.

5. Understand the concepts of gravitational force and weight.

Examples:

a. Qualitatively and quantitatively describe Newton's Law of Gravitation and the factors that affect the gravitational force between two objects.

b. Describe weight as a force of attraction to a large body and make computations of weight (using W = mg).

c. Give examples to differentiate between mass and weight.

B. Vectors

1. Understand how vectors are used to represent physical quantities.

Examples:

a. State several examples of scalar quantities.

b. State several examples of vector quantities.

c. Convert a numerical vector quantity (magnitude and direction) into a graphical vector representation.

2. Demonstrate knowledge of vector mathematics using a graphical representation.

Examples:

a. Resolve a vector quantity (magnitude and direction) into perpendicular components using paper, a ruler, and a protractor.

b. Add and subtract various vectors using paper, a ruler, and a protractor.

3. Demonstrate knowledge of vector mathematics using a numerical representation.

Examples:

a. Resolve a numerical vector quantity (magnitude and direction) into perpendicular components using trigonometric functions and a calculator.

b. Add and subtract various vectors using trigonometric functions and a calculator.

C. Forces and Motion

1. Understand the fundamental concepts of kinematics.

   Examples:

   a. State the definitions for displacement, distance, velocity, speed, and acceleration.

   b. Solve problems involving displacement, distance, velocity, speed, and acceleration.

   c. Solve one-dimensional kinematics problems for the case of constant acceleration.

   d. Create and interpret graphs of one-dimensional motion (e.g., position vs. time, velocity vs. time).

   e. Describe two-dimensional trajectory motion qualitatively and quantitatively.

   f. Describe the concept of relative motion and define a frame of reference.

2. Understand forces and Newton's Laws.

   Examples:

   a. State Newton's Laws of Motion and demonstrate understanding of their application through lab activities.

   b. Solve for an unknown quantity using Newton's Second Law and the concept of equilibrium.

   c. Distinguish qualitatively between static and kinetic friction, and describe their effects on the motion of objects.

3. Understand the concept of momentum.

   Examples:

   a. Define and calculate momentum and impulse. Clearly indicate how momentum is a vector.

   b. State the conditions under which momentum is conserved.

   c. Describe the term "impulse" in terms of force, time, and momentum. Illustrate the principle of impulse by citing several examples.

   d. Solve problems using impulse and the conservation of momentum.

D. Mechanical Energy

1. Understand potential and kinetic energy.

   Examples:

   a. Calculate potential energy values for various types of potential energy (gravitational, elastic, and electrical).

   b. Calculate kinetic energy values (translational and rotational).

   c. Using a diagram of a pendulum or another energy conserving system, identify potential and kinetic energy at various locations.

2. Understand conservation of energy.

   Examples:

   a. Describe the conversion of potential energy into kinetic energy (and vice-versa) in closed systems for which only conservative forces are present.

   b. Describe the conversion of energy in systems in which dissipative forces are present.

   c. Describe the general conservation of energy.

3. Understand the relationship of work and mechanical energy.

   Examples:

   a. Compute net work as the product of net force and displacement, as the change in kinetic energy, and as the negative change in potential energy.

   b. Describe the concept of power and calculate average power.

   c. Distinguish between energy and power qualitatively, and state the dimensional units for each.

E. Rotating systems

1. Understand rotational kinematics.

   Examples:

   a. Describe the relationships between the concepts and equations used for translational motion and those used for rotational motion.

   b. Define qualitatively: angular displacement, angular velocity, and angular acceleration.

   c. Complete computations including angular displacement, angular velocity, angular acceleration, tangential acceleration, and centripetal (radial) acceleration.

   d. Use examples to illustrate differences between tangential acceleration and centripetal (radial) acceleration.

   e. Explain why a net force (called centripetal) is required in order for an object to move in a circular path.

2. Understand the concept of torque.

   Examples:

   a. Describe the concept of torque and compute torque values for various situations.

   b. Describe the concept of moment of inertia and compute moment of inertia values for various objects.

   c. Perform calculations using Newton's Second Law of Motion as applied to rotation.

3. Apply the concept of static equilibrium.

   Examples:

   a. Describe the two conditions for which an object is in static equilibrium.

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b. Construct an equation using the concept of static equilibrium and solve for an unknown quantity.

4. Understand angular momentum.

Examples:

a. Describe the concept of angular momentum.

b. Describe changes in angular velocity when moment of inertia changes.

F. Fluids

1. Understand pressure in a fluid and its applications.

Examples:

a. Define pressure and make basic pressure computations using pressure = force/area 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.

Examples:

a. Describe and calculate changes in fluid pressure when external pressure is applied, especially as observed in hydraulic systems.

b. Show how Pascal's Principle applies to hydraulic systems and calculate forces on both sides of a hydraulic system.

3. Understand buoyancy.

Examples:

a. Define buoyant force and state Archimedes' Principle.

b. Draw all the forces acting on an object submerged in a fluid. Discuss the conditions for sinking and floating in terms of the forces in the diagram.

4. Understand Bernoulli's principle.

Examples:

a. Qualitatively describe the relationship between fluid speed and fluid pressure in a closed system.

G. Oscillations and waves

1. Understand basic oscillatory motion and simple harmonic motion.

Examples:

a. Identify examples of oscillatory motion.

b. Recognize examples of simple harmonic motion.

2. Understand the difference between transverse and longitudinal waves.

Examples:

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.

Examples:

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.

Examples:

a. Describe the properties and behavior of sound including compressions, rarefactions, and travel through various media.

b. Compare and contrast sound and electro-magnetic waves in terms of wave speed, wave type, wavelength, frequency, and medium.

c. Describe the apparent change in frequency of waves due to the motion of a source or a receiver (the Doppler Effect).

H. Thermodynamics

1. Understand the gain and loss of heat energy in matter.

Examples:

a. Describe, qualitatively and quantitatively, the relationship between heat and change in temperature, including the effects of mass and specific heat.

b. Identify and compute the energy involved in changes of state.

c. Explain the relationships among evaporation, condensation, cooling, and warming.

d. Describe the transfer of heat by conduction, convection, and radiation.

2. Understand the basic laws of thermodynamics.

Examples:

a. State and describe the laws of thermodynamics.

b. Describe qualitative applications of the laws of thermodynamics and relate each to the concept of conservation of energy.

I. Electromagnetism

1. Discuss electric charge and electric force.

Examples:

a. Describe electrical repulsion and attraction.

b. State Coulomb's Law and use it to compute electrical force.

c. Describe the concept of an electric field.

2. Gain qualitative and quantitative understandings of voltage, current, and resistance.

Examples:

a. Describe the concept of electric potential.

b. Describe the concept of electrical charge flow and what limits that flow.

c. Describe the concept of electrical resistance to charge flow.

3. Understand Ohm's Law.

Examples:

a. Solve for unknown quantities using Ohm's Law.

b. Determine electrical resistance from graphs of voltage versus current.

4. Apply the concept of power to electricity.

Examples:

a. Define electrical power as the product of current and voltage; perform simple calculations of power consumption.

5. Discuss basic DC circuits that include voltage sources and combinations of resistors.

Examples:

a. Summarize the electrical characteristics (current, voltage, total resistance) of a circuit consisting of two or more resistors wired in series.

b. Summarize the electrical characteristics (e.g., current, voltage) of a circuit consisting of two or more resistors wired in parallel.

c. Compare the electrical characteristics (e.g., current, voltage) of a circuit consisting of two or more resistors wired in parallel with those of the same components wired in series.

6. Discuss basic DC circuits that include voltage sources and combinations of capacitors.

Examples:

a. Describe what a capacitor is and how it works.

b. Summarize the electrical characteristics (e.g., current, voltage) of a DC circuit consisting of a battery and a capacitor.

c. Summarize the electrical characteristics (e.g., current, voltage) of a DC circuit consisting of a capacitor and a resistor wired in series.

7. Understand magnetic fields and their relationship to electricity.

Examples:

a. Describe the force experienced by a moving electric charge in a magnetic field.

b. Describe moving electrical charge as the source of magnetic fields.

c. Describe Faraday's Law and Lenz's Law.

d. Describe the source of magnetism in matter.

e. State the law of magnetic poles.

8. Relate electricity and magnetism to everyday life.

Examples:

a. Explain how an electric motor works. State which electromagnetic laws or principles govern the workings of a motor.

b. Explain how an electric generator works. State which electromagnetic laws or principles govern the workings of a generator.

c. Make quantitative predictions of whether or not a circuit breaker will "trip" when a variety of electrical appliances are in use.

J. Optics

1. Know the electromagnetic spectrum.

Examples:

a. Discuss the regions of the electromagnetic spectrum, including radio waves, microwaves, infrared, visible, ultraviolet, x-rays, and gamma rays.

b. Discuss visible light as part of the electromagnetic spectrum. Emphasize that light is an electromagnetic wave.

c. Recognize that electromagnetic waves are transverse waves and travel at the speed of light through a vacuum.

d. Compare and contrast transmission, reflection, and absorption of radiation.

2. Understand the wave/particle duality of light.

Examples:

a. Describe the behavior of light and why scientists have chosen to model it as both a particle and a wave.

b. Give a practical example that illustrates light acting as a wave. Give a practical example that illustrates light acting as a particle.

3. Understand concepts of geometric optics.

Examples:

a. Predict the path of a reflected light ray by applying the law of reflection to both diffuse and specular reflection.

b. Define index of refraction. Predict the path of a light ray through a transparent material by application of Snell's Law.

c. Identify convex, concave, and plane mirrors.

d. Identify convex and concave lenses.

e. Discuss qualitatively the images formed by mirrors and single lenses.

f. Discuss qualitatively the images formed by combinations of mirrors and lenses (e.g., telescopes, microscopes, cameras).

IX. Earth and Space Science

A. Earth systems

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

   Examples:

   a. Describe major components and interactions within the atmosphere: gas composition, temperatures at various levels, ozone formation, and breakdown.

   b. Describe characteristics that identify and distinguish the core, mantle, and crust, including their locations, compositions, interactions with each other, and changes through time.

   c. Describe major components and interactions within the hydrosphere (the global ocean and its components).

   d. Describe major components and interactions within the biosphere, including major biogeochemical cycles (e.g., carbon cycle, oxygen-water cycle, nitrogen cycle, sulfur cycle, flow and storage of energy).

2. Understand relationships and interactions among atmosphere, geosphere, hydrosphere, and biosphere.

   Examples:

   a. Describe interactions between oceans and climate.

   b. Describe effects of catastrophic events (e.g., volcanoes, earthquakes) on Earth systems.

   c. Describe impacts of the oceans on the Earth system (e.g., how the Earth's geologic history and present structure would have differed if the ocean had never formed).

   d. Describe effects of biological activity on the atmosphere (e.g., CO_2 levels, O_2 levels).

   e. Describe major effects of solar activity on the earth's atmosphere, hydrosphere including climate, ocean circulation, ozone formation, etc.

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

   Examples:

   a. Describe methods and techniques for absolute and relative dating of geologic events and deposits.

   b. Describe general features of the geological history of Earth, including generally-accepted dates and sequence of the geologic time scale, physical and chemical conditions prevailing on Earth at different times, and major extinction events among organisms during these time periods.

   c. Explain how different surface processes (e.g., volcanism, erosion, tectonic, cratering) affect the planetary surface.

4. Utilize the tools scientists use to study and understand the Earth's systems.

   Examples:

   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.

   Examples:

   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.

   Examples:

   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.

   Examples:

   a. Identify and describe the major components of the solar system (e.g., star, planets, comets, dwarf planets, kuiper objects, asteroids).

2. Possess a scientific understanding of the formation of the solar system.

   Examples:

   a. Describe the formation of the sun and the evidence that supports our understanding of this process.

   b. Explain the differences between the formation of rocky and gaseous planets.

D. Origin and structure of the universe

1. Understand scientific theories for the formation of the universe.

   Examples:

   a. Describe current scientific theories and evidence for the origin of the Universe (the Big Bang) and formation of galaxies (Red Shift observations).

   b. Describe the life cycle of stars using the Hertzsprung-Russell diagram.

2. Know the current scientific descriptions of the components of the universe.

   Examples:

   a. Describe types of galaxies and the characteristics that distinguish them.

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b. Describe general features of quasars and pulsars and the characteristics that distinguish them.

E. Plate tectonics

1. Describe the evidence that supports the current theory of plate tectonics.

Examples:

a. Describe general features of the Earth's interior.

b. Describe the role of convection currents in plate motion.

2. Identify the major tectonic plates.

Examples:

a. Locate and identify the major tectonic plates and plate boundaries on a map.

3. Describe the motions and interactions of tectonic plates.

Examples:

a. Describe the geologic features that result from convergent, divergent, and transform plate boundaries.

4. Describe the rock cycle and its products.

Examples:

a. Identify common rocks and rock forming minerals.

b. Classify and describe the formation of rocks (igneous, metamorphic, sedimentary).

F. Energy transfer within and among systems

1. Matter and energy in the Earth system.

Examples:

a. Describe Earth's principal sources of internal and external energy (e.g., radioactive decay, gravity, solar energy).

2. Give examples of effects of energy transfer within and among systems.

Examples:

a. Describe energy sources and energy transfer processes (e.g., convection, conduction, radiation) that produce thunderstorms, hurricanes, tornadoes, and other weather events.

b. Provide examples of how the uneven heating of Earth influences global circulation patterns (e.g., currents, winds, weather).

c. Describe the effects of ocean currents on weather patterns.

d. Describe the effects of large impacts on geological structures and atmospheric conditions, and cite examples of evidence of large impacts in Earth's history.

X. Environmental Science

A. Earth systems

1. Recognize the Earth's systems.

Examples:

a. Describe the characteristics that identify and distinguish the geosphere, atmosphere, hydrosphere, and biosphere.

2. Know the major features of the geosphere and the factors that modify them.

Examples:

a. Describe the characteristics that identify and distinguish the core, mantle, crust, and tectonic plates, including their locations, compositions, interactions among them, and changes through time.

b. Describe processes of weathering, erosion, deposition, etc., that make up the rock cycle.

c. Describe factors such as earthquakes, volcanoes, and other natural disasters and their impact on the size and location of populations of organisms, and the habitats they occupy.

3. Know the major features of the atmosphere.

Examples:

a. Describe the physical and chemical characteristics that identify different regions of the atmosphere.

b. Describe the factors that influence weather and climate, including atmospheric circulation, Coriolis Effect, and atmosphere-ocean interactions.

4. Know the major features of the hydrosphere.

Examples:

a. Describe the composition and location of bodies of salt water and fresh water.

b. Describe patterns of ocean circulation, including currents and upwellings.

5. Be familiar with Earth's major biomes.

Examples:

a. Name and describe Earth's major terrestrial and aquatic biomes, including their locations, the characteristic organisms found in each, and important physical factors (e.g., temperature, rain fall) that produce these distribution patterns.

b. Describe the adaptations of organisms found in each biome.

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6. Describe the Earth's major biogeochemical cycles.

Examples:

a. Describe the carbon, oxygen-water, sulfur, nitrogen, and phosphorus cycles, including the chemical forms of each element at each stage of the cycle, and the chemical patterns of winds and ocean currents and provide information about changes in these patterns during events such as El Niño/La Niña.

B. Energy

1. Understand energy transformations.

Examples:

a. Describe patterns of winds and ocean currents and provide information about changes in these patterns during events such as El Niño/La Niña.

b. Describe how energy flows through the Earth's ecosystems while materials cycle repeatedly within these systems (e.g., food chains and webs, trophic levels, niches, predator-prey interactions, succession).

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

Examples:

a. Describe the major sources of energy, including fossil fuels, geothermal sources, wind energy, solar energy, nuclear energy, and others.

b. Describe methods and practices of energy conservation.

C. Populations

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

Examples:

a. Describe and explain carrying capacity, cultural and economic influences, urbanization, distribution, loss of biodiversity, endangered plants and animals, and deforestation.

b. Explain how 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.

Examples:

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.

Examples:

a. Name the major U.S. National Parks and Monuments, stating where each is located, and the important features of each that justify protection.

E. Human practices and their impacts

1. Describe the different uses for land (land management).

Examples:

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.

Examples:

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.

Examples:

a. Describe the features that identify and distinguish intensive agriculture, sustainable agriculture, organic agriculture, and other food and fiber production methods, including genetically modified organisms and livestock practices.

4. Understand land and water usage and management practices.

Examples:

a. Describe forestry practices (e.g., tree plantations, fire management).

b. Describe rangeland management practices (e.g., grazing practices, conversion to grasslands, federal regulation).

c. Describe management of urban land development, transportation infrastructure, public lands, and land conservation options.

d. Describe regulation and management of mining practices.

e. Describe regulation and management of fishing practices.

5. Understand how human practices affect air, water, and soil quality.

Examples:

a. Describe the formation and effects of acid deposition, ozone depletion, green house effect, and global warming.

b. Describe different methods of managing waste.

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c. Describe the essential components and features of recycling, reuse, remediation, renew, landfills, wastewater, and water recycling.

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Section C: ACT's College Readiness Standards Included in the Texas College Readiness Standards

In recent years ACT has brought a distinctive voice to the debate on what it means to be truly ready for college. Using a wealth of longitudinal data—data that no one else possesses—ACT has pioneered empirical approaches to assessing students' college readiness. Using thousands of student records and responses, content and measurement experts at ACT have developed detailed statements that describe what students typically know and are able to do at different levels of test performance. These data-driven, empirically derived score descriptors, known as ACT's College Readiness Standards, describe student achievement within various score ranges on the English, Reading, Writing, Mathematics, and Science tests on the EXPLORE, PLAN, and ACT.

In this section (Section C), the ACT College Readiness Standards included in the Texas College Readiness Standards are highlighted. College Readiness Standards not highlighted are those that include specific content, complexity, and/or proficiency level descriptors that ACT content experts determined were not included in the Texas College Readiness Standards.

Table C-1. ACT's College Readiness Standards — English

	Topic Development in Terms of Purpose and Focus	Organization, Unity, and Coherence	Word Choice in Terms of Style, Tone, Clarity, and Economy
13–15		Use conjunctive adverbs or phrases to show time relationships in simple narrative essays (e.g., *then*, *this time*)	Revise sentences to correct awkward and confusing arrangements of sentence elements Revise vague nouns and pronouns that create obvious logic problems
16–19	Identify the basic purpose or role of a specified phrase or sentence Delete a clause or sentence because it is obviously irrelevant to the essay	Select the most logical place to add a sentence in a paragraph	Delete obviously synonymous and wordy material in a sentence Revise expressions that deviate from the style of an essay
20–23	Identify the central idea or main topic of a straightforward piece of writing Determine relevancy when presented with a variety of sentence-level details	Use conjunctive adverbs or phrases to express straightforward logical relationships (e.g., *first*, *afterward*, *in response*) Decide the most logical place to add a sentence in an essay Add a sentence that introduces a simple paragraph	Delete redundant material when information is repeated in different parts of speech (e.g., "alarmingly startled") Use the word or phrase most consistent with the style and tone of a fairly straightforward essay Determine the clearest and most logical conjunction to link clauses
24–27	Identify the focus of a simple essay, applying that knowledge to add a sentence that sharpens that focus or to determine if an essay has met a specified goal Delete material primarily because it disturbs the flow and development of the paragraph Add a sentence to accomplish a fairly straightforward purpose such as illustrating a given statement	Determine the need for conjunctive adverbs or phrases to create subtle logical connections between sentences (e.g., *therefore*, *however*, *in addition*) Rearrange the sentences in a fairly uncomplicated paragraph for the sake of logic Add a sentence to introduce or conclude the essay or to provide a transition between paragraphs when the essay is fairly straightforward	Revise a phrase that is redundant in terms of the meaning and logic of the entire sentence Identify and correct ambiguous pronoun references Use the word or phrase most appropriate in terms of the content of the sentence and tone of the essay
28–32	Apply an awareness of the focus and purpose of a fairly involved essay to determine the rhetorical effect and suitability of an existing phrase or sentence, or to determine the need to delete plausible but irrelevant material Add a sentence to accomplish a subtle rhetorical purpose such as to emphasize, to add supporting detail, or to express meaning through connotation	Make sophisticated distinctions concerning the logical use of conjunctive adverbs or phrases, particularly when signaling a shift between paragraphs Rearrange sentences to improve the logic and coherence of a complex paragraph Add a sentence to introduce or conclude a fairly complex paragraph	Correct redundant material that involves sophisticated vocabulary and sounds acceptable as conversational English (e.g., "an aesthetic viewpoint" versus "the outlook of an aesthetic viewpoint") Correct vague and wordy or clumsy and confusing writing containing sophisticated language
33–36	Determine whether a complex essay has accomplished a specific purpose Add a phrase or sentence to accomplish a complex purpose, often expressed in terms of the main focus of the essay	Consider the need for introductory sentences or transitions, basing decisions on a thorough understanding of both the logic and rhetorical effect of the paragraph and essay	Delete redundant material that involves subtle concepts or that is redundant in terms of the paragraph as a whole

Table C-1. ACT's College Readiness Standards — English (continued)

	Sentence Structure and Formation	Conventions of Usage	Conventions of Punctuation
13–15	Use conjunctions or punctuation to join simple clauses Revise shifts in verb tense between simple clauses in a sentence or between simple adjoining sentences	Solve such basic grammatical problems as how to form the past and past participle of irregular but commonly used verbs and how to form comparative and superlative adjectives	Delete commas that create basic sense problems (e.g., between verb and direct object)
16–19	Determine the need for punctuation and conjunctions to avoid awkward-sounding sentence fragments and fused sentences Decide the appropriate verb tense and voice by considering the meaning of the entire sentence	Solve such grammatical problems as whether to use an adverb or adjective form, how to ensure straightforward subject-verb and pronoun-antecedent agreement, and which preposition to use in simple contexts Recognize and use the appropriate word in frequently confused pairs such as *there* and *their*, *past* and *passed*, and *led* and *lead*	Provide appropriate punctuation in straightforward situations (e.g., items in a series) Delete commas that disturb the sentence flow (e.g., between modifier and modified element)
20–23	Recognize and correct marked disturbances of sentence flow and structure (e.g., participial phrase fragments, missing or incorrect relative pronouns, dangling or misplaced modifiers)	Use idiomatically appropriate prepositions, especially in combination with verbs (e.g., *long for*, *appeal to*) Ensure that a verb agrees with its subject when there is some text between the two	Use commas to set off simple parenthetical phrases Delete unnecessary commas when an incorrect reading of the sentence suggests a pause that should be punctuated (e.g., between verb and direct object clause)
24–27	Revise to avoid faulty placement of phrases and faulty coordination and subordination of clauses in sentences with subtle structural problems Maintain consistent verb tense and pronoun person on the basis of the preceding clause or sentence	Ensure that a pronoun agrees with its antecedent when the two occur in separate clauses or sentences Identify the correct past and past participle forms of irregular and infrequently used verbs and form present-perfect verbs by using *have* rather than *of*	Use punctuation to set off complex parenthetical phrases Recognize and delete unnecessary commas based on a careful reading of a complicated sentence (e.g., between the elements of a compound subject or compound verb joined by *and*) Use apostrophes to indicate simple possessive nouns Recognize inappropriate uses of colons and semicolons
28–32	Use sentence-combining techniques, effectively avoiding problematic comma splices, run-on sentences, and sentence fragments, especially in sentences containing compound subjects or verbs Maintain a consistent and logical use of verb tense and pronoun person on the basis of information in the paragraph or essay as a whole	Correctly use reflexive pronouns, the possessive pronouns *its* and *your*, and the relative pronouns *who* and *whom* Ensure that a verb agrees with its subject in unusual situations (e.g., when the subject-verb order is inverted or when the subject is an indefinite pronoun)	Use commas to set off a nonessential/nonrestrictive appositive or clause Deal with multiple punctuation problems (e.g., compound sentences containing unnecessary commas and phrases that may or may not be parenthetical) Use an apostrophe to show possession, especially with irregular plural nouns Use a semicolon to indicate a relationship between closely related independent clauses
33–36	Work comfortably with long sentences and complex clausal relationships within sentences, avoiding weak conjunctions between independent clauses and maintaining parallel structure between clauses	Provide idiomatically and contextually appropriate prepositions following verbs in situations involving sophisticated language or ideas Ensure that a verb agrees with its subject when a phrase or clause between the two suggests a different number for the verb	Use a colon to introduce an example or an elaboration

Table C-2. ACT's College Readiness Standards — Reading		
	Main Ideas and Author's Approach	**Supporting Details**
13–15	Recognize a clear intent of an author or narrator in uncomplicated literary narratives	Locate basic facts (e.g., names, dates, events) clearly stated in a passage
16–19	Identify a clear main idea or purpose of straightforward paragraphs in uncomplicated literary narratives	Locate simple details at the sentence and paragraph level in uncomplicated passages Recognize a clear function of a part of an uncomplicated passage
20–23	Infer the main idea or purpose of straightforward paragraphs in uncomplicated literary narratives Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in uncomplicated passages	Locate important details in uncomplicated passages Make simple inferences about how details are used in passages
24–27	Identify a clear main idea or purpose of any paragraph or paragraphs in uncomplicated passages Infer the main idea or purpose of straightforward paragraphs in more challenging passages Summarize basic events and ideas in more challenging passages Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in more challenging passages	Locate important details in more challenging passages Locate and interpret minor or subtly stated details in uncomplicated passages Discern which details, though they may appear in different sections throughout a passage, support important points in more challenging passages
28–32	Infer the main idea or purpose of more challenging passages or their paragraphs Summarize events and ideas in virtually any passage Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in virtually any passage	Locate and interpret minor or subtly stated details in more challenging passages Use details from different sections of some complex informational passages to support a specific point or argument
33–36	Identify clear main ideas or purposes of complex passages or their paragraphs	Locate and interpret details in complex passages Understand the function of a part of a passage when the function is subtle or complex

Descriptions of the ACT Reading Passages

Uncomplicated Literary Narratives refers to excerpts from essays, short stories, and novels that tend to use simple language and structure, have a clear purpose and a familiar style, present straightforward interactions between characters, and employ only a limited number of literary devices such as metaphor, simile, or hyperbole.

More Challenging Literary Narratives refers to excerpts from essays, short stories, and novels that tend to make moderate use of figurative language, have a more intricate structure and messages conveyed with some subtlety, and may feature somewhat complex interactions between characters.

Complex Literary Narratives refers to excerpts from essays, short stories, and novels that tend to make generous use of ambiguous language and literary devices, feature complex and subtle interactions between characters, often contain challenging context-dependent vocabulary, and typically contain messages and/or meanings that are not explicit but are embedded in the passage.

Table C-2. ACT's College Readiness Standards — Reading (continued)

	Sequential, Comparative, and Cause-Effect Relationships	Meanings of Words	Generalizations and Conclusions
13–15	Determine when (e.g., first, last, before, after) or if an event occurred in uncomplicated passages Recognize clear cause-effect relationships described within a single sentence in a passage	Understand the implication of a familiar word or phrase and of simple descriptive language	Draw simple generalizations and conclusions about the main characters in uncomplicated literary narratives
16–19	Identify relationships between main characters in uncomplicated literary narratives Recognize clear cause-effect relationships within a single paragraph in uncomplicated literary narratives	Use context to understand basic figurative language	Draw simple generalizations and conclusions about people, ideas, and so on in uncomplicated passages
20–23	Order simple sequences of events in uncomplicated literary narratives Identify clear relationships between people, ideas, and so on in uncomplicated passages Identify clear cause-effect relationships in uncomplicated passages	Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in uncomplicated passages	Draw generalizations and conclusions about people, ideas, and so on in uncomplicated passages Draw simple generalizations and conclusions using details that support the main points of more challenging passages
24–27	Order sequences of events in uncomplicated passages Understand relationships between people, ideas, and so on in uncomplicated passages Identify clear relationships between characters, ideas, and so on in more challenging literary narratives Understand implied or subtly stated cause-effect relationships in uncomplicated passages Identify clear cause-effect relationships in more challenging passages	Use context to determine the appropriate meaning of virtually any word, phrase, or statement in uncomplicated passages Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in more challenging passages	Draw subtle generalizations and conclusions about characters, ideas, and so on in uncomplicated literary narratives Draw generalizations and conclusions about people, ideas, and so on in more challenging passages
28–32	Order sequences of events in more challenging passages Understand the dynamics between people, ideas, and so on in more challenging passages Understand implied or subtly stated cause-effect relationships in more challenging passages	Determine the appropriate meaning of words, phrases, or statements from figurative or somewhat technical contexts	Use information from one or more sections of a more challenging passage to draw generalizations and conclusions about people, ideas, and so on
33–36	Order sequences of events in complex passages Understand the subtleties in relationships between people, ideas, and so on in virtually any passage Understand implied, subtle, or complex cause-effect relationships in virtually any passage	Determine, even when the language is richly figurative and the vocabulary is difficult, the appropriate meaning of context-dependent words, phrases, or statements in virtually any passage	Draw complex or subtle generalizations and conclusions about people, ideas, and so on, often by synthesizing information from different portions of the passage Understand and generalize about portions of a complex literary narrative

Uncomplicated Informational Passages refers to materials that tend to contain a limited amount of data, address basic concepts using familiar language and conventional organizational patterns, have a clear purpose, and are written to be accessible.

More Challenging Informational Passages refers to materials that tend to present concepts that are not always stated explicitly and that are accompanied or illustrated by more—and more detailed—supporting data, include some difficult context-dependent words, and are written in a somewhat more demanding and less accessible style.

Complex Informational Passages refers to materials that tend to include a sizable amount of data, present difficult concepts that are embedded (not explicit) in the text, use demanding words and phrases whose meaning must be determined from context, and are likely to include intricate explanations of processes or events.

Table C-3. ACT's College Readiness Standards — Writing

	Expressing Judgments	Focusing on the Topic	Developing a Position
3–4	Show a little understanding of the persuasive purpose of the task but neglect to take or to maintain a position on the issue in the prompt Show limited recognition of the complexity of the issue in the prompt	Maintain a focus on the general topic in the prompt through most of the essay	Offer a little development, with one or two ideas; if examples are given, they are general and may not be clearly relevant; resort often to merely repeating ideas Show little or no movement between general and specific ideas and examples
5–6	Show a basic understanding of the persuasive purpose of the task by taking a position on the issue in the prompt but may not maintain that position Show a little recognition of the complexity of the issue in the prompt by acknowledging, but only briefly describing, a counterargument to the writer's position	Maintain a focus on the general topic in the prompt throughout the essay	Offer limited development of ideas using a few general examples; resort sometimes to merely repeating ideas Show little movement between general and specific ideas and examples
7–8	Show understanding of the persuasive purpose of the task by taking a position on the issue in the prompt Show some recognition of the complexity of the issue in the prompt by • acknowledging counterarguments to the writer's position • providing some response to counter-arguments to the writer's position	Maintain a focus on the general topic in the prompt throughout the essay and attempt a focus on the specific issue in the prompt Present a thesis that establishes focus on the topic	Develop ideas by using some specific reasons, details, and examples Show some movement between general and specific ideas and examples
9–10	Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a broad context for discussion Show recognition of the complexity of the issue in the prompt by • partially evaluating implications and/or complications of the issue, and/or • posing and partially responding to counter-arguments to the writer's position	Maintain a focus on discussion of the specific topic and issue in the prompt throughout the essay Present a thesis that establishes a focus on the writer's position on the issue	Develop most ideas fully, using some specific and relevant reasons, details, and examples Show clear movement between general and specific ideas and examples
11–12	Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a critical context for discussion Show understanding of the complexity of the issue in the prompt by • examining different perspectives, and/or • evaluating implications or complications of the issue, and/or • posing and fully discussing counter-arguments to the writer's position	Maintain a clear focus on discussion of the specific topic and issue in the prompt throughout the essay Present a critical thesis that clearly establishes the focus on the writer's position on the issue	Develop several ideas fully, using specific and relevant reasons, details, and examples Show effective movement between general and specific ideas and examples

Table C-3. ACT's College Readiness Standards — Writing (continued)

	Organizing Ideas	Using Language
3–4	Provide a discernible organization with some logical grouping of ideas in parts of the essay Use a few simple and obvious transitions Present a discernible, though minimally developed, introduction and conclusion	Show limited control of language by • correctly employing some of the conventions of standard English grammar, usage, and mechanics, but with distracting errors that sometimes significantly impede understanding • using simple vocabulary • using simple sentence structure
5–6	Provide a simple organization with logical grouping of ideas in parts of the essay Use some simple and obvious transitional words, though they may at times be inappropriate or misleading Present a discernible, though underdeveloped, introduction and conclusion	Show a basic control of language by • correctly employing some of the conventions of standard English grammar, usage, and mechanics, but with distracting errors that sometimes impede understanding • using simple but appropriate vocabulary • using a little sentence variety, though most sentences are simple in structure
7–8	Provide an adequate but simple organization with logical grouping of ideas in parts of the essay but with little evidence of logical progression of ideas Use some simple and obvious, but appropriate, transitional words and phrases Present a discernible introduction and conclusion with a little development	Show adequate use of language to communicate by • correctly employing many of the conventions of standard English grammar, usage, and mechanics, but with some distracting errors that may occasionally impede understanding • using appropriate vocabulary • using some varied kinds of sentence structures to vary pace
9–10	Provide unity and coherence throughout the essay, sometimes with a logical progression of ideas Use relevant, though at times simple and obvious, transitional words and phrases to convey logical relationships between ideas Present a somewhat developed introduction and conclusion	Show competent use of language to communicate ideas by • correctly employing most conventions of standard English grammar, usage, and mechanics, with a few distracting errors but none that impede understanding • using some precise and varied vocabulary • using several kinds of sentence structures to vary pace and to support meaning
11–12	Provide unity and coherence throughout the essay, often with a logical progression of ideas Use relevant transitional words, phrases, and sentences to convey logical relationships between ideas Present a well-developed introduction and conclusion	Show effective use of language to clearly communicate ideas by • correctly employing most conventions of standard English grammar, usage, and mechanics, with just a few, if any, errors • using precise and varied vocabulary • using a variety of kinds of sentence structures to vary pace and to support meaning

Table C-4. ACT's College Readiness Standards — Mathematics

	Basic Operations & Applications	Probability, Statistics, & Data Analysis	Numbers: Concepts & Properties	Expressions, Equations, & Inequalities
13–15	Perform one-operation computation with whole numbers and decimals Solve problems in one or two steps using whole numbers Perform common conversions (e.g., inches to feet or hours to minutes)	Calculate the average of a list of positive whole numbers Perform a single computation using information from a table or chart	Recognize equivalent fractions and fractions in lowest terms	Exhibit knowledge of basic expressions (e.g., identify an expression for a total as $b + g$) Solve equations in the form $x + a = b$, where a and b are whole numbers or decimals
16–19	Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent Solve some routine two-step arithmetic problems	Calculate the average of a list of numbers Calculate the average, given the number of data values and the sum of the data values Read tables and graphs Perform computations on data from tables and graphs Use the relationship between the probability of an event and the probability of its complement	Recognize one-digit factors of a number Identify a digit's place value	Substitute whole numbers for unknown quantities to evaluate expressions Solve one-step equations having integer or decimal answers Combine like terms (e.g., $2x + 5x$)
20–23	Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportion, tax added, percentage off, and computing with a given average	Calculate the missing data value, given the average and all data values but one Translate from one representation of data to another (e.g., a bar graph to a circle graph) Determine the probability of a simple event Exhibit knowledge of simple counting techniques	Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor	Evaluate algebraic expressions by substituting integers for unknown quantities Add and subtract simple algebraic expressions Solve routine first-degree equations Perform straightforward word-to-symbol translations Multiply two binomials
24–27	Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour)	Calculate the average, given the frequency counts of all the data values Manipulate data from tables and graphs Compute straightforward probabilities for common situations Use Venn diagrams in counting	Find and use the least common multiple Order fractions Work with numerical factors Work with scientific notation Work with squares and square roots of numbers Work problems involving positive integer exponents Work with cubes and cube roots of numbers Determine when an expression is undefined Exhibit some knowledge of the complex numbers	Solve real-world problems using first-degree equations Write expressions, equations, or inequalities with a single variable for common pre-algebra settings (e.g., rate and distance problems and problems that can be solved by using proportions) Identify solutions to simple quadratic equations Add, subtract, and multiply polynomials Factor simple quadratics (e.g., the difference of squares and perfect square trinomials) Solve first-degree inequalities that do not require reversing the inequality sign
28–32	Solve word problems containing several rates, proportions, or percentages	Calculate or use a weighted average Interpret and use information from figures, tables, and graphs Apply counting techniques Compute a probability when the event and/or sample space are not given or obvious	Apply number properties involving prime factorization Apply number properties involving even/odd numbers and factors/multiples Apply number properties involving positive/negative numbers Apply rules of exponents Multiply two complex numbers	Manipulate expressions and equations Write expressions, equations, and inequalities for common algebra settings Solve linear inequalities that require reversing the inequality sign Solve absolute value equations Solve quadratic equations Find solutions to systems of linear equations
33–36	Solve complex arithmetic problems involving percent of increase or decrease and problems requiring integration of several concepts from pre-algebra and/or pre-geometry (e.g., comparing percentages or averages, using several ratios, and finding ratios in geometry settings)	Distinguish between mean, median, and mode for a list of numbers Analyze and draw conclusions based on information from figures, tables, and graphs Exhibit knowledge of conditional and joint probability	Draw conclusions based on number concepts, algebraic properties, and/or relationships between expressions and numbers Exhibit knowledge of logarithms and geometric sequences Apply properties of complex numbers	Write expressions that require planning and/or manipulating to accurately model a situation Write equations and inequalities that require planning, manipulating, and/or solving Solve simple absolute value inequalities

Table C-4. ACT's College Readiness Standards — Mathematics (continued)

	Graphical Representations	Properties of Plane Figures	Measurement	Functions
13–15	Identify the location of a point with a positive coordinate on the number line		Estimate or calculate the length of a line segment based on other lengths given on a geometric figure	
16–19	Locate points on the number line and in the first quadrant	Exhibit some knowledge of the angles associated with parallel lines	Compute the perimeter of polygons when all side lengths are given Compute the area of rectangles when whole number dimensions are given	
20–23	Locate points in the coordinate plane Comprehend the concept of length on the number line Exhibit knowledge of slope	Find the measure of an angle using properties of parallel lines Exhibit knowledge of basic angle properties and special sums of angle measures (e.g., 90°, 180°, and 360°)	Compute the area and perimeter of triangles and rectangles in simple problems Use geometric formulas when all necessary information is given	Evaluate quadratic functions, expressed in function notation, at integer values
24–27	Identify the graph of a linear inequality on the number line Determine the slope of a line from points or equations Match linear graphs with their equations Find the midpoint of a line segment	Use several angle properties to find an unknown angle measure Recognize Pythagorean triples Use properties of isosceles triangles	Compute the area of triangles and rectangles when one or more additional simple steps are required Compute the area and circumference of circles after identifying necessary information Compute the perimeter of simple composite geometric figures with unknown side lengths	Evaluate polynomial functions, expressed in function notation, at integer values Express the sine, cosine, and tangent of an angle in a right triangle as a ratio of given side lengths
28–32	Interpret and use information from graphs in the coordinate plane Match number line graphs with solution sets of linear inequalities Use the distance formula Use properties of parallel and perpendicular lines to determine an equation of a line or coordinates of a point Recognize special characteristics of parabolas and circles (e.g., the vertex of a parabola and the center or radius of a circle)	Apply properties of 30°-60°-90°, 45°-45°-90°, similar, and congruent triangles Use the Pythagorean theorem	Use relationships involving area, perimeter, and volume of geometric figures to compute another measure	Evaluate composite functions at integer values Apply basic trigonometric ratios to solve right-triangle problems
33–36	Match number line graphs with solution sets of simple quadratic inequalities Identify characteristics of graphs based on a set of conditions or on a general equation such as $y = ax^2 + c$ Solve problems integrating multiple algebraic and/or geometric concepts Analyze and draw conclusions based on information from graphs in the coordinate plane	Draw conclusions based on a set of conditions Solve multistep geometry problems that involve integrating concepts, planning, visualization, and/or making connections with other content areas Use relationships among angles, arcs, and distances in a circle	Use scale factors to determine the magnitude of a size change Compute the area of composite geometric figures when planning or visualization is required	Write an expression for the composite of two simple functions Use trigonometric concepts and basic identities to solve problems Exhibit knowledge of unit circle trigonometry Match graphs of basic trigonometric functions with their equations

Table C-5. ACT's College Readiness Standards — Science

	Interpretation of Data	Scientific Investigation	Evaluation of Models, Inferences, and Experimental Results
13–15	Select a single piece of data (numerical or nonnumerical) from a simple data presentation (e.g., a table or graph with two or three variables; a food web diagram) Identify basic features of a table, graph, or diagram (e.g., headings, units of measurement, axis labels)		
16–19	Select two or more pieces of data from a simple data presentation Understand basic scientific terminology Find basic information in a brief body of text Determine how the value of one variable changes as the value of another variable changes in a simple data presentation	Understand the methods and tools used in a simple experiment	
20–23	Select data from a complex data presentation (e.g., a table or graph with more than three variables; a phase diagram) Compare or combine data from a simple data presentation (e.g., order or sum data from a table) Translate information into a table, graph, or diagram	Understand the methods and tools used in a moderately complex experiment Understand a simple experimental design Identify a control in an experiment Identify similarities and differences between experiments	Select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or a model Identify key issues or assumptions in a model
24–27	Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table) Compare or combine data from a complex data presentation Interpolate between data points in a table or graph Determine how the value of one variable changes as the value of another variable changes in a complex data presentation Identify and/or use a simple (e.g., linear) mathematical relationship between data Analyze given information when presented with new, simple information	Understand the methods and tools used in a complex experiment Understand a complex experimental design Predict the results of an additional trial or measurement in an experiment Determine the experimental conditions that would produce specified results	Select a simple hypothesis, prediction, or conclusion that is supported by two or more data presentations or models Determine whether given information supports or contradicts a simple hypothesis or conclusion, and why Identify strengths and weaknesses in one or more models Identify similarities and differences between models Determine which model(s) is(are) supported or weakened by new information Select a data presentation or a model that supports or contradicts a hypothesis, prediction, or conclusion
28–32	Compare or combine data from a simple data presentation with data from a complex data presentation Identify and/or use a complex (e.g., nonlinear) mathematical relationship between data Extrapolate from data points in a table or graph	Determine the hypothesis for an experiment Identify an alternate method for testing a hypothesis	Select a complex hypothesis, prediction, or conclusion that is supported by a data presentation or model Determine whether new information supports or weakens a model, and why Use new information to make a prediction based on a model
33–36	Compare or combine data from two or more complex data presentations Analyze given information when presented with new, complex information	Understand precision and accuracy issues Predict how modifying the design or methods of an experiment will affect results Identify an additional trial or experiment that could be performed to enhance or evaluate experimental results	Select a complex hypothesis, prediction, or conclusion that is supported by two or more data presentations or models Determine whether given information supports or contradicts a complex hypothesis or conclusion, and why

Science College Readiness Standards are measured in the context of science topics students encounter in science courses. These topics may include:

Life Science/Biology	Physical Science/Chemistry, Physics	Earth & Space Science
• Animal behavior • Animal development and growth • Body systems • Cell structure and processes • Ecology • Evolution • Genetics • Homeostasis • Life cycles • Molecular basis of heredity • Origin of life • Photosynthesis • Plant development, growth, structure • Populations • Taxonomy	• Atomic structure • Chemical bonding, equations, nomenclature, reactions • Electrical circuits • Elements, compounds, mixtures • Force and motions • Gravitation • Heat and work • Kinetic and potential energy • Magnetism • Momentum • The Periodic Table • Properties of solutions • Sound and light • States, classes, and properties of matter • Waves	• Earthquakes and volcanoes • Earth's atmosphere • Earth's resources • Fossils and geological time • Geochemical cycles • Groundwater • Lakes, rivers, oceans • Mass movements • Plate tectonics • Rocks, minerals • Solar system • Stars, galaxies, and the universe • Water cycle • Weather and climate • Weathering and erosion