



STATE MATCH

Pennsylvania Academic Standards

Reading, Writing, Speaking,
and Listening; Mathematics;
and Science and Technology

and

ACT[®]
EXPLORE, PLAN,
and ACT

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About This Report

EXECUTIVE SUMMARY

(pp. 1–2)

This portion summarizes the findings of the alignment between EXPLORE® (8th and 9th grades); PLAN® (10th grade); and the ACT (11th and 12th grades) and Pennsylvania's Academic Standards. It also presents ACT's involvement in meeting NCLB requirements and describes additional critical information that ACT could provide to Pennsylvania.

SECTION A

(pp. 3–5)

This section provides tables by content area (Reading, Writing, Speaking, and Listening; Mathematics; and Science and Technology) listing the precise number of Pennsylvania Academic Standards measured by ACT's EPAS tests, by grade level.

SECTION B

(pp. 6–36)

All Pennsylvania Academic Standards are listed here; each one highlighted is measured by ACT's EPAS tests. Underlined science content indicates that the content topics are included in, but not directly measured by, ACT's EPAS Science Tests.

SECTION C

(pp. 37–46)

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

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



Executive Summary

We at ACT believe our programs offer many advantages to Pennsylvania students and educators, and this report offers strong evidence for this belief. This alignment analysis clearly answers three critical questions:

1. To what extent do ACT's Educational Planning and Assessment System (EPAS™) tests—EXPLORE (8th and 9th grades); PLAN (10th grade); and the ACT (11th and 12th grades)—measure Pennsylvania's Academic Standards?
2. Can ACT's EPAS test results be used to meet Pennsylvania's NCLB requirement?
3. Why should Pennsylvania choose ACT?

ACT'S TESTS MEASURE
MANY IMPORTANT
PENNSYLVANIA
ACADEMIC STANDARDS
IN READING, WRITING,
SPEAKING, AND
LISTENING,
MATHEMATICS, AND
SCIENCE.

1. Match Results: Comparisons conducted by our content specialists show that ACT's Reading, English, Writing, Mathematics and Science Tests measure many of Pennsylvania's Reading, Writing, Speaking, and Listening; Mathematics; and Science and Technology Academic Standards (with grade-level skills match totals appearing in Section B):

- **Reading, Writing, Speaking, and Listening:** 5 out of 8 Academic Standards
Many important Reading, Writing, Speaking, and Listening Academic Standards are covered by ACT's English, Reading, and Writing Tests.
- **Mathematics:** 11 out of 11 Academic Standards
All Pennsylvania's Mathematics Academic Standards are covered by ACT's Mathematics Tests.
- **Science and Technology:** 1 out of 8 Academic Standards directly measured
7 out of 8 Academic Standards included in content
Many of Pennsylvania's Science and Technology Academic Standards are covered by ACT's Science Tests.

(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 Science and Technology Academic 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 Academic 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 ACT's tests and Pennsylvania's Academic Standards arise from standards not being assessable in group settings, standards that are personal in nature, and standards requiring measurement over extended time. If additional testing is deemed necessary, ACT would be



**STATES CHOOSE ACT
BECAUSE:**

- **STUDENT MOTIVATION IS HIGH.**
- **ACT'S IS THE ONLY CURRICULUM-BASED ASSESSMENT SYSTEM THAT MEASURES STUDENT READINESS ALONG A CONTINUUM OF EMPIRICALLY DERIVED COLLEGE READINESS BENCHMARKS.**
- **EPAS DATA PROVIDE HELPFUL FEEDBACK FOR TEACHERS, STUDENTS, AND POLICYMAKERS TO MAKE EDUCATIONAL DECISIONS AND IDENTIFY WAYS TO IMPROVE.**

**ACT BUILDS ITS
DEFINITION OF COLLEGE
READINESS ON A
SOUND EMPIRICAL
BASE:**

- 1. THE ACT NATIONAL CURRICULUM SURVEY**
- 2. ACT'S COLLEGE READINESS BENCHMARK SCORES**
- 3. ACT'S COLLEGE READINESS STANDARDS**

interested in working with Pennsylvania on developing any necessary augmentation.

2. NCLB requirement? Yes; states like Illinois intend to use ACT EPAS components as part of testing that will be submitted to the U.S. Department of Education for NCLB approval.

3. Why choose ACT? States and school districts choose ACT's EPAS programs because student motivation is high, and EPAS is the *only curriculum-based assessment system that measures student readiness along a continuum of empirically derived college readiness benchmarks*. Various groups claim to describe what students truly need to know and be able to do for college and/or workplace readiness. Such groups typically ask individual experts in education to gather and discuss what they feel is important for students to understand. Not surprisingly, the answers vary. In contrast, ACT defines college readiness through a unique and rigorous empirical process:

- **The knowledge and skills necessary for students to be ready for college-level work are empirically identified via the ACT National Curriculum Survey.[®]**

ACT surveys thousands of secondary and postsecondary instructors across the nation to determine which skills and knowledge are most important at each course level and for college and work readiness. The responses drive the test specifications for EXPLORE, PLAN, and the ACT.

- **The empirically derived performance levels necessary for students to be ready to succeed in college-level work are defined in ACT's College Readiness Benchmark Scores.**

ACT analyzed thousands of student records to identify the ACT scores associated with success in postsecondary coursework (i.e., a 50% chance of earning a B or better in credit-bearing first-year college courses): 18 for English, 22 for Math, 21 for Reading, and 24 for Science.

- **Skills and knowledge a student currently has and areas for improvement can be identified by the empirically derived ACT College Readiness Standards.**

Using thousands of student records and responses, content and measurement experts worked backwards to develop data-driven, empirically derived statements of what students typically know and are able to do in various score ranges on ACT's English, Reading, Writing, Mathematics, and Science Tests. These statements provide specific details about students' college readiness and can be used to identify next steps for improvement.

In sum, ACT's EPAS programs provide abundant data relevant to Pennsylvania's Academic Standards and to Pennsylvania students' readiness for college and work.



**Section A: Number of Pennsylvania Academic Standards
Measured by EXPLORE, PLAN, and the ACT**

Table A-1. Number of Reading, Writing, Speaking, and Listening Academic Standards Measured by EXPLORE, PLAN, and the ACT

Pennsylvania Academic Standard*	Number of Pennsylvania's Grade-Level Skills Measured by ACT's tests	Aspects of Not-Measured Pennsylvania Academic Standards
1.1 Learning to Read Independently	8th: 6 out of 8 11th: 5 out of 8	Locate various texts, media, and traditional resources
1.2 Reading Critically in All Content Areas	8th: 1 out of 3 11th: 1 out of 3	Use and understand a variety of media
1.3 Reading, Analyzing, and Interpreting Literature	8th: 4 out of 6 11th: 4 out of 6	Analyze the effects of literary devices Read and respond
1.4 Types of Writing	8th: 2 out of 4 11th: 2 out of 5	Maintain records Write a personal resume
1.5 Quality of Writing	8th: 6 out of 7 11th: 6 out of 7	Present and/or defend written work
1.6 Speaking and Listening	8th: 0 out of 6 11th: 0 out of 6	Listen to others Speak using skills Contribute to discussions Use media
1.7 Characteristics and Functions of the English Language	8th: 0 out of 3 11th: 0 out of 3	Describe the influence of historical events on the English language Analyze when differences in language are a source of negative or positive stereotypes among groups
1.8 Research	8th: 0 out of 3 11th: 0 out of 3	Select and refine a topic for research Locate information Organize, summarize, and present research
TOTALS	8th: 19 out of 40 11th: 18 out of 41	

*Refer to Pennsylvania's Reading, Writing, Speaking, and Listening Academic Standards on pages 6–13



Table A-2. Number of Mathematics Academic Standards Measured by EXPLORE, PLAN, and the ACT

Pennsylvania Academic Standard*	Number of Pennsylvania's Grade-Level Skills Measured by ACT's tests	Aspects of Not-Measured Pennsylvania Academic Standards
2.1. Numbers, Number Systems and Number Relationships	8th: 7 out of 7 11th: 1 out of 1	
2.2. Computation and Estimation	8th: 6 out of 6 11th: 3 out of 6	Describe and explain amount of error Recognize precision needed Demonstrate skills for computer spreadsheets
2.3. Measurement and Estimation	8th: 7 out of 7 11th: 2 out of 3	Produce angles of specified measures
2.4. Mathematical Reasoning and Connections	8th: 5 out of 6 11th: 3 out of 5	Construct arguments Determine validity
2.5. Mathematical Problem Solving and Communication	8th: 3 out of 4 11th: 3 out of 4	Justify strategies
2.6. Statistics and Data Analysis	8th: 3 out of 7 11th: 5 out of 9	Explain effects of sampling Design and carry out sampling procedure Use computers to organize data Determine validity of sampling method
2.7. Probability and Predictions	8th: 4 out of 5 11th: 5 out of 5	
2.8. Algebra and Functions	8th: 9 out of 10 11th: 19 out of 20	Use concrete objects to model concepts Explain systems of equations
2.9. Geometry	8th: 7 out of 11 11th: 9 out of 10	Construct figures Approximate value of pi Use computer software
2.10. Trigonometry	8th: 2 out of 2 11th: 2 out of 2	
2.11. Concepts of Calculus	8th: 3 out of 3 11th: 5 out of 5	
TOTALS	8th: 56 out of 68 11th: 57 out of 70	

*Refer to Pennsylvania's Mathematics Academic Standards on pages 14–19



Table A-3. Number of Science and Technology Academic Standards Measured by EXPLORE, PLAN, and the ACT

Pennsylvania Academic Standard*	Number of Pennsylvania's Grade-Level Skills Measured by ACT's tests	Aspects of Not-Measured Pennsylvania Standards
3.1. Unifying Themes	7th: (4) out of 5 10th: (4) out of 5 12th: (4) out of 5	Explain parts of systems Apply concepts of systems, feedback, and control to solve complex technological problems
3.2. Inquiry and Design	7th: 4 out of 4 10th: 4 out of 4 12th: 4 out of 4	
3.3. Biological Sciences	7th: (4) out of 4 10th: (4) out of 4 12th: (4) out of 4	
3.4. Physical Science, Chemistry and Physics	7th: (4) out of 4 10th: (4) out of 4 12th: (4) out of 4	
3.5. Earth Sciences	7th: (4) out of 4 10th: (4) out of 4 12th: (3) out of 4	Analyze the availability of earth resources
3.6. Technology Education	7th: (2) out of 3 10th: (2) out of 3 12th: (2) out of 3	Explain or apply knowledge of information of information technologies such as encoding, transmitting, etc.
3.7. Technological Devices	7th: (1) out of 5 10th: (1) out of 5 12th: (1) out of 5	Use computers Explain and describe communication systems
3.8. Science, Technology & Human Endeavors	7th: (2) out of 3 10th: (1) out of 3 12th: (0) out of 3	Identify pros and cons of science and technology's impact on society Evaluate consequences of impacts
TOTALS	7th: 4 out of 4 10th: 4 out of 4 12th: 4 out of 4	Science Process Skills Directly Measured
	7th: (21) out of 28 10th: (20) out of 28 12th: (18) out of 28	Content Topics Included

*Refer to Pennsylvania's Science and Technology Academic Standards on pages 20–36



Section B: Pennsylvania's Grades 7–12 Academic Standards Measured by EXPLORE, PLAN, and the ACT

Reading, Writing, Speaking, and Listening

PENNSYLVANIA Grade 8 Academic Standards and Grade-Level Skills

1.1. Learning to Read Independently

1.1.8. Grade 8

. . . every student . . . acquire the knowledge and skills needed to:

- A. Locate appropriate texts (literature, information, documents) for an assigned purpose before reading.
- B. Identify and use common organizational structures and graphic features to comprehend information.
- C. Use knowledge of root words as well as context clues and glossaries to understand specialized vocabulary in the content areas during reading. Use these words accurately in speaking and writing.
- D. Identify basic facts and ideas in text using specific strategies (e.g., recall genre characteristics, set a purpose for reading, generate essential questions as aids to comprehension and clarify understanding through rereading and discussion).
- E. Expand a reading vocabulary by identifying and correctly using idioms and words with literal and figurative meanings. Use a dictionary or related reference.
- F. Understand the meaning of and apply key vocabulary across the various subject areas.
- G. Demonstrate after reading understanding and interpretation of both fiction and nonfiction text, including public documents.
 - Make, and support with evidence, assertions about texts.
 - Compare and contrast texts using themes, settings, characters and ideas.
 - Make extensions to related ideas, topics or information.
 - Describe the context of a document.
 - Analyze the positions, arguments and evidence in public documents.
- H. Demonstrate fluency and comprehension in reading.
 - Read familiar materials aloud with accuracy.
 - Self-correct mistakes.
 - Use appropriate rhythm, flow, meter and pronunciation.
 - Read a variety of genres and types of text.
 - Demonstrate comprehension (Standard 1.1.8.G.).

1.2. Reading Critically in All Content Areas

1.2.8. Grade 8

. . . every student . . . acquire the knowledge and skills needed to:

- A. Read and understand essential content of informational texts and documents in all academic areas.
 - Differentiate fact from opinion utilizing resources that go beyond traditional text (e.g., newspapers, magazines and periodicals) to electronic media.
 - Distinguish between essential and nonessential information across texts and going beyond texts to a variety of media; identify bias and propaganda where present.
 - Draw inferences based on a variety of information sources.
 - Evaluate text organization and content to determine the author's purpose and effectiveness according to the author's theses, accuracy and thoroughness.
- B. Use and understand a variety of media and evaluate the quality of material produced.
 - Compare and analyze how different media offer a unique perspective on the information presented.
 - Analyze the techniques of particular media messages and their effect on a targeted audience.
 - Use, design and develop a media project that expands understanding (e.g., authors and works from a particular historical period).
- C. Produce work in at least one literary genre that follows the conventions of the genre.

1.3. Reading, Analyzing and Interpreting Literature

1.3.8. Grade 8

... every student ... acquire the knowledge and skills needed to:

- A. Read and understand works of literature.
- B. Analyze the use of literary elements by an author including characterization, setting, plot, theme, point of view, tone and style.
- C. Analyze the effect of various literary devices.
 - Sound techniques (e.g., rhyme, rhythm, meter, alliteration).
 - Figurative language (e.g., personification, simile, metaphor, hyperbole, allusion).
- D. Identify poetic forms (e.g., ballad, sonnet, couplet)
- E. Analyze drama to determine the reasons for a character's actions taking into account the situation and basic motivation of the character.
- F. Read and respond to nonfiction and fiction including poetry and drama.

1.4. Types of Writing

1.4.8. Grade 8

... every student ... acquire the knowledge and skills needed to:

- A. Write short stories, poems and plays.
 - Apply varying organizational methods.
 - Use relevant illustrations.
 - Utilize dialogue.
 - Apply literary conflict.
 - Include literary elements (Standard 1.3.8.B.).
 - Use literary devices (Standard 1.3.8.C.).
- B. Write multi-paragraph informational pieces (e.g., letters, descriptions, reports, instructions, essays, articles, interviews).
 - Include cause and effect.
 - Develop a problem and solution when appropriate to the topic.
 - Use relevant graphics (e.g., maps, charts, graphs, tables, illustrations, photographs).
 - Use primary and secondary sources.
- C. Write persuasive pieces.
 - Include a clearly stated position or opinion.
 - Include convincing, elaborated and properly cited evidence.
 - Develop reader interest.
 - Anticipate and counter reader concerns and arguments.
- D. Maintain a written record of activities, course work, experience, honors and interests.

1.5. Quality of Writing

1.5.8. Grade 8

... every student ... acquire the knowledge and skills needed to:

- A. Write with a sharp, distinct focus.
 - Identify topic, task and audience.
 - Establish a single point of view.
- B. Write using well-developed content appropriate for the topic.
 - Gather, determine validity and reliability of and organize information.
 - Employ the most effective format for purpose and audience.
 - Write paragraphs that have details and information specific to the topic and relevant to the focus.
- C. Write with controlled and/or subtle organization.

- Sustain a logical order within sentences and between paragraphs using meaningful transitions.
 - Establish topic and purpose in the introduction.
 - Reiterate the topic and purpose in the conclusion.
- D. Write with an understanding of the stylistic aspects of composition.
- Use different types and lengths of sentences.
 - Use tone and voice through the use of precise language.
- E. Revise writing after rethinking logic of organization and rechecking central idea, content, paragraph development, level of detail, style, tone and word choice.
- F. Edit writing using the conventions of language.
- Spell common, frequently used words correctly.
 - Use capital letters correctly.
 - Punctuate correctly (periods, exclamation points, question marks, commas, quotation marks, apostrophes, colons, semicolons, parentheses).
 - Use nouns, pronouns, verbs, adjectives, adverbs, conjunctions, prepositions and interjections properly.
 - Use complete sentences (simple, compound, complex, declarative, interrogative, exclamatory and imperative).
- G. Present and/or defend written work for publication when appropriate.

1.6. Speaking and Listening

1.6.8. Grade 8

. . . every student . . . acquire the knowledge and skills needed to:

- A. Listen to others.
- Ask probing questions.
 - Analyze information, ideas and opinions to determine relevancy.
 - Take notes when needed.
- B. Listen to selections of literature (fiction and/or nonfiction).
- Relate them to previous knowledge.
 - Predict content/events.
 - Summarize events and identify the significant points.
 - Identify and define new words and concepts.
 - Analyze the selections.
- C. Speak using skills appropriate to formal speech situations.
- Use complete sentences.
 - Pronounce words correctly.
 - Adjust volume to purpose and audience.
 - Add stress (emphasis) and inflection to enhance meaning.
- D. Contribute to discussions.
- Ask relevant, probing questions.
 - Respond with relevant information, ideas or reasons in support of opinions expressed.
 - Listen to and acknowledge the contributions of others.
 - Adjust tone and involvement to encourage equitable participation.
 - Clarify, illustrate or expand on a response when asked.
 - Present support for opinions.
 - Paraphrase and summarize, when prompted.
- E. Participate in small and large group discussions and presentations.
- Initiate everyday conversation.
 - Select a topic and present an oral reading.
 - Conduct interviews as part of the research process.

- Organize and participate in informal debates.
- F. Use media for learning purposes.
- Describe how the media provides information that is sometimes accurate, sometimes biased based on a point of view or by the opinion or beliefs of the presenter.
 - Analyze the role of advertising in the media.
 - Create a multimedia (e.g., film, music, computer-graphic) presentation for display or transmission.

1.7. Characteristics and Functions of the English Language

1.7.8. Grade 8

. . . every student . . . acquire the knowledge and skills needed to:

- A. Describe the origins and meanings of common, learned and foreign words used frequently in English language (e.g., *carte blanche*, *faux pas*).
- B. Analyze the role and place of standard American English in speech, writing and literature.
- C. Identify new words that have been added to the English language over time.

1.8. Research

1.8.8. Grade 8

. . . every student . . . acquire the knowledge and skills needed to:

- A. Select and refine a topic for research.
- B. Locate information using appropriate sources and strategies.
- Determine valid resources for researching the topic, including primary and secondary sources.
 - Evaluate the importance and quality of the sources.
 - Select essential sources (e.g., dictionaries, encyclopedias, other reference materials, interviews, observations, computer databases).
 - Use tables of contents, indices, key words, cross-references and appendices.
 - Use traditional and electronic search tools.
- C. Organize, summarize and present the main ideas from research.
- Identify the steps necessary to carry out a research project.
 - Take relevant notes from sources.
 - Develop a thesis statement based on research.
 - Give precise, formal credit for others' ideas, images or information using a standard method of documentation.
 - Use formatting techniques to create an understandable presentation for a designated audience.

Reading, Writing, Speaking, and Listening

PENNSYLVANIA Grade 11 Academic Standards and Grade-Level Skills

1.1. Learning to Read Independently

1.1.11. Grade 11

... every student ... acquire the knowledge and skills needed to:

- A. Locate various texts, media and traditional resources for assigned and independent projects before reading.
- B. **Analyze the structure of informational materials explaining how authors used these to achieve their purposes.**
- C. Use knowledge of root words and words from literary works to recognize and understand the meaning of new words during reading. Use these words accurately in speaking and writing.
- D. **Identify, describe, evaluate and synthesize the essential ideas in text.** Assess those reading strategies that were most effective in learning from a variety of texts.
- E. Establish a reading vocabulary by **identifying and correctly using new words acquired through the study of their relationships to other words.** Use a dictionary or related reference.
- F. Understand the meaning of and apply key vocabulary across the various subject areas.
- G. **Demonstrate after reading understanding and interpretation of both fiction and nonfiction text,** including public documents.
 - **Make, and support with evidence, assertions about texts.**
 - Compare and contrast texts using themes, settings, characters and ideas.
 - Make extensions to related ideas, topics or information.
 - Assess the validity of the document based on context.
 - **Analyze the positions, arguments and evidence** in public documents.
 - Evaluate the author's strategies.
 - Critique public documents to identify strategies common in public discourse.
- H. **Demonstrate fluency and comprehension in reading.**
 - Read familiar materials aloud with accuracy.
 - Self-correct mistakes.
 - Use appropriate rhythm, flow, meter and pronunciation.
 - **Read a variety of genres and types of text.**
 - **Demonstrate comprehension** (Standard 1.1.11.G.).

1.2. Reading Critically In All Content Areas

1.2.11. Grade 11

... every student ... acquire the knowledge and skills needed to:

- A. **Read and understand essential content of informational texts** and documents **in all academic areas.**
 - **Differentiate fact from opinion** across a variety of texts by using complete and accurate information, coherent arguments and points of view.
 - **Distinguish between essential and nonessential information** across a variety of sources, identifying the use of proper references or authorities and propaganda techniques where present.
 - Use teacher and student established criteria for making decisions and drawing conclusions.
 - **Evaluate text organization and content to determine the author's purpose** and **effectiveness according to the author's** theses, accuracy, thoroughness, **logic and reasoning.**
- B. Use and understand a variety of media and evaluate the quality of material produced.
 - Select appropriate electronic media for research and evaluate the quality of the information received.
 - Explain how the techniques used in electronic media modify traditional forms of discourse for different purposes.
 - Use, design and develop a media project to demonstrate understanding (e.g., a major writer or literary period or movement).
- C. Produce work in at least one literary genre that follows the conventions of the genre.

1.3. Reading, Analyzing and Interpreting Literature

1.3.11. Grade 11

... every student ... acquire the knowledge and skills needed to:

- A. Read and understand works of literature.
- B. Analyze the relationships, uses and effectiveness of literary elements used by one or more authors in similar genres including characterization, setting, plot, theme, point of view, tone and style.
- C. Analyze the effectiveness, in terms of literary quality, of the author's use of literary devices.
 - Sound techniques (e.g., rhyme, rhythm, meter, alliteration).
 - Figurative language (e.g., personification, simile, metaphor, hyperbole, irony, satire).
 - Literary structures (e.g., foreshadowing, flashbacks, progressive and digressive time).
- D. Analyze and evaluate in poetry the appropriateness of diction and figurative language (e.g., irony, understatement, overstatement, paradox).
- E. Analyze how a scriptwriter's use of words creates tone and mood, and how choice of words advances the theme or purpose of the work.
- F. Read and respond to nonfiction and fiction including poetry and drama.

1.4. Types of Writing

1.4.11. Grade 11

... every student ... acquire the knowledge and skills needed to:

- A. Write short stories, poems and plays.
 - Apply varying organizational methods.
 - Use relevant illustrations.
 - Utilize dialogue.
 - Apply literary conflict.
 - Include varying characteristics (e.g., from limerick to epic, from whimsical to dramatic).
 - Include literary elements (Standard 1.3.11.B.) .
 - Use literary devices (Standard 1.3.11.C.).
- B. Write complex informational pieces (e.g., research papers, analyses, evaluations, essays).
 - Include a variety of methods to develop the main idea.
 - Use precise language and specific detail.
 - Include cause and effect.
 - Use relevant graphics (e.g., maps, charts, graphs, tables, illustrations, photographs).
 - Use primary and secondary sources.
- C. Write persuasive pieces.
 - Include a clearly stated position or opinion.
 - Include convincing, elaborated and properly cited evidence.
 - Develop reader interest.
 - Anticipate and counter reader concerns and arguments.
 - Include a variety of methods to advance the argument or position.
- D. Maintain a written record of activities, course work, experience, honors and interests.
- E. Write a personal résumé.

1.5. Quality of Writing

1.5.11. Grade 11

... every student ... acquire the knowledge and skills needed to:

- A. Write with a sharp, distinct focus.
 - Identify topic, task and audience.
 - Establish and maintain a single point of view.

- B. Write using well-developed content appropriate for the topic.
- Gather, determine validity and reliability of, analyze and organize information.
 - Employ the most effective format for purpose and audience.
 - Write fully developed paragraphs that have details and information specific to the topic and relevant to the focus.
- C. Write with controlled and/or subtle organization.
- Sustain a logical order throughout the piece.
 - Include an effective introduction and conclusion.
- D. Write with a command of the stylistic aspects of composition.
- Use different types and lengths of sentences.
 - Use precise language.
- E. Revise writing to improve style, word choice, sentence variety and subtlety of meaning after rethinking how questions of purpose, audience and genre have been addressed.
- F. Edit writing using the conventions of language.
- Spell all words correctly.
 - Use capital letters correctly.
 - Punctuate correctly (periods, exclamation points, question marks, commas, quotation marks, apostrophes, colons, semicolons, parentheses, hyphens, brackets, ellipses).
 - Use nouns, pronouns, verbs, adjectives, adverbs, conjunctions, prepositions and interjections properly.
 - Use complete sentences (simple, compound, complex, declarative, interrogative, exclamatory and imperative).
- G. Present and/or defend written work for publication when appropriate.

1.6. Speaking and Listening

1.6.11. Grade 11

... every student ... acquire the knowledge and skills needed to:

- A. Listen to others.
- Ask clarifying questions.
 - Synthesize information, ideas and opinions to determine relevancy.
 - Take notes.
- B. Listen to selections of literature (fiction and/or nonfiction).
- Relate them to previous knowledge.
 - Predict solutions to identified problems.
 - Summarize and reflect on what has been heard.
 - Identify and define new words and concepts.
 - Analyze and synthesize the selections relating them to other selections heard or read.
- C. Speak using skills appropriate to formal speech situations.
- Use a variety of sentence structures to add interest to a presentation.
 - Pace the presentation according to audience and purpose.
 - Adjust stress, volume and inflection to provide emphasis to ideas or to influence the audience.
- D. Contribute to discussions.
- Ask relevant, clarifying questions.
 - Respond with relevant information or opinions to questions asked.
 - Listen to and acknowledge the contributions of others.
 - Adjust tone and involvement to encourage equitable participation.
 - Facilitate total group participation.
 - Introduce relevant, facilitating information, ideas and opinions to enrich the discussion.
 - Paraphrase and summarize as needed.
- E. Participate in small and large group discussions and presentations.

- Initiate everyday conversation.
 - Select and present an oral reading on an assigned topic.
 - Conduct interviews.
 - Participate in a formal interview (e.g., for a job, college).
 - Organize and participate in informal debate around a specific topic.
 - Use evaluation guides (e.g., National Issues Forum, Toastmasters) to evaluate group discussion (e.g., of peers, on television).
- F. Use media for learning purposes.
- Use various forms of media to elicit information, to make a student presentation and to complete class assignments and projects.
 - Evaluate the role of media in focusing attention and forming opinions.
 - Create a multi-media (e.g., film, music, computer-graphic) presentation for display or transmission that demonstrates an understanding of a specific topic or issue or teaches others about it.

1.7. Characteristics and Functions of the English Language

1.7.11. Grade 11

. . . every student . . . acquire the knowledge and skills needed to:

- A. Describe the influence of historical events on the English language.
- B. Analyze when differences in language are a source of negative or positive stereotypes among groups.
- C. Explain and evaluate the role and influence of the English language within and across countries.

1.8. Research

1.8.11. Grade 11

. . . every student . . . acquire the knowledge and skills needed to:

- A. Select and refine a topic for research.
- B. Locate information using appropriate sources and strategies.
 - Determine valid resources for researching the topic, including primary and secondary sources.
 - Evaluate the importance and quality of the sources.
 - Select sources appropriate to the breadth and depth of the research (e.g., dictionaries, thesauruses, other reference materials, interviews, observations, computer databases).
 - Use tables of contents, indices, key words, cross-references and appendices.
 - Use traditional and electronic search tools.
- C. Organize, summarize and present the main ideas from research.
 - Take notes relevant to the research topic.
 - Develop a thesis statement based on research.
 - Anticipate readers' problems or misunderstandings.
 - Give precise, formal credit for others' ideas, images or information using a standard method of documentation.
 - Use formatting techniques (e.g., headings, graphics) to aid reader understanding.

Mathematics

PENNSYLVANIA Grade 8 Academic Standards and Grade-Level Skills

2.1. Numbers, Number Systems and Number Relationships

2.1.8. Grade 8

... every student ... acquire the knowledge and skills needed to:

- A. Represent and use numbers in equivalent forms (e.g., integers, fractions, decimals, percents, exponents, scientific notation, square roots).
- B. Simplify numerical expressions involving exponents, scientific notation and using order of operations.
- C. Distinguish between and order rational and irrational numbers.
- D. Apply ratio and proportion to mathematical problem situations involving distance, rate, time and similar triangles.
- E. Simplify and expand algebraic expressions using exponential forms.
- F. Use the number line model to demonstrate integers and their applications.
- G. Use the inverse relationships between addition, subtraction, multiplication, division, exponentiation and root extraction to determine unknown quantities in equations.

2.2. Computation and Estimation

2.2.8. Grade 8

... every student ... acquire the knowledge and skills needed to:

- A. Complete calculations by applying the order of operations.
- B. Add, subtract, multiply and divide different kinds and forms of rational numbers including integers, decimal fractions, percents and proper and improper fractions.
- C. Estimate the value of irrational numbers.
- D. Estimate amount of tips and discounts using ratios, proportions and percents.
- E. Determine the appropriateness of overestimating or underestimating in computation.
- F. Identify the difference between exact value and approximation and determine which is appropriate for a given situation.

2.3. Measurement and Estimation

2.3.8. Grade 8

... every student ... acquire the knowledge and skills needed to:

- A. Develop formulas and procedures for determining measurements (e.g., area, volume, distance).
- B. Solve rate problems (e.g., $\text{rate} \times \text{time} = \text{distance}$, $\text{principal} \times \text{interest rate} = \text{interest}$).
- C. Measure angles in degrees and determine relations of angles.
- D. Estimate, use and describe measures of distance, rate, perimeter, area, volume, weight, mass and angles.
- E. Describe how a change in linear dimension of an object affects its perimeter, area and volume.
- F. Use scale measurements to interpret maps or drawings.
- G. Create and use scale models.

2.4. Mathematical Reasoning and Connections

2.4.8. Grade 8

... every student ... acquire the knowledge and skills needed to:

- A. Make conjectures based on logical reasoning and test conjectures by using counter-examples.
- B. Combine numeric relationships to arrive at a conclusion.
- C. Use if...then statements to construct simple, valid arguments.

- D. Construct, use and explain algorithmic procedures for computing and estimating with whole numbers, fractions, decimals and integers.
- E. Distinguish between inductive and deductive reasoning.
- F. Use measurements and statistics to quantify issues (e.g., in family, consumer science situations).

2.5. Mathematical Problem Solving and Communication

2.5.8. Grade 8

... every student ... acquire the knowledge and skills needed to:

- A. Invent, select, use and justify the appropriate methods, materials and strategies to solve problems.
- B. Verify and interpret results using precise mathematical language, notation and representations, including numerical tables and equations, simple algebraic equations and formulas, charts, graphs and diagrams.
- C. Justify strategies and defend approaches used and conclusions reached.
- D. Determine pertinent information in problem situations and whether any further information is needed for solution.

2.6. Statistics and Data Analysis

2.6.8. Grade 8

... every student ... acquire the knowledge and skills needed to:

- A. Compare and contrast different plots of data using values of mean, median, mode, quartiles and range.
- B. Explain effects of sampling procedures and missing or incorrect information on reliability.
- C. Fit a line to the scatter plot of two quantities and describe any correlation of the variables.
- D. Design and carry out a random sampling procedure.
- E. Analyze and display data in stem-and-leaf and box-and-whisker plots.
- F. Use scientific and graphing calculators and computer spreadsheets to organize and analyze data.
- G. Determine the validity of the sampling method described in studies published in local or national newspapers.

2.7. Probability and Predictions

2.7.8. Grade 8

... every student ... acquire the knowledge and skills needed to:

- A. Determine the number of combinations and permutations for an event.
- B. Present the results of an experiment using visual representations (e.g., tables, charts, graphs).
- C. Analyze predictions (e.g., election polls).
- D. Compare and contrast results from observations and mathematical models.
- E. Make valid inferences, predictions and arguments based on probability.

2.8. Algebra and Functions

2.8.8. Grade 8

... every student ... acquire the knowledge and skills needed to:

- A. Apply simple algebraic patterns to basic number theory and to spatial relations
- B. Discover, describe and generalize patterns, including linear, exponential and simple quadratic relationships.
- C. Create and interpret expressions, equations or inequalities that model problem situations.
- D. Use concrete objects to model algebraic concepts.
- E. Select and use a strategy to solve an equation or inequality, explain the solution and check the solution for accuracy.
- F. Solve and graph equations and inequalities using scientific and graphing calculators and computer spreadsheets.
- G. Represent relationships with tables or graphs in the coordinate plane and verbal or symbolic rules.
- H. Graph a linear function from a rule or table.
- I. Generate a table or graph from a function and use graphing calculators and computer spreadsheets to graph and analyze functions.
- J. Show that an equality relationship between two quantities remains the same as long as the same change is made to both quantities; explain how a change in one quantity determines another quantity in a functional relationship.

2.9. Geometry

2.9.8. Grade 8

. . . every student . . . acquire the knowledge and skills needed to:

- A. Construct figures incorporating perpendicular and parallel lines, the perpendicular bisector of a line segment and an angle bisector using computer software.
- B. Draw, label, measure and list the properties of complementary, supplementary and vertical angles.
- C. Classify familiar polygons as regular or irregular up to a decagon.
- D. Identify, name, draw and list all properties of squares, cubes, pyramids, parallelograms, quadrilaterals, trapezoids, polygons, rectangles, rhombi, circles, spheres, triangles, prisms and cylinders.
- E. Construct parallel lines, draw a transversal and measure and compare angles formed (e.g., alternate interior and exterior angles).
- F. Distinguish between similar and congruent polygons.
- G. Approximate the value of π (pi) through experimentation.
- H. Use simple geometric figures (e.g., triangles, squares) to create, through rotation, transformational figures in three dimensions.
- I. Generate transformations using computer software.
- J. Analyze geometric patterns (e.g., tessellations, sequences of shapes) and develop descriptions of the patterns.
- K. Analyze objects to determine whether they illustrate tessellations, symmetry, congruence, similarity and scale.

2.10. Trigonometry

2.10.8. Grade 8

. . . every student . . . acquire the knowledge and skills needed to:

- A. Compute measures of sides and angles using proportions, the Pythagorean Theorem and right triangle relationships.
- B. Solve problems requiring indirect measurement for lengths of sides of triangles.

2.11. Concepts of Calculus

2.11.8. Grade 8

. . . every student . . . acquire the knowledge and skills needed to:

- A. Analyze graphs of related quantities for minimum and maximum values and justify the findings.
- B. Describe the concept of unit rate, ratio and slope in the context of rate of change.
- C. Continue a pattern of numbers or objects that could be extended infinitely.

Mathematics

PENNSYLVANIA Grade 11 Academic Standards and Grade-Level Skills

2.1. Numbers, Number Systems and Number Relationships

2.1.11. Grade 11

... every student ... acquire the knowledge and skills needed to:

- A. Use operations (e.g., opposite, reciprocal, absolute value, raising to a power, finding roots, finding logarithms).

2.2. Computation and Estimation

2.2.11. Grade 11

... every student ... acquire the knowledge and skills needed to:

- A. Develop and use computation concepts, operations and procedures with real numbers in problem-solving situations.
- B. Use estimation to solve problems for which an exact answer is not needed.
- C. Construct and apply mathematical models, including lines and curves of best fit, to estimate values of related quantities.
- D. Describe and explain the amount of error that may exist in a computation using estimates.
- E. Recognize that the degree of precision needed in calculating a number depends on how the results will be used and the instruments used to generate the measure.
- F. Demonstrate skills for using computer spreadsheets and scientific and graphing calculators.

2.3. Measurement and Estimation

2.3.11. Grade 11

... every student ... acquire the knowledge and skills needed to:

- A. Select and use appropriate units and tools to measure to the degree of accuracy required in particular measurement situations.
- B. Measure and compare angles in degrees and radians.
- C. Demonstrate the ability to produce measures with specified levels of precision.

2.4. Mathematical Reasoning and Connections

2.4.11. Grade 11

... every student ... acquire the knowledge and skills needed to:

- A. Use direct proofs, indirect proofs or proof by contradiction to validate conjectures.
- B. Construct valid arguments from stated facts.
- C. Determine the validity of an argument.
- D. Use truth tables to reveal the logic of mathematical statements.
- E. Demonstrate mathematical solutions to problems (e.g., in the physical sciences).

2.5. Mathematical Problem Solving and Communication

2.5.11. Grade 11

... every student ... acquire the knowledge and skills needed to:

- A. Select and use appropriate mathematical concepts and techniques from different areas of mathematics and apply them to solving non-routine and multi-step problems.
- B. Use symbols, mathematical terminology, standard notation, mathematical rules, graphing and other types of mathematical representations to communicate observations, predictions, concepts, procedures, generalizations, ideas and results.
- C. Present mathematical procedures and results clearly, systematically, succinctly and correctly.
- D. Conclude a solution process with a summary of results and evaluate the degree to which the results obtained represent an acceptable response to the initial problem and why the reasoning is valid.

2.6. Statistics and Data Analysis

2.6.11. Grade 11

... every student ... acquire the knowledge and skills needed to:

- A. Design and conduct an experiment using random sampling. Describe the data as an example of a distribution using statistical measures of center and spread. Organize and represent the results with graphs. (Use standard deviation, variance and t-tests.)
- B. Use appropriate technology to organize and analyze data taken from the local community.
- C. Determine the regression equation of best fit (e.g., linear, quadratic, exponential).
- D. Make predictions using interpolation, extrapolation, regression and estimation using technology to verify them.
- E. Determine the validity of the sampling method described in a given study.
- F. Determine the degree of dependence of two quantities specified by a two-way table.
- G. Describe questions of experimental design, control groups, treatment groups, cluster sampling and reliability.
- H. Use sampling techniques to draw inferences about large populations.
- I. Describe the normal curve and use its properties to answer questions about sets of data that are assumed to be normally distributed.

2.7. Probability and Predictions

2.7.11. Grade 11

... every student ... acquire the knowledge and skills needed to:

- A. Compare odds and probability.
- B. Apply probability and statistics to perform an experiment involving a sample and generalize its results to the entire population.
- C. Draw and justify a conclusion regarding the validity of a probability or statistical argument.
- D. Use experimental and theoretical probability distributions to make judgments about the likelihood of various outcomes in uncertain situations.
- E. Solve problems involving independent simple and compound events.

2.8. Algebra and Functions

2.8.11. Grade 11

... every student ... acquire the knowledge and skills needed to:

- A. Analyze a given set of data for the existence of a pattern and represent the pattern algebraically and graphically.
- B. Give examples of patterns that occur in data from other disciplines.
- C. Use patterns, sequences and series to solve routine and non-routine problems.
- D. Formulate expressions, equations, inequalities, systems of equations, systems of inequalities and matrices to model routine and non-routine problem situations.
- E. Use equations to represent curves (e.g., lines, circles, ellipses, parabolas, hyperbolas).
- F. Identify whether systems of equations and inequalities are consistent or inconsistent.
- G. Analyze and explain systems of equations, systems of inequalities and matrices
- H. Select and use an appropriate strategy to solve systems of equations and inequalities using graphing calculators, symbol manipulators, spreadsheets and other software.
- I. Use matrices to organize and manipulate data, including matrix addition, subtraction, multiplication and scalar multiplication.
- J. Demonstrate the connection between algebraic equations and inequalities and the geometry of relations in the coordinate plane.
- K. Select, justify and apply an appropriate technique to graph a linear function in two variables, including slope-intercept, x- and y-intercepts, graphing by transformations and the use of a graphing calculator.
- L. Write the equation of a line when given the graph of the line, two points on the line, or the slope of the line and a point on the line.
- M. Given a set of data points, write an equation for a line of best fit.
- N. Solve linear, quadratic and exponential equations both symbolically and graphically.

- O. Determine the domain and range of a relation, given a graph or set of ordered pairs.
- P. Analyze a relation to determine whether a direct or inverse variation exists and represent it algebraically and graphically.
- Q. Represent functional relationships in tables, charts and graphs.
- R. Create and interpret functional models.
- S. Analyze properties and relationships of functions (e.g., linear, polynomial, rational, trigonometric, exponential, logarithmic).
- T. Analyze and categorize functions by their characteristics.

2.9. Geometry

2.9.11. Grade 11

... every student ... acquire the knowledge and skills needed to:

- A. Construct geometric figures using dynamic geometry tools (e.g., Geometer's Sketchpad, Cabri Geometre).
- B. Prove that two triangles or two polygons are congruent or similar using algebraic, coordinate and deductive proofs.
- C. Identify and prove the properties of quadrilaterals involving opposite sides and angles, consecutive sides and angles and diagonals using deductive proofs.
- D. Identify corresponding parts in congruent triangles to solve problems.
- E. Solve problems involving inscribed and circumscribed polygons.
- F. Use the properties of angles, arcs, chords, tangents and secants to solve problems involving circles.
- G. Solve problems using analytic geometry.
- H. Construct a geometric figure and its image using various transformations.
- I. Model situations geometrically to formulate and solve problems.
- J. Analyze figures in terms of the kinds of symmetries they have.

2.10. Trigonometry

2.10.11. Grade 11

... every student ... acquire the knowledge and skills needed to:

- A. Use graphing calculators to display periodic and circular functions; describe properties of the graphs.
- B. Identify, create and solve practical problems involving right triangles using the trigonometric functions and the Pythagorean Theorem.

2.11. Concepts of Calculus

2.11.11. Grade 11

... every student ... acquire the knowledge and skills needed to:

- A. Determine maximum and minimum values of a function over a specified interval.
- B. Interpret maximum and minimum values in problem situations.
- C. Graph and interpret rates of growth/decay.
- D. Determine sums of finite sequences of numbers and infinite geometric series.
- E. Estimate areas under curves using sequences of areas.

Science and Technology

PENNSYLVANIA Grade 7 Academic Standards and Grade-Level Skills

3.1. Unifying Themes

3.1.7. Grade 7

... every student ... acquire the knowledge and skills needed to:

- A. Explain the parts of a simple system and their relationship to each other.
- Describe a system as a group of related parts that work together to achieve a desired result (e.g., digestive system).
 - Explain the importance of order in a system.
 - Distinguish between system inputs, system processes and system outputs.
 - Distinguish between open loop and closed loop systems.
 - Apply systems analysis to solve problems.
- B. Describe the use of models as an application of scientific or technological concepts.
- Identify and describe different types of models and their functions.
 - Apply models to predict specific results and observations (e.g., population growth, effects of infectious organisms).
 - Explain systems by outlining a system's relevant parts and its purpose and/or designing a model that illustrates its function.
- C. Identify patterns as repeated processes or recurring elements in science and technology.
- Identify different forms of patterns and use them to group and classify specific objects.
 - Identify repeating structure patterns.
 - Identify and describe patterns that occur in physical systems (e.g., construction, manufacturing, transportation), informational systems and biochemical-related systems.
- D. Explain scale as a way of relating concepts and ideas to one another by some measure.
- Apply various applications of size and dimensions of scale to scientific, mathematical, and technological applications.
 - Describe scale as a form of ratio and apply to a life situation.
- E. Identify change as a variable in describing natural and physical systems.
- Describe fundamental science and technology concepts that could solve practical problems.
 - Explain how ratio is used to describe change.
 - Describe the effect of making a change in one part of a system on the system as a whole.

3.2. Inquiry and Design

3.2.7. Grade 7

... every student ... acquire the knowledge and skills needed to:

- A. Explain and apply scientific and technological knowledge.
- Distinguish between a scientific theory and a belief.
 - Answer "What if" questions based on observation, inference or prior knowledge or experience.
 - Explain how skepticism about an accepted scientific explanation led to a new understanding.
 - Explain how new information may change existing theories and practice.
- B. Apply process knowledge to make and interpret observations.
- Measure materials using a variety of scales.
 - Describe relationships by making inferences and predictions.

- **Communicate**, use space / time relationships, define operationally, **raise questions, formulate hypotheses, test and experiment**,
 - **Design controlled experiments, recognize variables, and manipulate variables.**
 - **Interpret data, formulate models, design models, and produce solutions.**
- C. **Identify and use the elements of scientific inquiry to solve problems.**
- **Generate questions about objects, organisms and/or events that can be answered through scientific investigations.**
 - **Evaluate the appropriateness of questions.**
 - **Design an investigation with limited variables to investigate a question.**
 - **Conduct a two-part experiment.**
 - **Judge the significance of experimental information in answering the question.**
 - **Communicate appropriate conclusions from the experiment.**
- D. **Know and use the technological design process to solve problems.**
- Define different types of problems.
 - **Define** all aspects of the problem, **necessary information and questions that must be answered.**
 - **Propose the best solution.**
 - **Design and propose alternative methods to achieve solutions.**
 - Apply a solution.
 - **Explain the results**, present improvements, identify and infer the impacts of the solution.

3.3. Biological Sciences

3.3.7. Grade 7

... every student ... acquire the knowledge and skills needed to:

- A. Describe the similarities and differences that characterize diverse living things.
- Describe how the structures of living things help them function in unique ways.
 - Explain how to use a dichotomous key to identify plants and animals.
 - Account for adaptations among organisms that live in a particular environment.
- B. Describe the cell as the basic structural and functional unit of living things.
- Identify the levels of organization from cell to organism.
 - Compare life processes at the organism level with life processes at the cell level.
 - Explain that cells and organisms have particular structures that underlie their functions.
 - Describe and distinguish among cell cycles, reproductive cycles and life cycles.
 - Explain disease effects on structures or functions of an organism.
- C. Know that every organism has a set of genetic instructions that determines its inherited traits.
- Identify and explain inheritable characteristics.
 - Identify that the gene is the basic unit of inheritance.
 - Identify basic patterns of inheritance (e.g., dominance, recessive, codominance).
 - Describe how traits are inherited.
 - Distinguish how different living things reproduce (e.g., vegetative budding, sexual).
 - recognize that mutations can alter a gene.
 - Describe how selective breeding, natural selection and genetic technologies can change genetic makeup of organisms.
- D. Explain basic concepts of natural selection.
- Identify adaptations that allow organisms to survive in their environment.
 - Describe how an environmental change can affect the survival of organisms and entire species.
 - know that differences in individuals of the same species may give some advantage in surviving and reproducing.
 - recognize that populations of organisms can increase rapidly.

- Describe the role that fossils play in studying the past.
- Explain how biologic extinction is a natural process.

3.4. Physical Science, Chemistry and Physics

3.4.7. Grade 7

. . . every student . . . acquire the knowledge and skills needed to:

- A. Describe concepts about the structure and properties of matter.
- Identify elements as basic building blocks of matter that cannot be broken down chemically.
 - Distinguish compounds from mixtures.
 - Describe and conduct experiments that identify chemical and physical properties.
 - Describe reactants and products of simple chemical reactions.
- B. Relate energy sources and transfers to heat and temperature.
- Identify and describe sound changes in moving objects.
 - Know that the sun is a major source of energy that emits wavelengths of visible light, infrared and ultraviolet radiation.
 - Explain the conversion of one form of energy to another by applying knowledge of each form of energy.
 - Explain the parts and functions in an electrical circuit.
- C. Identify and explain the principles of force and motion.
- Describe the motion of an object based on its position, direction and speed.
 - Classify fluid power systems according to fluid used or mode of power transmission (e.g., air, oil).
 - Explain various motions using models.
 - Explain how convex and concave mirrors and lens change light images.
 - Explain how sound and light travel in waves of differing speeds, sizes and frequencies.
- D. Describe essential ideas about the composition and structure of the universe and the earth's place in it.
- Compare various planets' characteristics.
 - Describe basic star types and identify the sun as a star type.
 - Describe and differentiate comets, asteroids and meteors.
 - Identify gravity as the force that keeps planets in orbit around the sun and governs the rest of the movement of the solar system and the universe.
 - Illustrate how the positions of stars and constellations change in relation to the Earth during an evening and from month to month.
 - Identify equipment and instruments that explore the universe.
 - Identify the accomplishments and contributions provided by selected past and present scientists in the field of astronomy.
 - Identify and articulate space program efforts to investigate possibilities of living in space and on other planets.

3.5. Earth Sciences

3.5.7. Grade 7

. . . every student . . . acquire the knowledge and skills needed to:

- A. Describe earth features and processes.
- Describe major layers of the earth.
 - Describe the processes involved in the creation of geologic features (e.g., folding, faulting, volcanism, sedimentation) and that these processes seen today (e.g., erosion, weathering, crustal plate movement) are similar to those in the past.
 - Describe the processes that formed Pennsylvania geologic structures and resources including mountains, glacial formations, water gaps and ridges.
 - Explain how the rock cycle affected rock formations in the state of Pennsylvania.
 - Distinguish between examples of rapid surface changes (e.g., landslides, earthquakes) and slow surface changes (e.g., weathering).

- Identify living plants and animals that are similar to fossil forms.
- B. Recognize earth resources and how they affect everyday life.
- Identify and locate significant earth resources (e.g., rock types, oil, gas, coal deposits) in Pennsylvania.
 - Explain the processes involved in the formation of oil and coal in Pennsylvania.
 - Explain the value and uses of different earth resources (e.g., selected minerals, ores, fuel sources, agricultural uses).
 - Compare the locations of human settlements as related to available resources.
- C. Describe basic elements of meteorology.
- Explain weather forecasts by interpreting weather data and symbols.
 - Explain the oceans' impact on local weather and the climate of a region.
 - Identify how cloud types, wind directions and barometric pressure changes are associated with weather patterns in different regions of the country.
 - Explain and illustrate the processes of cloud formation and precipitation.
 - Describe and illustrate the major layers of the earth's atmosphere.
 - Identify different air masses and global wind patterns and how they relate to the weather patterns in different regions of the U.S.
- D. Explain the behavior and impact of the earth's water systems.
- Explain the water cycle using the processes of evaporation and condensation.
 - Describe factors that affect evaporation and condensation.
 - Distinguish salt from fresh water (e.g., density, electrical conduction).
 - Compare the effect of water type (e.g., polluted, fresh, salt water) and the life contained in them.
 - Identify ocean and shoreline features, (e.g., bays, inlets, spit, tidal marshes).

3.6. Technology Education

3.6.7. Grade 7

. . . every student . . . acquire the knowledge and skills needed to:

- A. Explain biotechnologies that relate to related technologies of propagating, growing, maintaining, adapting, treating and converting.
- Identify the environmental, societal and economic impacts that waste has in the environment.
 - Identify and explain the impact that a specific medical advancement has had on society.
 - Explain the factors that were taken into consideration when a specific object was designed.
 - Define and describe how fuels and energy can be generated through the process of biomass conversion.
 - Identify and group basic plant and animal production processes.
 - explain the impact that agricultural science has had on biotechnology.
- B. Explain information technologies of encoding, transmitting, receiving, storing, retrieving and decoding.
- Demonstrate the effectiveness of image generating technique to communicate a story (e.g., photography, video).
 - Analyze and evaluate the effectiveness of a graphic object designed and produced to communicate a thought or concept.
 - Apply basic technical drawing techniques to communicate an idea or solution to a problem.
 - Apply the appropriate method of communications technology to communicate a thought.
- C. Explain physical technologies of structural design, analysis and engineering, personnel relations, financial affairs, structural production, marketing, research and design.
- Use knowledge of material effectiveness to solve specific construction problems (e.g., steel vs. wood bridges).
 - Differentiate among the different types of construction applications (e.g., microwave tower, power plants, aircrafts).
 - Explain basic material processes that manufactured objects undergo during production. (e.g., separating, forming, combining).
 - Evaluate a construction activity by specifying task analyses and necessary resources.

- Explain the relationships among the basic resources needed in the production process for a specific manufactured object.
- Explain the difference between design engineering and production engineering processes.
- Analyze manufacturing steps that affect waste and pollutants.
- Explain transportation technologies of propelling, structuring, suspending, guiding, controlling and supporting.
- Identify and explain the workings of several mechanical power systems.
- Model and explain examples of vehicular propulsion, control, guidance, structure and suspension systems.
- Explain the limitations of land, marine, air and space transportation systems.

3.7. Technological Devices

3.7.7. Grade 7

... every student ... acquire the knowledge and skills needed to:

- Describe the safe and appropriate use of tools, materials and techniques to answer questions and solve problems.
 - Identify uses of tools, machines, materials, information, people, money, energy and time that meet specific design criteria.
 - Describe safe procedures for using tools and materials.
 - Assess materials for appropriateness of use.
- Use appropriate instruments and apparatus to study materials.
 - Select appropriate instruments to measure the size, weight, shape and temperature of living and non-living objects.
 - Apply knowledge of different measurement systems to measure and record objects' properties.
- Explain and demonstrate basic computer operations and concepts.
 - Know specialized computer applications used in the community.
 - Describe the function of advanced input and output devices (e.g., scanners, video images, plotters, projectors) and demonstrate their use.
 - Demonstrate age appropriate keyboarding skills and techniques.
- Apply computer software to solve specific problems.
 - Identify software designed to meet specific needs (e.g., Computer Aided Drafting, design software, tutorial, financial, presentation software).
 - Identify and solve basic software problems relevant to specific software applications.
 - Identify basic multimedia applications.
 - Demonstrate a basic knowledge of desktop publishing applications.
 - Apply intermediate skills in utilizing word processing, database and spreadsheet software.
 - Apply basic graphic manipulation techniques.
- Explain basic computer communications systems.
 - Describe the organization and functions of the basic parts that make up the World Wide Web.
 - Apply advanced electronic mail functions.
 - Apply basic on-line research techniques to solve a specific problem.

3.8. Science, Technology and Human Endeavors

3.8.7. Grade 7

... every student ... acquire the knowledge and skills needed to:

- Explain how sciences and technologies are limited in their effects and influences on society.
 - Identify and describe the unavoidable constraints of technological design.
 - Identify changes in society as a result of a technological development.
 - Identify and explain improvements in transportation, health, sanitation and communications as a result of advancements in science and technology and how they effect our lives.
- Explain how human ingenuity and technological resources satisfy specific human needs and improve the quality of life.

- Identify interrelationships between systems and resources.
 - Identify and describe the resources necessary to solve a selected problem in a community and improve the quality of life.
 - Identify and explain specific examples of how agricultural science has met human needs and has improved the quality of life.
- C. Identify the pros and cons of applying technological and scientific solutions to address problems and the effect upon society.
- Describe the positive and negative expected and unexpected effects of specific technological developments.
 - Describe ways technology extends and enhances human abilities.

Science and Technology
PENNSYLVANIA Grade 10
Academic Standards and Grade-Level Skills

3.1. Unifying Themes

3.1.10. Grade 10

... every student ... acquire the knowledge and skills needed to:

- A. Discriminate among the concepts of systems, subsystems, feedback and control in solving technological problems.
- Identify the function of subsystems within a larger system (e.g., role of thermostat in an engine, pressure switch).
 - Describe the interrelationships among inputs, processes, outputs, feedback and control in specific systems.
 - Explain the concept of system redesign and apply it to improve technological systems.
 - Apply the universal systems model to illustrate specific solutions and troubleshoot specific problems.
 - Analyze and describe the effectiveness of systems to solve specific problems.
- B. Describe concepts of models as a way to predict and understand science and technology.
- Distinguish between different types of models and modeling techniques and apply their appropriate use in specific applications (e.g., kinetic gas theory, DNA).
 - Examine the advantages of using models to demonstrate processes and outcomes (e.g., blue print analysis, structural stability).
 - Apply mathematical models to science and technology.
- C. Apply patterns as repeated processes or recurring elements in science and technology.
- Examine and describe recurring patterns that form the basis of biological classification, chemical periodicity, geological order and astronomical order.
 - Examine and describe stationary physical patterns.
 - Examine and describe physical patterns in motion.
- D. Apply scale as a way of relating concepts and ideas to one another by some measure.
- Apply dimensional analysis and scale as a ratio.
 - Convert one scale to another.
- E. Describe patterns of change in nature, physical and man made systems.
- Describe how fundamental science and technology concepts are used to solve practical problems (e.g., momentum, Newton's laws of universal gravitation, tectonics, conservation of mass and energy, cell theory, theory of evolution, atomic theory, theory of relativity, Pasteur's germ theory, relativity, heliocentric theory, gas laws, feedback systems).
 - Recognize that stable systems often involve underlying dynamic changes (e.g., a chemical reaction at equilibrium has molecules reforming continuously).
 - Describe the effects of error in measurements.
 - Describe changes to matter caused by heat, cold, light or chemicals using a rate function.

3.2. Inquiry and Design

3.2.10. Grade 10

... every student ... acquire the knowledge and skills needed to:

- A. Apply knowledge and understanding about the nature of scientific and technological knowledge.
- Compare and contrast scientific theories and beliefs.
 - Know that science uses both direct and indirect observation means to study the world and the universe.
 - Integrate new information into existing theories and explain implied results.
- B. Apply process knowledge and organize scientific and technological phenomena in varied ways.
- Describe materials using precise quantitative and qualitative skills based on observations.
 - Develop appropriate scientific experiments: raising questions, formulating hypotheses, testing, controlled experiments, recognizing variables, manipulating variables, interpreting data, and producing solutions.

- Use process skills to make inferences and predictions using collected information and to communicate, using space / time relationships, defining operationally.
- C. Apply the elements of scientific inquiry to solve problems.
- Generate questions about objects, organisms and/or events that can be answered through scientific investigations.
 - Evaluate the appropriateness of questions.
 - Design an investigation with adequate control and limited variables to investigate a question.
 - Conduct a multiple step experiment.
 - Organize experimental information using a variety of analytic methods.
 - Judge the significance of experimental information in answering the question.
 - Suggest additional steps that might be done experimentally.
- D. Identify and apply the technological design process to solve problems.
- Examine the problem, rank all necessary information and all questions that must be answered.
 - Propose and analyze a solution.
 - Implement the solution.
 - Evaluate the solution, test, redesign and improve as necessary.
 - Communicate the process and evaluate and present the impacts of the solution.

3.3. Biological Sciences

3.3.10. Grade 10

... every student ... acquire the knowledge and skills needed to:

- A. Explain the structural and functional similarities and differences found among living things.
- Identify and characterize major life forms according to their placement in existing classification groups.
 - Explain the relationship between structure and function at the molecular and cellular levels.
 - Describe organizing schemes of classification keys.
 - Identify and characterize major life forms by kingdom, phyla, class and order.
- B. Describe and explain the chemical and structural basis of living organisms.
- Describe the relationship between the structure of organic molecules and the function they serve in living organisms.
 - Identify the specialized structures and regions of the cell and the functions of each.
 - Explain how cells store and use information to guide their functions.
 - Explain cell functions and processes in terms of chemical reactions and energy changes.
- C. Describe how genetic information is inherited and expressed.
- Compare and contrast the function of mitosis and meiosis.
 - Describe mutations' effects on a trait's expression.
 - Distinguish different reproductive patterns in living things (e.g., budding, spores, fission).
 - Compare random and selective breeding practices and their results (e.g., antibiotic resistant bacteria).
 - Explain the relationship among DNA, genes and chromosomes.
 - Explain different types of inheritance (e.g., multiple allele, sex-influenced traits).
 - Describe the role of DNA in protein synthesis as it relates to gene expression.
- D. Explain the mechanisms of the theory of evolution.
- analyze data from fossil records, similarities in anatomy and physiology, embryological studies and DNA studies that are relevant to the theory of evolution.
 - Explain the role of mutations and gene recombination in changing a population of organisms.
 - Compare modern day descendants of extinct species and propose possible scientific accounts for their present appearance.
 - describe the factors (e.g., isolation, differential reproduction) affecting gene frequency in a population over time and their consequences.

- describe and differentiate between the roles of natural selection and genetic drift.
- Describe changes that illustrate major events in the earth's development based on a time line.
- explain why natural selection can act only on inherited traits.
- Apply the concept of natural selection to illustrate and account for a species' survival, extinction or change over time.

3.4. Physical Science, Chemistry and Physics

3.4.10. Grade 10

... every student ... acquire the knowledge and skills needed to:

A. Explain concepts about the structure and properties of matter.

- Know that atoms are composed of even smaller sub-atomic structures whose properties are measurable.
- Explain the repeating pattern of chemical properties by using the repeating patterns of atomic structure within the periodic table.
- Predict the behavior of gases through the use of Boyle's, Charles' or the ideal gas law, in everyday situations.
- Describe phases of matter according to the Kinetic Molecular Theory.
- Explain the formation of compounds and their resulting properties using bonding theories (ionic and covalent).
- Recognize formulas for simple inorganic compounds.
- Describe various types of chemical reactions by applying the laws of conservation of mass and energy.
- Apply knowledge of mixtures to appropriate separation techniques.
- Understand that carbon can form several types of compounds.

B. Analyze energy sources and transfers of heat.

- Determine the efficiency of chemical systems by applying mathematical formulas.
- Use knowledge of chemical reactions to generate an electrical current.
- Evaluate energy changes in chemical reactions.
- Use knowledge of conservation of energy and momentum to explain common phenomena (e.g., refrigeration system, rocket propulsion).
- Explain resistance, current and electro-motive force (Ohm's Law).

C. Distinguish among the principles of force and motion.

- Identify the relationship of electricity and magnetism as two aspects of a single electromagnetic force.
- Identify elements of simple machines in compound machines.
- Explain fluid power systems through the design and construction of appropriate models.
- Describe sound effects (e.g., Doppler effect, amplitude, frequency, reflection, refraction, absorption, sonar, seismic).
- Describe light effects (e.g., Doppler effect, dispersion, absorption, emission spectra, polarization, interference).
- Describe and measure the motion of sound, light and other objects.
- Know Newton's laws of motion (including inertia, action and reaction) and gravity and apply them to solve problems related to forces and mass.
- Determine the efficiency of mechanical systems by applying mathematical formulas.

D. Explain essential ideas about the composition and structure of the universe.

- Compare the basic structures of the universe (e.g., galaxy types, nova, black holes, neutron stars).
- Describe the structure and life cycle of star, using the Hertzsprung-Russell diagram.
- Describe the nuclear processes involved in energy production in a star.
- Explain the "red-shift" and Hubble's use of it to determine stellar distance and movement.
- Compare absolute versus apparent star magnitude and their relation to stellar distance.
- Explain the impact of the Copernican and Newtonian thinking on man's view of the universe.
- Identify and analyze the findings of several space instruments in regard to the extent and composition of the solar system and universe.

3.5. Earth Sciences

3.5.10. Grade 10

... every student ... acquire the knowledge and skills needed to:

- A. Relate earth features and processes that change the earth.
- Illustrate and explain plate tectonics as the mechanism of continental movement and sea floor changes.
 - Compare examples of change to the earth's surface over time as they related to continental movement and ocean basin formation (e.g., Delaware, Susquehanna, Ohio Rivers system formations, dynamics).
 - Interpret topographic maps to identify and describe significant geologic history/structures in Pennsylvania.
 - Evaluate and interpret geologic history using geologic maps.
 - Explain several methods of dating earth materials and structures.
 - Correlate rock units with general geologic time periods in the history of the earth.
 - Describe and identify major types of rocks and minerals.
- B. Explain sources and uses of earth resources.
- Compare the locations of strategic minerals and earth resources in the world with their geologic history using maps and global information systems.
 - Demonstrate the effects of sedimentation and erosion before and after a conservation plan is implemented.
 - Evaluate the impact of geologic activities/hazards (e.g., earthquakes, sinkholes, landslides).
 - Evaluate land use (e.g., agricultural, recreational, residential, commercial) in Pennsylvania based upon soil characteristics.
- C. Interpret meteorological data.
- Analyze information from meteorological instruments and online sources to predict weather patterns.
 - Describe weather and climate patterns on global levels.
 - Evaluate specific adaptations plants and animals have made that enable them to survive in different climates.
- D. Assess the value of water as a resource.
- Compare specific sources of potable water (e.g., wells, public systems, rivers) used by people in Pennsylvania.
 - Identify the components of a municipal/agricultural water supply system and a wastewater treatment system.
 - Relate aquatic life to water conditions (e.g., turbidity, temperature, salinity, dissolved oxygen, nitrogen levels, pressure).
 - Compare commercially important aquatic species in or near Pennsylvania.
 - Identify economic resources found in marine areas.
 - Assess the natural and man-made factors that affect the availability of clean water (e.g., rock and mineral deposits, man-made pollution).

3.6. Technology Education

3.6.10. Grade 10

... every student ... acquire the knowledge and skills needed to:

- A. Apply biotechnologies that relate to propagating, growing, maintaining, adapting, treating and converting.
- Apply knowledge of plant and animal production processes in designing an improvement to existing processes.
 - Apply knowledge of biomedical technology applications in designing a solution to a simple medical problem (e.g., wheel chair design, artificial arteries).
 - Apply knowledge of how biomedical technology affects waste products in designing a solution that will result in reduced waste.
 - Apply ergonomic engineering factors when devising a solution to a specific problem.
 - Describe various methods of biochemical conversion.
 - describe specific examples that reflect the impact that agricultural science has had on biotechnology.
- B. Apply knowledge of information technologies of encoding, transmitting, receiving, storing, retrieving and decoding.
- Describe the proper use of graphic and electronic communication systems.

- Apply a variety of advanced mechanical and electronic drafting methods to communicate a solution to a specific problem.
 - Apply and analyze advanced communication techniques to produce an image that effectively conveys a message (e.g., desktop publishing, audio and/or video production).
 - Illustrate an understanding of a computer network system by modeling, constructing or assembling its components.
- C. Apply physical technologies of structural design, analysis and engineering, personnel relations, financial affairs, structural production, marketing, research and design to real world problems.
- Describe and classify common construction by their characteristics and composition.
 - Compare and contrast specific construction systems that depend on each other in order to complete a project.
 - Evaluate material failure common to specific applications.
 - Demonstrate knowledge of various construction systems by building or interpreting models.
 - Select and apply the necessary resources to successfully conduct a manufacturing enterprise.
 - Apply concepts of design engineering and production engineering in the organization and application of a manufacturing activity.
 - Apply the concepts of manufacturing by redesigning an enterprise to improve productivity or reduce or eliminate waste and/or pollution.
 - Evaluate the interrelationship of various transportation systems in the community.
 - Analyze the impacts that transportation systems have on a community.

3.7. Technological Devices

3.7.10. Grade 10

. . . every student . . . acquire the knowledge and skills needed to:

- A. Identify and safely use a variety of tools, basic machines, materials and techniques to solve problems and answer questions.
- Select and safely apply appropriate tools, materials and processes necessary to solve complex problems.
 - Apply advanced tool and equipment manipulation techniques to solve problems.
- B. Apply appropriate instruments and apparatus to examine a variety of objects and processes.
- Describe and use appropriate instruments to gather and analyze data.
 - Compare and contrast different scientific measurement systems; select the best measurement system for a specific situation.
 - Explain the need to estimate measurements within error of various instruments.
 - Apply accurate measurement knowledge to solve everyday problems.
 - Describe and demonstrate the instrumentation in evaluating material and chemical properties (e.g., scanning electron microscope, nuclear magnetic resonance machines).
- C. Apply basic computer operations and concepts.
- Identify solutions to basic hardware and software problems.
 - Apply knowledge of advanced input devices.
 - Apply knowledge of hardware setup.
 - Describe the process for basic software installation and demonstrate it.
 - Analyze and solve basic operating systems problems.
 - Apply touch keyboarding skills and techniques at expectable speed and accuracy.
 - Demonstrate the ability to perform basic software installation.
- D. Utilize computer software to solve specific problems.
- Identify legal restrictions in the use of software and the output of data.
 - Apply advanced graphic manipulation and desktop publishing techniques.
 - Apply basic multimedia applications.
 - Apply advanced word processing, database and spreadsheet skills.

- Describe and demonstrate how two or more software applications can be used to produce an output.
 - Select and apply software designed to meet specific needs.
- E. Apply basic computer communications systems.
- Identify and explain various types of on-line services.
 - Identify and explain the function of the parts of a basic network.
 - Describe and apply the components of a web page and their function.
 - Explain and demonstrate file transfer within and out side of a computer network.
 - Identify, describe and complete advanced on-line research.

3.8. Science, Technology and Human Endeavors

3.8.10. Grade 10

. . . every student . . . acquire the knowledge and skills needed to:

- A. Analyze the relationship between societal demands and scientific and technological enterprises.
- Identify past and current tradeoffs between increased production, environmental harm and social values (e.g., increased energy needs, power plants, automobiles).
 - Compare technologies that are applied and accepted differently in various cultures (e.g., factory farming, nuclear power).
 - Describe and evaluate social change as a result of technological developments.
 - Assess the social impacts of a specific international environmental problem by designing a solution that applies the appropriate technologies and resources.
- B. Analyze how human ingenuity and technological resources satisfy specific human needs and improve the quality of life.
- Identify several problems and opportunities that exist in your community, apply various problem-solving methods to design and evaluate possible solutions.
 - Analyze a recently invented item, prompted its invention and the current and potential social impacts of the specific invention.
 - Apply knowledge of oceanography, meteorology, geology and human anatomy to explain important considerations that need to be made for construction of homes, buildings and businesses in the United States.
 - Assess the impacts that agricultural science has had on meeting human needs and improving the quality of life.
- C. Evaluate possibilities consequences and impacts of scientific and technological solutions.
- Relate scientific and technological advancements in terms of cause and effect.
 - Describe and evaluate the impacts that financial considerations have had on specific scientific and technological applications.
 - Compare and contrast potential solutions to technological, social, economic and environmental problems.
 - Analyze the impacts on society of accepting or rejecting scientific and technological advances.

Science and Technology
PENNSYLVANIA Grade 12
Academic Standards and Grade-Level Skills

3.1. Unifying Themes

3.1.12. Grade 12

... every student ... acquire the knowledge and skills needed to:

- A. Apply concepts of systems, subsystems, feedback and control to solve complex technological problems.
- Apply knowledge of control systems concept by designing and modeling control systems that solve specific problems.
 - Apply systems analysis to predict results.
 - Analyze and describe the function, interaction and relationship among subsystems and the system itself.
 - Compare and contrast several systems that could be applied to solve a single problem.
 - Evaluate the causes of a system's inefficiency.
- B. Apply concepts of models as a method to predict and understand science and technology.
- Evaluate technological processes by collecting data and applying mathematical models (e.g., process control).
 - Apply knowledge of complex physical models to interpret data and apply mathematical models.
 - Appraise the importance of computer models in interpreting science and technological systems.
- C. Assess and apply patterns in science and technology.
- Assess and apply recurring patterns in natural and technological systems.
 - Compare and contrast structure and function relationships as they relate to patterns.
 - Assess patterns in nature using mathematical formulas.
- D. Analyze scale as a way of relating concepts and ideas to one another by some measure.
- Compare and contrast various forms of dimensional analysis.
 - Assess the use of several units of measurement to the same problem.
 - Analyze and apply appropriate measurement scales when collecting data.
- E. Evaluate change in nature, physical systems and man made systems.
- Evaluate fundamental science and technology concepts and their development over time (e.g., DNA, cellular respiration, unified field theory, energy measurement, automation, miniaturization, Copernican and Ptolemaic universe theories).
 - Analyze how models, systems and technologies have changed over time (e.g., germ theory, theory of evolution, solar system, cause of fire).
 - Explain how correlation of variables does not necessarily imply causation.
 - Evaluate the patterns of change within a technology (e.g., changes in engineering in the automotive industry).

3.2. Inquiry and Design

3.2.12. Grade 12

... every student ... acquire the knowledge and skills needed to:

- A. Evaluate the nature of scientific and technological knowledge.
- Know and use the ongoing scientific processes to continually improve and better understand how things work.
 - Critically evaluate the status of existing theories (e.g., germ theory of disease, wave theory of light, classification of subatomic particles, theory of evolution, epidemiology of aids).
- B. Evaluate experimental information for appropriateness and adherence to relevant science processes.
- Evaluate experimental data correctly within experimental limits.
 - Judge that conclusions are consistent and logical with experimental conditions.
 - Interpret results of experimental research to predict new information or improve a solution.
- C. Apply the elements of scientific inquiry to solve multi-step problems.
- Generate questions about objects, organisms and/or events that can be answered through scientific investigations.

- Evaluate the appropriateness of questions.
 - Design an investigation with adequate control and limited variables to investigate a question.
 - Organize experimental information using analytic and descriptive techniques.
 - Evaluate the significance of experimental information in answering the question.
 - Project additional questions from a research study that could be studied.
- D. Analyze and use the technological design process to solve problems.
- Assess all aspects of the problem, prioritize the necessary information and formulate questions that must be answered.
 - Propose, develop and appraise the best solution and develop alternative solutions.
 - Implement and assess the solution.
 - Evaluate and assess the solution, redesign and improve as necessary.
 - Communicate and assess the process and evaluate and present the impacts of the solution.

3.3. Biological Sciences

3.3.12. Grade 12

... every student ... acquire the knowledge and skills needed to:

- A. Explain the relationship between structure and function at all levels of organization.
- Identify and explain interactions among organisms (e.g., mutually beneficial, harmful relationships).
 - Explain and analyze the relationship between structure and function at the molecular, cellular and organ-system level.
 - Describe and explain structural and functional relationships in each of the five (or six) kingdoms.
 - Explain significant biological diversity found in each of the biomes.
- B. Analyze the chemical and structural basis of living organisms.
- Identify and describe factors affecting metabolic function (e.g., temperature, acidity, hormones).
 - Evaluate metabolic activities using experimental knowledge of enzymes.
 - Evaluate relationships between structure and functions of different anatomical parts given their structure.
 - Describe potential impact of genome research on the biochemistry and physiology of life.
- C. Explain gene inheritance and expression at the molecular level.
- Analyze gene expression at the molecular level.
 - Describe the roles of nucleic acids in cellular reproduction and protein synthesis.
 - Describe genetic engineering techniques, applications and impacts.
 - Explain birth defects from the standpoint of embryological development and/or changes in genetic makeup.
- D. Analyze the theory of evolution.
- Examine human history by describing the progression from early hominids to modern humans.
 - apply the concept of natural selection as a central concept in illustrating evolution theory.

3.4. Physical Science, Chemistry and Physics

3.4.12. Grade 12

... every student ... acquire the knowledge and skills needed to:

- A. Apply concepts about the structure and properties of matter.
- Apply rules of systematic nomenclature and formula writing to chemical substances.
 - Classify and describe, in equation form, types of chemical and nuclear reactions.
 - Explain how radioactive isotopes that are subject to decay can be used to estimate the age of materials.
 - Explain how the forces that bind solids, liquids and gases affect their properties.
 - Characterize and identify important classes of compounds (e.g., acids, bases, salts).
 - Apply the conservation of energy concept to fields as diverse as mechanics, nuclear particles and studies of the origin of the universe.

- Apply the predictability of nuclear decay to estimate the age of materials that contain radioactive isotopes.
 - Quantify the properties of matter (e.g., density, solubility coefficients) by applying mathematical formulas.
- B. Apply and analyze energy sources and conversions and their relationship to heat and temperature.
- Determine the heat involved in illustrative chemical reactions.
 - Evaluate mathematical formulas that calculate the efficiency of specific chemical and mechanical systems.
 - Use knowledge of oxidation and reduction to balance complex reactions
 - Apply appropriate thermodynamic concepts (e.g., conservation, entropy) to solve problems relating to energy and heat.
- C. Apply the principles of motion and force.
- Evaluate wave properties of frequency, wavelength and speed as applied to sound and light through different media.
 - Propose and produce modifications to specific mechanical power systems that will improve their efficiency.
 - Analyze the principles of translational motion, velocity and acceleration as they relate to free fall and projectile motion.
 - Analyze the principles of rotational motion to solve problems relating to angular momentum, and torque.
 - Interpret a model that illustrates circular motion and acceleration.
 - Describe inertia, motion, equilibrium, and action/reaction concepts through words, models and mathematical symbols.
- D. Analyze the essential ideas about the composition and structure of the universe.
- Analyze the Big Bang Theory's use of gravitation and nuclear reaction to explain a possible origin of the universe.
 - Compare the use of visual, radio and x-ray telescopes to collect data regarding the structure and evolution of the universe.
 - Correlate the use of the special theory of relativity and the life of a star.

3.5. Earth Sciences

3.5.12. Grade 12

. . . every student . . . acquire the knowledge and skills needed to:

- A. Analyze and evaluate earth features and processes that change the earth.
- Apply knowledge of geophysical processes to explain the formation and degradation of earth structures (e.g., mineral deposition, cave formations, soil composition).
 - Interpret geological evidence supporting evolution.
 - Apply knowledge of radioactive decay to assess the age of various earth features and objects.
- B. Analyze the availability, location and extraction of earth resources.
- Describe how the location of earth's major resources has affected a country's strategic decisions.
 - Compare locations of earth features and country boundaries.
 - Analyze the impact of resources (e.g., coal deposits, rivers) on the life of Pennsylvania's settlements and cities.
- C. Analyze atmospheric energy transfers.
- Describe how weather and climate involve the transfer of energy in and out of the atmosphere.
 - Explain how unequal heating of the air, ocean and land produces wind and ocean currents.
 - Analyze the energy transformations that occur during the greenhouse effect and predict the long-term effects of increased pollutant levels in the atmosphere.
 - Analyze the mechanisms that drive a weather phenomena (e.g., El Niño, hurricane, tornado) using the correlation of three methods of heat energy transfer.
- D. Analyze the principles and history of hydrology.
- Analyze the operation and effectiveness of a water purification and desalination system.
 - Evaluate the pros and cons of surface water appropriation for commercial and electrical use.
 - Analyze the historical development of water use in Pennsylvania (e.g., recovery of Lake Erie).
 - Compare the marine life and type of water found in the intertidal, neritic and bathyal zones.

3.6. Technology Education

3.6.12. Grade 12

. . . every student . . . acquire the knowledge and skills needed to:

- A. Analyze biotechnologies that relate to propagating, growing, maintaining, adapting, treating and converting.
- Analyze and solve a complex production process problem using biotechnologies (e.g., hydroponics, fish farming, crop propagation).
 - Analyze specific examples where engineering has impacted society in protection, personal health application or physical enhancement.
 - Appraise and evaluate the cause and effect and subsequent environmental, economic and societal impacts that result from biomass and biochemical conversion.
 - Evaluate and apply biotechnical processes to complex plant and animal production methods.
 - Apply knowledge of biochemical-related technologies to propose alternatives to hazardous waste treatment.
 - apply knowledge of agricultural science to solve or improve a biochemical related problem.
- B. Analyze knowledge of information technologies of processes encoding, transmitting, receiving, storing, retrieving and decoding.
- Apply and analyze advanced information techniques to produce a complex image that effectively conveys a message (e.g., desktop publishing, audio and/or video production).
 - Analyze and evaluate a message designed and produced using still, motion and animated communication techniques.
 - Describe the operation of fiber optic, microwave and satellite informational systems.
 - Apply various graphic and electronic information techniques to solve real world problems (e.g., data organization and analysis, forecasting, interpolation).
- C. Analyze physical technologies of structural design, analysis and engineering, personnel relations, financial affairs, structural production, marketing, research and design to real world problems.
- Apply knowledge of construction technology by designing, planning and applying all the necessary resources to successfully solve a construction problem.
 - Compare resource options in solving a specific manufacturing problem.
 - Analyze and apply complex skills needed to process materials in complex manufacturing enterprises.
 - Apply advanced information collection and communication techniques to successfully convey solutions to specific construction problems.
 - Assess the importance of capital on specific construction applications.
 - Analyze the positive and negative qualities of several different types of materials as they would relate to specific construction applications.
 - Analyze transportation technologies of propelling, structuring, suspending, guiding, controlling and supporting.
 - Analyze the concepts of vehicular propulsion, guidance, control, suspension and structural systems while designing and producing specific complex transportation systems.

3.7. Technological Devices

3.7.12. Grade 12

. . . every student . . . acquire the knowledge and skills needed to:

- A. Apply advanced tools, materials and techniques to answer complex questions.
- Demonstrate the safe use of complex tools and machines within their specifications.
 - Select and safely apply appropriate tools, materials and processes necessary to solve complex problems that could result in more than one solution.
 - Evaluate and use technological resources to solve complex multistep problems.
- B. Evaluate appropriate instruments and apparatus to accurately measure materials and processes.
- Apply and evaluate the use of appropriate instruments to accurately measure scientific and technologic phenomena within the error limits of the equipment.
 - Evaluate the appropriate use of different measurement scales (macro and micro).

- Evaluate the utility and advantages of a variety of absolute and relative measurement scales for their appropriate application.
- C. Evaluate computer operations and concepts as to their effectiveness to solve specific problems.
- Describe and demonstrate atypical software installation.
 - Analyze and solve hardware and advanced software problems.
 - Assess and apply multiple input and output devices to solve specific problems.
- D. Evaluate the effectiveness of computer software to solve specific problems.
- Evaluate the effectiveness of software to produce an output and demonstrate the process.
 - Design and apply advanced multimedia techniques.
 - Analyze, select and apply the appropriate software to solve complex problems.
 - Evaluate the effectiveness of the computer as a presentation tool.
 - Analyze the legal responsibilities of computer users.
- E. Assess the effectiveness of computer communications systems.
- Assess the effectiveness of a computer based communications system.
 - Transfer files among different computer platforms.
 - Analyze the effectiveness of online information resources to meet the needs for collaboration, research, publications, communications and productivity.
 - Apply knowledge of protocol standards to solve connectivity problems.

3.8. Science, Technology and Human Endeavors

3.8.12. Grade 12

... every student ... acquire the knowledge and skills needed to:

- A. Synthesize and evaluate the interactions and constraints of science and technology on society.
- Compare and contrast how scientific and technological knowledge is both shared and protected.
 - Evaluate technological developments that have changed the way humans do work and discuss their impacts (e.g., genetically engineered crops).
 - Evaluate socially proposed limitations of scientific research and technological application.
- B. Apply the use of ingenuity and technological resources to solve specific societal needs and improve the quality of life.
- Apply appropriate tools, materials and processes to solve complex problems.
 - Use knowledge of human abilities to design or modify technologies that extend and enhance human abilities.
 - Apply appropriate tools, materials and processes to physical, informational or biotechnological systems to identify and recommend solutions to international problems.
 - apply knowledge of agricultural science to develop a solution that will improve on a human need or want.
- C. Evaluate the consequences and impacts of scientific and technological solutions.
- Propose solutions to specific scientific and technological applications, identifying possible financial considerations.
 - Analyze scientific and technological solutions through the use of risk/benefit analysis.
 - Analyze and communicate the positive or negative impacts that a recent technological invention had on society.
 - Evaluate and describe potential impacts from emerging technologies and the consequences of not keeping abreast of technological advancements (e.g., assessment alternatives, risks, benefits, costs, economic impacts, constraints).

Section C: **ACT's College Readiness Standards Included in Pennsylvania's Grades 7–12 Academic Standards**

Using thousands of student records and responses, content and measurement experts worked backwards to develop data-driven, empirically derived statements of what students know and are typically able to do in various score ranges on the English, Reading, Writing, Mathematics, and Science tests on the EXPLORE, PLAN, and ACT tests. These empirically derived score descriptors are called **ACT's College Readiness Standards**. Because of this unique way the ACT Standards were derived, ACT's Standards contain specific descriptions of proficiency and content including descriptions of the complexity of the test material. The ACT standards prove to be an effective way to communicate the skills and knowledge measured by our EXPLORE, PLAN, and ACT tests.

In this section (Section C), the ACT Standards that are highlighted are those that are included in Pennsylvania's Academic Standards. ACT Standards not highlighted are those statements that include specific content, complexity and/or proficiency level descriptions that were not described in Pennsylvania's Academic Standards.

Because Pennsylvania educators are the experts on the Pennsylvania Academic Standards, we would strongly encourage them to examine this document and offer their interpretations.



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., <i>then, this time</i>)	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., <i>first, afterward, in response</i>) 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., <i>therefore, however, in addition</i>) 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	<p>Use conjunctions or punctuation to join simple clauses</p> <p>Revise shifts in verb tense between simple clauses in a sentence or between simple adjoining sentences</p>	<p>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</p>	<p>Delete commas that create basic sense problems (e.g., between verb and direct object)</p>
16–19	<p>Determine the need for punctuation and conjunctions to avoid awkward-sounding sentence fragments and fused sentences</p> <p>Decide the appropriate verb tense and voice by considering the meaning of the entire sentence</p>	<p>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</p> <p>Recognize and use the appropriate word in frequently confused pairs such as <i>there</i> and <i>their</i>, <i>past</i> and <i>passed</i>, and <i>led</i> and <i>lead</i></p>	<p>Provide appropriate punctuation in straightforward situations (e.g., items in a series)</p> <p>Delete commas that disturb the sentence flow (e.g., between modifier and modified element)</p>
20–23	<p>Recognize and correct marked disturbances of sentence flow and structure (e.g., participial phrase fragments, missing or incorrect relative pronouns, dangling or misplaced modifiers)</p>	<p>Use idiomatically appropriate prepositions, especially in combination with verbs (e.g., <i>long for</i>, <i>appeal to</i>)</p> <p>Ensure that a verb agrees with its subject when there is some text between the two</p>	<p>Use commas to set off simple parenthetical phrases</p> <p>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)</p>
24–27	<p>Revise to avoid faulty placement of phrases and faulty coordination and subordination of clauses in sentences with subtle structural problems</p> <p>Maintain consistent verb tense and pronoun person on the basis of the preceding clause or sentence</p>	<p>Ensure that a pronoun agrees with its antecedent when the two occur in separate clauses or sentences</p> <p>Identify the correct past and past participle forms of irregular and infrequently used verbs and form present-perfect verbs by using <i>have</i> rather than <i>of</i></p>	<p>Use punctuation to set off complex parenthetical phrases</p> <p>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 <i>and</i>)</p> <p>Use apostrophes to indicate simple possessive nouns</p> <p>Recognize inappropriate uses of colons and semicolons</p>
28–32	<p>Use sentence-combining techniques, effectively avoiding problematic comma splices, run-on sentences, and sentence fragments, especially in sentences containing compound subjects or verbs</p> <p>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</p>	<p>Correctly use reflexive pronouns, the possessive pronouns <i>its</i> and <i>your</i>, and the relative pronouns <i>who</i> and <i>whom</i></p> <p>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)</p>	<p>Use commas to set off a nonessential/nonrestrictive appositive or clause</p> <p>Deal with multiple punctuation problems (e.g., compound sentences containing unnecessary commas and phrases that may or may not be parenthetical)</p> <p>Use an apostrophe to show possession, especially with irregular plural nouns</p> <p>Use a semicolon to indicate a relationship between closely related independent clauses</p>
33–36	<p>Work comfortably with long sentences and complex clausal relationships within sentences, avoiding weak conjunctions between independent clauses and maintaining parallel structure between clauses</p>	<p>Provide idiomatically and contextually appropriate prepositions following verbs in situations involving sophisticated language or ideas</p> <p>Ensure that a verb agrees with its subject when a phrase or clause between the two suggests a different number for the verb</p>	<p>Use a colon to introduce an example or an elaboration</p>

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	<p>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</p> <p>Show limited recognition of the complexity of the issue in the prompt</p>	<p>Maintain a focus on the general topic in the prompt through most of the essay</p>	<p>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</p> <p>Show little or no movement between general and specific ideas and examples</p>
5–6	<p>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</p> <p>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</p>	<p>Maintain a focus on the general topic in the prompt throughout the essay</p>	<p>Offer limited development of ideas using a few general examples; resort sometimes to merely repeating ideas</p> <p>Show little movement between general and specific ideas and examples</p>
7–8	<p>Show understanding of the persuasive purpose of the task by taking a position on the issue in the prompt</p> <p>Show some recognition of the complexity of the issue in the prompt by</p> <ul style="list-style-type: none"> acknowledging counterarguments to the writer's position providing some response to counterarguments to the writer's position 	<p>Maintain a focus on the general topic in the prompt throughout the essay and attempt a focus on the specific issue in the prompt</p> <p>Present a thesis that establishes focus on the topic</p>	<p>Develop ideas by using some specific reasons, details, and examples</p> <p>Show some movement between general and specific ideas and examples</p>
9–10	<p>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</p> <p>Show recognition of the complexity of the issue in the prompt by</p> <ul style="list-style-type: none"> partially evaluating implications and/or complications of the issue, and/or posing and partially responding to counterarguments to the writer's position 	<p>Maintain a focus on discussion of the specific topic and issue in the prompt throughout the essay</p> <p>Present a thesis that establishes a focus on the writer's position on the issue</p>	<p>Develop most ideas fully, using some specific and relevant reasons, details, and examples</p> <p>Show clear movement between general and specific ideas and examples</p>
11–12	<p>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</p> <p>Show understanding of the complexity of the issue in the prompt by</p> <ul style="list-style-type: none"> examining different perspectives, and/or evaluating implications or complications of the issue, and/or posing and fully discussing counterarguments to the writer's position 	<p>Maintain a clear focus on discussion of the specific topic and issue in the prompt throughout the essay</p> <p>Present a critical thesis that clearly establishes the focus on the writer's position on the issue</p>	<p>Develop several ideas fully, using specific and relevant reasons, details, and examples</p> <p>Show effective movement between general and specific ideas and examples</p>

Table C-3. ACT's College Readiness Standards — Writing (continued)

	Organizing Ideas	Using Language
3–4	<p>Provide a discernible organization with some logical grouping of ideas in parts of the essay</p> <p>Use a few simple and obvious transitions</p> <p>Present a discernible, though minimally developed, introduction and conclusion</p>	<p>Show limited control of language by</p> <ul style="list-style-type: none"> 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	<p>Provide a simple organization with logical grouping of ideas in parts of the essay</p> <p>Use some simple and obvious transitional words, though they may at times be inappropriate or misleading</p> <p>Present a discernible, though underdeveloped, introduction and conclusion</p>	<p>Show a basic control of language by</p> <ul style="list-style-type: none"> 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	<p>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</p> <p>Use some simple and obvious, but appropriate, transitional words and phrases</p> <p>Present a discernible introduction and conclusion with a little development</p>	<p>Show adequate use of language to communicate by</p> <ul style="list-style-type: none"> 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	<p>Provide unity and coherence throughout the essay, sometimes with a logical progression of ideas</p> <p>Use relevant, though at times simple and obvious, transitional words and phrases to convey logical relationships between ideas</p> <p>Present a somewhat developed introduction and conclusion</p>	<p>Show competent use of language to communicate ideas by</p> <ul style="list-style-type: none"> 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	<p>Provide unity and coherence throughout the essay, often with a logical progression of ideas</p> <p>Use relevant transitional words, phrases, and sentences to convey logical relationships between ideas</p> <p>Present a well-developed introduction and conclusion</p>	<p>Show effective use of language to clearly communicate ideas by</p> <ul style="list-style-type: none"> 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	<p>Perform one-operation computation with whole numbers and decimals</p> <p>Solve problems in one or two steps using whole numbers</p> <p>Perform common conversions (e.g., inches to feet or hours to minutes)</p>	<p>Calculate the average of a list of positive whole numbers</p> <p>Perform a single computation using information from a table or chart</p>	<p>Recognize equivalent fractions and fractions in lowest terms</p>	<p>Exhibit knowledge of basic expressions (e.g., identify an expression for a total as $b + g$)</p> <p>Solve equations in the form $x + a = b$, where a and b are whole numbers or decimals</p>
16–19	<p>Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent</p> <p>Solve some routine two-step arithmetic problems</p>	<p>Calculate the average of a list of numbers</p> <p>Calculate the average, given the number of data values and the sum of the data values</p> <p>Read tables and graphs</p> <p>Perform computations on data from tables and graphs</p> <p>Use the relationship between the probability of an event and the probability of its complement</p>	<p>Recognize one-digit factors of a number</p> <p>Identify a digit's place value</p>	<p>Substitute whole numbers for unknown quantities to evaluate expressions</p> <p>Solve one-step equations having integer or decimal answers</p> <p>Combine like terms (e.g., $2x + 5x$)</p>
20–23	<p>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</p>	<p>Calculate the missing data value, given the average and all data values but one</p> <p>Translate from one representation of data to another (e.g., a bar graph to a circle graph)</p> <p>Determine the probability of a simple event</p> <p>Exhibit knowledge of simple counting techniques</p>	<p>Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor</p>	<p>Evaluate algebraic expressions by substituting integers for unknown quantities</p> <p>Add and subtract simple algebraic expressions</p> <p>Solve routine first-degree equations</p> <p>Perform straightforward word-to-symbol translations</p> <p>Multiply two binomials</p>
24–27	<p>Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour)</p>	<p>Calculate the average, given the frequency counts of all the data values</p> <p>Manipulate data from tables and graphs</p> <p>Compute straightforward probabilities for common situations</p> <p>Use Venn diagrams in counting</p>	<p>Find and use the least common multiple</p> <p>Order fractions</p> <p>Work with numerical factors</p> <p>Work with scientific notation</p> <p>Work with squares and square roots of numbers</p> <p>Work problems involving positive integer exponents</p> <p>Work with cubes and cube roots of numbers</p> <p>Determine when an expression is undefined</p> <p>Exhibit some knowledge of the complex numbers</p>	<p>Solve real-world problems using first-degree equations</p> <p>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)</p> <p>Identify solutions to simple quadratic equations</p> <p>Add, subtract, and multiply polynomials</p> <p>Factor simple quadratics (e.g., the difference of squares and perfect square trinomials)</p> <p>Solve first-degree inequalities that do not require reversing the inequality sign</p>
28–32	<p>Solve word problems containing several rates, proportions, or percentages</p>	<p>Calculate or use a weighted average</p> <p>Interpret and use information from figures, tables, and graphs</p> <p>Apply counting techniques</p> <p>Compute a probability when the event and/or sample space are not given or obvious</p>	<p>Apply number properties involving prime factorization</p> <p>Apply number properties involving even/odd numbers and factors/multiples</p> <p>Apply number properties involving positive/negative numbers</p> <p>Apply rules of exponents</p> <p>Multiply two complex numbers</p>	<p>Manipulate expressions and equations</p> <p>Write expressions, equations, and inequalities for common algebra settings</p> <p>Solve linear inequalities that require reversing the inequality sign</p> <p>Solve absolute value equations</p> <p>Solve quadratic equations</p> <p>Find solutions to systems of linear equations</p>
33–36	<p>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)</p>	<p>Distinguish between mean, median, and mode for a list of numbers</p> <p>Analyze and draw conclusions based on information from figures, tables, and graphs</p> <p>Exhibit knowledge of conditional and joint probability</p>	<p>Draw conclusions based on number concepts, algebraic properties, and/or relationships between expressions and numbers</p> <p>Exhibit knowledge of logarithms and geometric sequences</p> <p>Apply properties of complex numbers</p>	<p>Write expressions that require planning and/or manipulating to accurately model a situation</p> <p>Write equations and inequalities that require planning, manipulating, and/or solving</p> <p>Solve simple absolute value inequalities</p>

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