

Instructor's Guide: Linking Pennsylvania Core Standards to Career and Technical Education Programs of Study

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Introduction

Pennsylvania Core Standards in reading, writing, mathematics, and technical careers were developed as a result of national and state initiatives to help teachers prepare American school students to compete internationally in a global economy. Educational leaders who developed the standards accomplished this by identifying the most vital academic and job skills that students must learn in high school to meet the expectations of colleges, postsecondary technical schools and the 21st century workplace. These educators are confident that students who achieve the Pennsylvania Core Standards will have the best chance for success when they embark upon a college career or when they compete for careers in business or industry where high-tech skills, personal discipline, and a positive work ethic are required for success and advancement.

Nearly every state in the nation, including Pennsylvania, has adopted Pennsylvania Core Standards (PCS) for their schools. As increased attention is being focused on the standards, the question most often asked by teachers of career and technical education is, "How do I identify Pennsylvania Core Standards (for college and career readiness), and link them to my approved Program of Study?" Information in this Instructor's Guide has been compiled to provide teachers with a procedure they may want to follow to answer this question.

References for Pennsylvania Core Standards in reading, writing and math

Procedures that teachers may follow to link Pennsylvania Core Standards in reading, writing and math to programs of study in career and technical education are based on references available online on the Pennsylvania Department of Education's (PDE) Standards Aligned System (SAS) website at www.pdesas.org. To access the references, click on the word, Standards, on the SAS homepage. After that, click on Pennsylvania Core Standards.

NOTE: For references 1, 2, and 3 listed below, search under the heading, "Pennsylvania Core Standards (Draft Versions)." To find references, 4, 5, and 6, search under the heading, "Mathematics Assessment Anchors and Eligible Content (Draft Versions)."

Reference # 1 - Pennsylvania Core Standards- Reading for Science and Technical Subjects 6-12 (Draft)

Reference # 2 - Pennsylvania Core Standards - Writing in Science and Technical Subjects 6-12 (Draft)

Reference # 3 - Pennsylvania Core Standards - Mathematics PreK-12 (Draft)

Reference # 4 - Algebra I Assessment Anchors and Eligible Content for Algebra I

Reference # 5 - Algebra II Assessment Anchors and Eligible Content for Algebra II

Reference # 6 - Geometry Assessment Anchors and Eligible Content

Please note that abridged versions of these six references (showing Pennsylvania Core Standards for high school students only) have been included in this Instructor's Guide and are located in the Appendix. Teachers who want complete versions of the Pennsylvania Core Standards for all grades, kindergarten through grade 12, can download full versions of the standards at: www.pdesas.org/Standard/CommonCore.

Reference #7 – Career and Technical Education (CTE) Program of Study (POS) Task Grid

Teachers of career and technical education programs must locate a Program of Study Task Grid for their area of specialization. Task Grids are available on PDE's website, at: www.education.state.pa.us, keyword Programs of Study.

NOTE: The occupation of Welding Technology/Welder, will be used as an example of a Program of Study, throughout this Instructor's Guide to illustrate how to link units of instruction to Pennsylvania Core Standards. For this reason, a portion of PDE's Approved Task Grid for Welding (a Phase 1 Career and Technical Education program) is shown in Figure 1 below. The task grid for an individual's approved Program of Study will be similar to this one, but with different tasks.

FIGURE 1
A portion of PDE's Approved Task Grid for "Welding Technology/Welder"
 (Approved Task Grids may be found at www.education.state.pa.us under the descriptor, Programs of Study).

Unit/ Standard Number	 High School Graduation Years 2013, 2014 and 2015	Proficiency Level Achieved: (X) Indicates Competency Achieved to Industry Proficiency Level
	Welding Technology/Welder CIP 48.0508 Task Grid	
	Secondary Competency Task List	
100	OCCUPATIONAL ORIENTATION AND SAFETY	
101	Prepare and mark time or job sheet, reports or records.	
102	Perform housekeeping duties daily.	
103	Follow verbal instructions to complete work assignments and rules.	
104	Follow written instructions to complete work assignments and rules.	
105	Demonstrate proper use and inspection of Personal Protection Equipment (PPE).	
106	Demonstrate proper work area operation.	
107	Demonstrate proper use of ventilation equipment.	
108	Discuss proper Hot Zone operation.	
109	Understand proper work actions for working in confined spaces.	
110	Understand MSDS sheets and precautionary labeling.	
111	Demonstrate proper use and inspection of equipment used for each required welding and thermal cutting process.	
112	Display familiarity with industrial and OSHA safety standards.	
113	Demonstrate knowledge of oxyfuel safety procedures.	
114	Demonstrate knowledge of arc welding safety procedures.	
115	Demonstrate emergency action plan (all inclusive).	

Reference #8: Common Career Technical Core Practices and Standards

The second Career and Technical Education reference that is available online is entitled, "Common Career Technical Core Practices and Standards." Please note that an abridged version of this document has been included in the Appendix of this Instructor’s Guide, but the full version of the Practices and Standards may be found on the website of the National Association of State Directors of Career Technical Education Consortium (NASDCTEC), at www.careertech.org. Log on to this site, and at the first screen a blue rectangle display, "Learn More about CCTC Common Career Technical Core." Click on this blue rectangle. When the next screen opens, scroll down to the words, "Download the CCTC here." Click on this phrase, which links to a 21 page document containing the Common Career Technical Core Practices and Standards. This document contains all the reference materials necessary to begin the process of linking Pennsylvania Core Standards (as well as anchors for reading, writing and math) to units of instruction in any Program of Study. The process may be completed in five steps, which follow.

Step 1 – Create a Crosswalk Chart

Creating a crosswalk chart is the first step in linking units of instruction to the Pennsylvania Core standards and anchors. This chart will serve as a graphic organizer and it will hold all the standards and anchors for reading, writing, math, etc., for a specified occupation. As the chart is developed, it will become apparent that it is a good visual aid that quickly and efficiently demonstrates linked standards to occupational skills in a specified Program of Study.

Drawing the crosswalk chart and entering tasks

Use Word, Excel or a similar computer program to create a six-column chart. Title the chart, “POS Task Grid for (name of the CTE program) Linked to Pennsylvania Core Standards” (See Figure 2 on page 6). After these headings have been created for the chart, add enough rows to accommodate all of the units of instruction and tasks that are on the Task Grid, downloaded from PDE’s website. Next, copy the units of instruction and tasks from the Program of Study Task Grid and paste them into the left column of the Crosswalk Chart under the heading, “Units of Instruction and Secondary Competency/Task List.”

Merging cells in the crosswalk chart

It is advantageous to merge the cells in each of the columns under the headings, “Common Career Technical Core Standards,” “Reading in Science & Technology Subjects,” “Writing in Science & Technology Subjects,” and “High School Mathematics.” Merging cells in each of the columns will provide the space needed in each column for typing Pennsylvania Core Standards, anchors, and career information, which will be linked to the units of instruction. Figure 2 below shows a sample of the format of a Crosswalk Chart that was developed for the sample occupation in "Welding Technology." Instructions for building the chart are repeated in yellow block arrows on the chart. Do not include these block arrows when building a chart.

FIGURE 2
Sample of a crosswalk chart with title and column headings
to illustrate an example for the occupation of Welding Technology/Welder

POS Task Grid for  Title of the CTE Program		Linked To Pennsylvania Core Standards			
Units & Task #	Units of Instruction and Secondary Competency / Task List	Common Career Technical Core Standards	PCS for reading in science and technology subjects	PCS for writing in science and technology subjects	PCS in high school mathematics
100	UNIT: OCCUPATIONAL ORIENTATION AND SAFETY				
101	Prepare and mark time or job sheet, reports or records.				
102	Perform housekeeping duties daily.				
103	Follow verbal instructions to complete work assignments and rules.				
104	Follow written instructions to complete work assignments and rules.				
105	Demonstrate proper use and inspection of Personal Protection Equipment (PPE).				
106	Demonstrate proper work area operation.				

Use Word or Excel to create a chart with the title and 6 headings shown above.

- Add all the rows needed to enter the units of instruction and tasks from your POS Task Grid from the PDE website.
- Paste units and competencies from the PDE task grid into rows on the chart under the heading, “Units of Instruction and Secondary Competency/Task List.”

Merge cells in each of these 4 columns to provide space for entering information on standards and anchors, relative to the POS.

Step 2 – Link Common Career and Technical Core Standards to Units of Instruction

What are Common Career Technical Core Standards

The National Association of State Directors of Career Technical Education has recently established a set of standards for the CTE community. Association members named the standards, Common Career Technical Core Standards, or CCTCS. The standards were created as the result of a national, state-led initiative. Forty-two of the participants from across the United States and the District of Columbia participated in the writing of the Technical Core Standards. Representatives from business and industry helped educators and other stakeholders guide the development of the CCTCS from beginning to end to ensure that graduates of CTE programs will have the knowledge, skills, and attitudes they must have in order to thrive in a global economy. For the first time, therefore, in the history of Career and Technical Education, states all across the nation have a list of common benchmarks (or standards) that educators may follow when they need to describe the behaviors that students should be able to exhibit after successfully completing any programs of study in Career and Technical Education.

The Common Career Technical Core Standards are arranged in 16 categories of occupations called Career Clusters.TM Each Cluster contains several related and corresponding Career Pathways. Every Pathway has a list of standards, which are the knowledge, skills and attitudes that students should be able to demonstrate after successfully completing instruction in that Pathway and Cluster. Instruction, of course, is delivered by way of a Program of Study at a Career and Technical Education Center or vocational school. For your convenience, the 16 Career Clusters with corresponding Career Pathways and their Standards are listed in the Appendix of this

Instructor's Guide. A portion of the information is shown below to demonstrate the manner in which the 16 Clusters, Career Pathways and Standards for each have been arranged. Note that Clusters 1 through 12 and Clusters 14, 15 and 16 with related Career Pathways and lists of Standards may be found in the Appendix of this instructor's guide.

CLUSTER 13: Manufacturing Career Cluster™ (MN)

Standards for this Cluster

1. Evaluate the nature and scope of the Manufacturing Career Cluster and the role of manufacturing in society and in the economy.
2. Analyze and summarize how manufacturing businesses improve performance.
3. Comply with federal, state and local regulations to ensure worker safety and health and environmental work practices.
4. Describe career opportunities and means to achieve those opportunities in each of the Manufacturing Career Pathways.
5. Describe government policies and industry standards that apply to manufacturing.
6. Demonstrate workplace knowledge and skills common to manufacturing.

Health, Safety, & Environmental Assurance Career Pathway (MN-HSE)

Standards for this Pathway

1. Demonstrate the safe use of manufacturing equipment.
2. Develop safety plans for production processes that meet health, safety and environmental standards.
3. Demonstrate a safety inspection process to assure a healthy and safe manufacturing environment.
4. Evaluate a system of health, safety and/or environmental programs, projects, policies or procedures to determine compliance.
5. Evaluate continuous improvement protocols and techniques in health, safety and/or environmental practices.
6. Conduct job safety and health analysis for manufacturing jobs, equipment and processes.
7. Develop the components of a training program based on environmental health and safety regulations.

Logistics & Inventory Control Career Pathway (MN-LOG)

Standards for this Pathway

1. Demonstrate positive customer service skills in regard to logistics and inventory control issues.
2. Demonstrate proper handling of products and materials in a manufacturing facility.
3. Develop a safety inspection process to assure a healthy and safe manufacturing facility.
4. Manage inventory using logistics and control processes and procedures.

Maintenance, Installation, & Repair Career Pathway (MN-MIR)

Standards for this Pathway

1. Demonstrate maintenance skills and proficient operation of equipment to maximize manufacturing performance.
2. Demonstrate the safe use of manufacturing equipment to ensure a safe and healthy environment.
3. Diagnose equipment problems and effectively repair manufacturing equipment.
4. Investigate and employ techniques to maximize manufacturing equipment performance.
5. Implement a preventative maintenance schedule to maintain manufacturing equipment, tools and workstations.
6. Implement an effective, predictive and preventive manufacturing equipment maintenance program.

Manufacturing Production Process Development Career Pathway (MN-PPD)

Standards for this Pathway

1. Produce quality products that meet manufacturing standards and exceed customer satisfaction.
2. Research, design and implement alternative manufacturing processes to manage production of new and/or improved products.
3. Monitor, promote and maintain a safe and productive workplace using techniques and solutions that ensure safe production of products.
4. Implement continuous improvement processes in order to maintain quality within manufacturing production.
5. Develop procedures to create products that meet customer needs.

Production Career Pathway (MN-PRO)

Standards for this Pathway

1. Diagnose production process problems and take corrective action to meet production quality standards.
2. Manage safe and healthy production working conditions and environmental risks.
3. Make continuous improvement recommendations based on results of production process audits and inspections.
4. Coordinate work teams when producing products to enhance production process and performance.
5. Demonstrate the safe use of manufacturing equipment.

For Clusters 1 through 12, Clusters 14, 15 and 16, and related Career Pathways, please refer to "Common Career Technical Core Standards," starting on page 1 in the Appendix.

How are the Common Career Core Technical Standards linked to Units of Instruction?

Begin the process of linking Common Career Technical Core Standards to Units of Instruction by reviewing the complete list of Clusters, Pathways and Standards listed in the Appendix. Documents may also be used which have been downloaded from the website of the National Association of State Directors of Career Technical Education Consortium. Find one cluster that contains the a specified occupation. Next, select one or more Career Pathways that students will be able to follow within that cluster after successfully completing an approved Program of Study. After selecting the appropriate Cluster and Pathway(s), enter their names on your Crosswalk Chart in the column to the right of your first "Unit of Instruction" in the column with the heading, "Common Career Technical Core Standards." An example of this is demonstrated by Figure 3 on page 9.

After the appropriate Cluster and Career Pathways have been selected, examine the standards listed for both Cluster and Pathway. Notice that each of the standards is numbered. The next task is to decide which of these standards will apply to each of the units of instruction that were pasted into your new Crosswalk Chart.

After deciding which of these standards apply to the tasks in each of the units of instruction in your program, go to your Crosswalk Chart and enter the numbers of the standards chosen for both Cluster and Pathway(s) beside each of the Units of Instruction, where appropriate. Common Career Technical Core Standards have now been linked to Units of Instruction.

An example of the procedure used for welding technology

Examine Figure 4 on page 10 to observe the correct linking of CCTCS to the Program of Study in Welding Technology. Figure 4 illustrates the procedure followed to link CCTC Standards to a Unit of Instruction entitled, Occupational Orientation and Safety. The Common Career Technical Core Standards were reviewed, and Cluster 13, or the Manufacturing Career Cluster, was selected to represent the welding occupation. By examining Cluster 13, as shown on page 7, the following six standards are evident:

1. Evaluate the nature and scope of the Manufacturing Career Cluster and the role of manufacturing in society and in the economy.
2. Analyze and summarize how manufacturing businesses improve performance.
3. Comply with federal, state and local regulations to ensure worker safety and health and environmental work practices.
4. Describe career opportunities and means to achieve those opportunities in each of the Manufacturing Career Pathways.
5. Describe government policies and industry standards that apply to manufacturing.
6. Demonstrate workplace knowledge and skills common to manufacturing.

The Pathway entitled, Manufacturing Production Process Development, was selected as one possible Career Pathway that students would be able to follow after successfully completing the welding program at the Career and Technology Center. The list of five standards for that Pathway are:

Standards for Manufacturing Production Process Development

1. Produce quality products that meet manufacturing standards and exceed customer satisfaction.
2. Research, design and implement alternative manufacturing processes to manage production of new and/or improved products.
3. Monitor, promote and maintain a safe and productive workplace using techniques and solutions that ensure safe production of products.
4. Implement continuous improvement processes in order to maintain quality
5. Develop procedures to create products that meet customer needs.

After reviewing the Standards for both Cluster and Pathway(s), and selecting those that would be addressed in the lesson plans in Unit 100, Occupational Orientation and Safety, the appropriate standard numbers were added to the Crosswalk Chart. Standards chosen to represent the Cluster were Standards 3 and 6.

Standards chosen to represent the Pathway, Manufacturing Production Process Development, were Standards 3, 4, and 5. Look at the green block arrows in Figure 4 on page 10. The arrows contain information that illustrates the process followed to link Cluster and Pathway standards to Unit 100, Occupational Orientation and Safety. This process would be repeated for all the remaining Units of Instruction, placing the Cluster, Pathway and Standards, where appropriate, for the Program of Study in Welding Technology.

It should be mentioned that, after exploring additional Clusters of occupations and additional Career Pathways, more career pathways and more workplace standards could be added to the Crosswalk Chart.

Individuals may need to make this decision, concerning the addition of Cluster and Career Pathways, as Crosswalk Charts for Programs of Study, in various areas of specialization, are developed.

Link the Common Career Technical Core Standards to Units of Instruction

Before continuing, it may be appropriate to practice linking Common Career Technical Core Standards from one Career Cluster and from one or more Career Pathways where they apply to the Units of Instruction on a Crosswalk Chart.

Figure 4 on page 10 illustrates how the Crosswalk Chart would look after Common Career Technical Core Standards were linked to Units 100 and 200 in the Program of Study. Please note that the chart will not include the text box of standards that is shown in the example in Figure 4. This was done in order to clarify chart construction.

FIGURE 3
Common Career Technical Core Standards, linked with units 100 and 200 in the sample Welding Technology Program

Welding Technology/Welder (C.I.P. 48.0508)					
POS Task Grid Linked To Pennsylvania Core Standards					
Unit & Task	Secondary Competency Task List High School Graduation (Years: 2013, 2014 and 2015)	Common Career Technical Core Standards	PCS for reading in science and technology subjects	PCS for writing in science and technology subjects	PCS in high school mathematics
100	OCCUPATIONAL ORIENTATION AND SAFETY	CLUSTER NAME: Manufacturing CAREER PATHWAY Manufacturing Production Process Development			
101	Prepare and mark time or job sheet, reports or records.				
102	Perform housekeeping duties daily.				
103	Follow verbal instructions to complete work assignments and rules.				
104	Follow written instructions to complete work assignments and rules.				
105	Demonstrate proper use and inspection of Personal Protection Equipment (PPE).				
106	Demonstrate proper work area operation.				
107	Demonstrate proper use of ventilation equipment.				
108	Discuss proper Hot Zone operation.				
109	Understand proper work actions for working in confined spaces.				
110	Understand MSDS sheets and precautionary labeling.				
111	Demonstrate proper use and inspection of equipment used for each required welding and thermal cutting process.				
112	Display familiarity with industrial and OSHA safety standards.				
113	Demonstrate knowledge of oxy-fuel safety procedures.				
114	Demonstrate knowledge of arc welding safety procedures.				
115	Demonstrate emergency action plan (all inclusive).				
200	PRINCIPLES OF WELDING	CLUSTER NAME: Manufacturing CAREER PATHWAY Manufacturing Production Process Development			
201	Identify major types of metals (ferrous and non-ferrous) used in welding.				
202	Describe the basic principles of heat				
203	Select appropriate welding technique				
204	Describe the industry accepted welding codes				
205	Identify various joint designs (joint geometry).				
206	Clean and prepare materials for welding and/or cutting.				

1. Enter the name of the Cluster selected on the chart.

2. Enter the name of the Career Pathway or Pathways in the unit of instruction.

4. Repeat the process described above for all of the units of instruction on the Task Grid.

FIGURE 4

Example of page 1 of a Crosswalk Chart for a Program of Study in Welding,
Common Technical Core Standards have been linked to units 100 and 200

Welding Technology/Welder (C.I.P. 48.0508) POS Task Grid Linked To Pennsylvania Core Standards					
Unit & Task #	Secondary Competency Task List High School Graduation (Years: 2013, 2014 and 2015)	Common Career Technical Core Standards	PCS for reading in science and technology subjects	PCS for writing in science and technology subjects	PCS in high school mathematics
100	OCCUPATIONAL ORIENTATION AND SAFETY	CLUSTER NAME: Manufacturing The cluster standards that are taught in this unit are 3 and 6, taken from the list shown in the box at left.			
101	Prepare and mark time or job				
STANDARDS FOR CLUSTER 13: MANUFACTURING 1. Evaluate the nature and scope of the Manufacturing Career Cluster and the role of manufacturing in society and in the economy. 2. Analyze and summarize how manufacturing businesses improve performance. 3. Comply with federal, state and local regulations to ensure worker safety and health and environmental work practices. 4. Describe career opportunities and means to achieve those opportunities in each of the Manufacturing Career Pathways. 5. Describe government policies and industry standards that apply to manufacturing. 6. Demonstrate workplace knowledge and skills common to manufacturing. STANDARDS FOR THE "MANUFACTURING PRODUCTION PROCESS DEVELOPMENT" PATHWAY 1. Produce quality products that meet manufacturing standards and exceed customer satisfaction. 2. Research, design and implement alternative manufacturing processes to manage production of new and/or improved products. 3. Monitor, promote and maintain a safe and productive workplace using techniques and solutions that ensure safe production of products. 4. Implement continuous improvement processes in order to maintain quality within manufacturing production. 5. Develop procedures to create products that meet customer needs.		CAREER PATHWAY: Manufacturing Production Process Development The pathway standards that are taught in this unit are 3,4, and 5, taken from the list shown in the box at left.			
	fuel safety procedures.				
114	Demonstrate knowledge of arc welding safety procedures.				
115	Demonstrate emergency action plan (all inclusive).				
200	PRINCIPLES OF WELDING	CLUSTER NAME: Manufacturing The cluster standards that are taught in this unit are 3 and 6. CAREER PATHWAY: Manufacturing Production Process Development The pathway standards that are taught in this unit are 3,4 and 5.			
201	Identify major types of metals (ferrous and non-ferrous) used in welding.				
202	Describe the basic principles of heat, expansion and contraction as it relates to metals.				

Next, add the numbers of CCTC Standards that are addressed by skills in the unit of instruction.

Next, add the numbers of CCTC Standards that are addressed by skills in the Pathway in this unit.

4. Repeat the process described above for all of the units of instruction on the Task Grid.

Remember that units of instruction may address different standards. It is also possible that some units may not address any standards.

Step 3 - Link Pennsylvania Core Standards for reading to Units of Instruction

Collaborate with Reading Specialists

Many teachers of CTE programs may discover that they are unfamiliar with reading as a subject area and as such, may think they do not have the knowledge needed to identify Pennsylvania Core Reading Standards or to know where such standards should be linked to skills in their technical program. If so, these teachers should ask if released time work sessions are available to them where they may collaborate with a reading specialist, or work in teams with their CTE colleagues, or a language arts teacher. Opportunities for collaboration and teamwork often help many CTE instructors quickly learn where the Pennsylvania Core Standards in reading might apply to various lessons and units of instruction in their Programs of Study. Teachers should talk to their school administrators to learn if this kind of assistance is available to them.

Step 3 outlines the procedure which needs to be followed to link the Pennsylvania Core Standards for reading in science and technical subjects to the units of instruction on the Crosswalk Chart. Before beginning, it may be helpful to see how the Reading Standards are structured. Pennsylvania Core Standard 3.5, for reading, addresses students' ability to read and comprehend informational text such as what they would find in a textbook, a machine operator's manual, or in other technical readings that they may see in any program or when they go to college or to work. Reading Standard 3.5 requires that "...students read, understand, and respond to informational text - with emphasis on comprehension, making connections among ideas and between texts, with focus on textual evidence." Students in grades 9 through 12, therefore, are required to read for the following four purposes:

- Purpose 1 - Key Ideas and Details (comprehend technical information)
- Purpose 2 - Craft and Structure (understand technical meanings of the material read)
- Purpose 3 - Integrate Knowledge and Ideas (grasp the meaning of technical information)
- Purpose 4 - Range of Reading and Complexity (demonstrate understanding of technical text to the appropriate grade level)

Reading Purpose 1. Key Ideas And Details

Please note that each of the four purposes listed above contains specific anchors that students must achieve, by grade level. Key ideas and details, for example, contains the following specific anchors for students in grades 9 and 10.

- Specific Anchor CC.3.5.9-10.A.: Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
- Specific Anchor CC.3.5.9-10.B.: Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
- Specific Anchor CC.3.5.9-10.C.: Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

In a similar fashion, key ideas and details for grades 11 and 12 also contain the following specific anchors. The anchors are similar to the anchors in grades 9 and 10, yet they have subtle differences, as shown in the language below.

- Specific Anchor CC.3.5.11-12.A.: Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- Specific Anchor CC.3.5.11-12.B.: Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
- Specific Anchor CC.3.5.11-12.C.: Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

Many teachers would agree that specific anchor "C" in key ideas and details for grades 9 through 12 could apply to almost everything that students will be asked to read in their educational program. In auto mechanics, for example,

this anchor would be vital for the safety of passengers in a vehicle when a student is reading instructions from a manufacturer's brake repair manual. An auto tech teacher, therefore, would want to link the anchor "C" in key ideas and details to all lessons in a Unit of Instruction on Passenger Vehicle Brake Systems. Many CTE programs of study contain tasks that ask students to follow instructions for various procedures and processes. Read on to see how key ideas and details were linked to Unit 100 in the Welding Technology Program of Study.

Linking Anchors in Key Ideas and Details to Units of Instruction in Welding Technology

After reviewing key ideas and details, it was necessary to decide where students would receive practice in this purpose for reading in Unit 100 of the Welding Technology program. The anchor seemed a logical link to the unit because specific anchor "C" described the kind of reading that students must do before attempting to carry out the complex multistep processes in most technical welding tasks.

The Crosswalk Chart in Figure 6 on page 15 illustrates how information for specific anchor "C" beneath the heading, PCS for Reading in Science and Technical Subjects. By examining the "blue" block arrows in Figure 6, it is apparent that they contain information which illustrates the process followed to link anchors in reading to Unit 100, Occupational Orientation and Safety. This process was repeated for Unit 200, Principles of Welding, and for the remaining units of instruction in the program, to decide which of the anchors for reading would apply to the tasks in each of the units.

Link the anchors for Key Ideas and Details in reading to Units of Instruction

Before continuing to learn more about the next purpose for student reading, and how to link it to units of instruction in a Program of Study, it may be appropriate to decide if a thorough comprehension has been attained, concerning the linking of specific anchors A, B, and C for grades 9 and 10 and; and, for grades 11 and 12 in key ideas and details, to any of the units of instruction on the Crosswalk Chart.

Reading Purpose 2 Craft and Structure

Now that anchors for key ideas and details have been added to the Crosswalk Chart, examine the second purpose, Craft and Structure, when students read and respond to informational text. Craft and Structure in reading of informational text relates to symbols, vocabulary words and other technical terms found in CTE textbooks, reference books and other resources. Craft and Structure is crucial when students attempt to learn various procedures in various CTE Programs of Study.

Craft and Structure contains the following current Pennsylvania Core Standards specific anchors for students to demonstrate in Grades 9 and 10.

- Specific Anchor CC.3.5.9-10.D.: Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context.
- Specific Anchor CC.3.5.9-10.E.: Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, or energy).
- Anchor CC.3.5.9-10.F.: Analyze the author's purpose by providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

Craft and Structure also contains the following current Pennsylvania Core Standards specific anchors for students in grades 11 and 12. The anchors are similar to the anchors in grades 9 and 10, yet they have subtle differences, as follows:

- Specific Anchor CC.3.5.11-12.D.: Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11 and 12 texts and topics.
- Specific Anchor CC.3.5.11-12.E.: Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
- Specific Anchor CC.3.5.11-12.F.: Analyze the author's purpose by providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.

Link the anchors for Craft and Structure in reading to Units of Instruction

Before continuing, examine Figure 6 on page 15. The specific anchor "D" was linked to Unit 100 because of the symbols students must learn in welding technology. After reviewing the chart in Figure 6 on page 15, determine the proper linkages for specific anchors D, E, and F for grades 9 and 10 and grades 11 and 12 in craft and structure to Units of Instruction.

Reading Purpose 3 Integrate Knowledge and Ideas

The third purpose students have for reading informational text is to integrate knowledge and ideas. This reading standard also has specific grade-level anchors. These anchors are designed to teach students to evaluate content presented in the media, both visually and in words; evaluate a writer's point of view in writing, including the reasoning, relevance and sufficiency of the evidence; and, analyze how two or more texts address similar themes or topics in order to build knowledge or to make comparisons.

Integrate Knowledge and Ideas contain the following specific anchors for students to demonstrate in grades 9 and 10.

- Specific Anchor CC.3.5.9-10.G.: Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
- Specific Anchor CC.3.5.9-10.H.: Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.
- Specific Anchor CC.3.5.9-10.I.: Compare and contrast findings presented in a text to those from other sources including their own experiments, noting when the findings support or contradict previous explanations or accounts.

Integrate Knowledge and Ideas contains the following specific anchors for students in grades 11 and 12.

- Specific Anchor CC.3.5.11-12.G.: Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
- Specific Anchor CC.3.5.11-12.H.: Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
- Specific Anchor CC.3.5.11-12.I.: Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

Link the anchors for Integrate Knowledge and Ideas in reading to Units of Instruction

Before continuing, consider whether anchors G, H and I for grades 9 and 10 and grades 11 and 12 concerning integrate knowledge and ideas might apply to Units of Instruction. Figure 6 on page 15 demonstrates that anchors to integrate knowledge and ideas were not included because none of these anchors apply to the tasks in Units 100 or 200 in the Welding Program of Study.

Reading Purpose 4 Range of Reading and Complexity

The fourth and final purpose students have for reading informational text in a CTE program is to attain skills in reading at a Range of Reading and Complexity that is equivalent to their grade in high school. Grade-level anchors for this purpose are stated as follows:

- Specific Anchor CC.3.5.9-10.J.: By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently.

- Specific Anchor CC.3.5.11-12.J.: By the end of grade 12, read and comprehend science/technical texts in the grades 11–12 text complexity band independently and proficiently.

Link the anchors for Range of Reading and Complexity in reading to Units of Instruction

Before continuing, attempt to link anchor J for grades 9 and 10 and grades 11 and 12 in Range of Reading and Complexity, where it applies to Units of Instruction.

An examination of Figure 6 on page 15 demonstrates that the anchor for Range of Reading and Complexity was included as a skill, which students would practice in both Units 100 and 200 because they must read and comprehend highly technical information at grade level. Students must demonstrate comprehension of technical information found in textbooks about welding techniques and procedures.

FIGURE 6
Common Career Technical Core and Pennsylvania Core Standards for Reading, linked with Units of Instruction in Welding

Welding Technology/Welder (C.I.P. 48.0508) POS Task Grid Linked To Pennsylvania Core Standards					
Unit & Task	Secondary Competency Task List High School Graduation (Years: 2013, 2014 and 2015)	Common Career Technical Core Standards	PCS for reading in science and technology subjects	PCS for writing in science and technology subjects	PCS in high school mathematics
100	OCCUPATIONAL ORIENTATION AND SAFETY	<p>CLUSTER NAME: Manufacturing The Cluster Standards that are taught in this unit are 3 and 6.</p> <p>CAREER PATHWAY Manufacturing Production Process Development The Pathway Standards that are taught in this unit are: 3, 4, and 5.</p>	<p>-Grades 9 and 10- Key Ideas and Details Anchor - C Craft and Structure Anchor- D Level of Complexity Anchor - J</p> <p>Grades -11 and 12- Key Ideas and Details Anchor - C Craft and Structure Anchor- D Level of Complexity Anchor - J</p>		
101	Prepare and mark time or job sheet, reports or records.				
102	Perform housekeeping duties daily.				
103	Follow verbal instructions to complete work assignments and rules.				
104	Follow written instructions to complete work assignments and rules.				
105	Demonstrate proper use and inspection of Personal Protection Equipment (PPE).				
106	Demonstrate proper work area operation.				
107	Demonstrate proper use of ventilation equipment.				
108	Discuss proper Hot Zone operation.				
109	Understand proper work actions for working in confined spaces.				
110	Understand MSDS sheets and precautionary labeling.				
111	Demonstrate proper use and inspection of equipment used for each required welding and thermal cutting process.				
112	Display familiarity with industrial and OSHA safety standards.				
113	Demonstrate knowledge of oxy-fuel safety procedures.				
114	Demonstrate knowledge of arc welding safety procedures.				
115	Demonstrate emergency action plan (all inclusive).				
200	PRINCIPLES OF WELDING	<p>CLUSTER NAME: Manufacturing The Cluster Standards that are taught in this unit are 3 and 6.</p> <p>CAREER PATHWAY Manufacturing Production Process Development The Pathway Standards that are taught in this unit are: 3, 4, and 5.</p>	<p>-Grades 9 and 10- Key Ideas and Details Anchor - C Craft and Structure Anchor- D Level of Complexity Anchor - J</p> <p>Grades -11 and 12- Key Ideas and Details Anchor - C Craft and Structure Anchor- D Level of Complexity Anchor - J</p>		
201	Identify major types of metals (ferrous and non-ferrous) used in welding.				
202	Describe the basic principles of heat				
203	Select appropriate welding technique				
204	Describe the industry accepted welding codes				
205	Identify various joint designs (joint geometry).				
206	Clean and prepare materials for welding and/or cutting.				

1. The letters of the anchors that are part of the PA Core Standards for Reading that apply to this Unit of Instruction for Grades 9 and 10, and Grades 11 and 12, have been added.

2. The process would be repeated for Unit 200 and for all the remaining Units of Instruction in Welding for grades 9 and 10, and grades 11 and 12.

Step 4 – Link Pennsylvania Core Standards for writing to Units of Instruction

Collaborate with writing specialists

Many teachers of CTE programs may find that they are unfamiliar with writing as a subject area and as such, may think they do not have the knowledge needed to identify Pennsylvania Core Reading Standards or to know where such standards should be linked to skills in their technical program. If so, these teachers should request time in which to collaborate with a reading/writing specialist, or work in teams with their CTE colleagues, or with a language arts teacher. Opportunities for collaboration and teamwork often help many CTE instructors quickly learn where the Pennsylvania Core Standards in writing might apply to various lessons and units of instruction in their Programs of Study. Teachers should talk to school administrators to learn if this assistance is available to them.

At this point, the Crosswalk Chart should reflect one or more links between the tasks in Units of Instruction and Standards for Technical Careers, and anchors for reading in science and technical subjects. The next set of standards and anchors that will be linked to units of instruction on the crosswalk chart are for writing for science and technical subjects.

The standards for writing maintain that high school students must be given opportunities to practice writing for different purposes and difference audiences. The standards also indicate that students should achieve the skills to write clear and focused text to convey a well-defined perspective and appropriate content. The Pennsylvania Core standards for writing contain four anchor areas.

- Anchor Area 1 - Text type and purposes
- Anchor Area 2 - Production and distribution of writing
- Anchor Area 3 - Research to build and present knowledge
- Anchor Area 4 - Range of writing

Once again, each of the four broad anchor areas listed above also contains specific anchors that students must achieve and demonstrate by grade levels 9 and 10; and, 11 and 12. Details of the specific anchors for each of the four anchor areas listed above will be explored.

Anchor Area 1 Text Type and Purposes

Text type and purposes, contains the following two specific anchors for students in grades 9 and 10.

Specific Anchor CC.3.6.9-10.A.: Write arguments focused on discipline-specific content.

- Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.
- Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience’s knowledge level and concerns.
- Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
- Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
- Provide a concluding statement or section that follows from or supports the argument presented.

Specific Anchor CC.3.6.9-10.B.: Write informative and explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

- Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

- Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience’s knowledge of the topic.
- Use varied transitions and sentence structures to link the major sections of the relationships among ideas and concepts.
- Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.
- Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
- Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

Text Types and Purposes, also contains two specific anchors for students in grades 11 and 12. Notice that these anchors are similar to the specific anchors written for students in grades 9 and 10, yet they have subtle differences. An explanation is provided below.

Specific Anchor CC.3.6.11-12.A.: Write arguments focused on discipline-specific content.

- Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.
- Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline appropriate form that anticipates the audience’s knowledge level, concerns, values, and possible biases.
- Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
- Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
- Provide a concluding statement or section that follows from or supports the argument presented.

Specific Anchor CC.3.6.11-12.B.: Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

- Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
- Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience’s knowledge of the topic.
- Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.
- Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey acknowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers.
- Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

An example of linking anchors in Text Types and Purposes to Units of Instruction in welding technology

In reference to the welding technology grid, and after reviewing the anchors for writing for science and technical subjects, a decision must be made, which will address where students would most likely be getting practice in Anchor Area 1, Text Type and Purposes. This anchor could be addressed through a writing assignment for Unit 100 (Safety) in the program because the instructor plans to assign students the task of listing the steps that are required to safely set up and light an oxyacetylene torch, which is task #113. This type of writing assignment would allow students to get practice in anchor CC.3.6.11-12.B, which states, "Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes."

Figure 7 on page 21 exhibits a Crosswalk Chart that illustrates how information was added for these anchors under the heading, PCS for writing in science and technical subjects. Examine the tan block arrows in Figure 7. The arrows contain information that illustrates the process followed to link anchors in writing to Unit 100, "Occupational Orientation and Safety." It is inferred that this process was repeated for Unit 200, "Principles of Welding." Also, the remaining Units of Instruction in the program would need to be reviewed, in order to decide if Anchor CC.3.6.9-10.B and Anchor CC.3.6.11-12.B would apply to the tasks in each Unit of Instruction.

Link the anchors for Text Types and Purposes in writing to Units of Instruction

Before continuing, interested individuals should investigate whether anchors A and/or B for grades 9 and 10; and, grades 11 and 12 in "Text Types and Purposes" would apply to their applicable programs of study. Many teachers agree that Anchor CC.3.6.11-12.B, which states, "Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes," applies to assignments where students may be asked to write an explanation of a procedure, or a list of steps to follow to carry out a technical process.

Anchor Area 2 Production and Distribution of Writing

This area contains three specific anchors for students in grades 9 and 10.

- Specific Anchor CC.3.6.9-10.C.: Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- Specific Anchor CC.3.6.9-10.D.: Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
- Specific Anchor CC.3.6.9-10.E.: Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Production and Distribution of Writing also contains two specific anchors for students in grades 11 and 12. The first two anchors are identical to those in grades 9 and 10 but the third anchor has subtle differences.

- Specific Anchor CC.3.6.11-12.C.: Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- Specific Anchor CC.3.6.11-12.D.: Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
- Specific Anchor CC.3.6.11-12.E.: Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

Link the Anchors for Productions and Distribution of Writing to Units of Instruction

Before continuing, determine whether anchors C, D, or E for grades 9 and 10; and, grades 11 and 12 in Production and Distribution of Writing would apply to any Units of Instruction. Examine the chart in Figure 7. Production and Distribution of Writing was added to Unit 100 because students are required, in task 101, to prepare job sheets, reports or records in the lab.

Anchor Area 3 Research to Build and Present Knowledge

The third anchor area in writing is, Research to Build and Present Knowledge. This anchor area is designed to give students practice in searching for information in books, media, libraries, classrooms or on the web. Research to Build and Present Knowledge contains the following three specific anchors for students in grades 9 and 10.

- Specific Anchor CC.3.6.9-10.F.: Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
- Specific Anchor CC.3.6.9-10.G.: Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.
- Specific Anchor CC.3.6.9-10.H.: Draw evidence from informational texts to support analysis, reflection, and research.

Research to Build and Present Knowledge also contains three specific anchors for students in grades 11 and 12. The second specific anchor has subtle differences between grades 9-10, and Grades 11-12.

- Specific Anchor CC.3.6.11-12.F.: Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
- Specific Anchor CC.3.6.11-12.G.: Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.
- Specific Anchor CC.3.6.11-12.H.; Draw evidence from informational texts to support analysis, reflection, and research.

Link the anchors for Research to Build and Present Knowledge to Units of Instruction

Before continuing, determine if anchors F, G, and H in Research to Build and Present Knowledge would apply to any of the Units of Instruction in a desired Program of Study.

As demonstrated, the anchors in Research to Build and Present Knowledge did not apply to units 100 and 200 of the welding program. The anchors will be used in other units where they apply.

Anchor Area 4 Range of Writing

The fourth and last anchor area in writing is, Range of Writing. This anchor is designed to ensure the students in a program of study have the ability to express themselves in writing in a fashion that reflects their grade level in school. The anchor area contains only one specific anchor for students in grades 9 and 10, as follows:

- Specific Anchor CC.3.6.9-10.I.: Write routinely over extended time frames (time for reflection and revision) and shorter timeframes (a single sitting of a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Range of Writing also contains one specific anchor for students in grades 11 and 12. Note that the anchor is identical to the anchor in grades 9 and 10.

- Specific Anchor CC.3.6.11-12.I.: Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting of a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Many teachers of science, career and technical education subjects incorporate writing practice in many of their Units of Instruction. An example of adding anchors of writing to Units of Instruction is exhibited in figure 7 on page 21.

Link the anchors for Range of Writing to Units of Instruction

Before continuing, interested individuals should investigate whether anchor I in Range of Writing might be appropriate to add to Units of Instruction in their applicable programs of study.

FIGURE 7
Technical Core and Pennsylvania Core Standards for Reading and Writing, linked with Units of Instruction in Welding

Welding Technology/Welder (C.I.P. 48.0508) POS Task Grid Linked To Pennsylvania Core Standards					
Unit & Task	Secondary Competency Task List High School Graduation (Years: 2013, 2014 and 2015)	Common Career Technical Core Standards	PCS for reading in science and technology subjects	PCS for writing in science and technology subjects	PCS in high school mathematics
100	OCCUPATIONAL ORIENTATION AND SAFETY	CLUSTER NAME: MANUFACTURING G The Cluster Standards that are taught in this unit are 3 and 6. CAREER PATHWAY Manufacturing Production Process Development The Pathway Standards that are taught in this unit are: 3, 4, and 5.	Grades 9 and 10- <u>Key Ideas and Details</u> Anchor - B <u>Craft & Structure</u> Anchors- D <u>Level of Complexity</u> Anchor - J Grades -11 and 12- <u>Key Ideas and Details</u> Anchor - B <u>Craft & Structure</u> Anchor- D <u>Level of Complexity</u> Anchor - J	Grades 9 and 10 <u>Text Type And Purposes</u> Anchor B Grades 11 and 12 <u>Text Type And Purposes</u> Anchor B Grades 9 and 10 <u>Production and Distribution of Writing</u> Anchor C Grades 11 and 12 <u>Production and Distribution of Writing</u> Anchor C Grades 9,10,11 and 12 <u>Range of Writing</u> Anchor I	1. Place the name and letter(s) of the Pennsylvania Core Standards Anchors for Writing that apply to this Unit of Instruction for grades 9-10, and grades 11-12. 2. Repeat the process of placing the name and letter(s) of the Core Anchors for Writing where they apply to remaining Units of Instruction for grades 9-10, and grades 11-12.
101	Prepare and mark time or job sheet, reports or records.				
102	Perform housekeeping duties daily.				
103	Follow verbal instructions to complete work assignments and rules.				
104	Follow written instructions to complete work assignments and rules.				
105	Demonstrate proper use and inspection of Personal Protection Equipment (PPE).				
106	Demonstrate proper work area operation.				
107	Demonstrate proper use of ventilation equipment.				
108	Discuss proper Hot Zone operation.				
109	Understand proper work actions for working in confined spaces.				
110	Understand MSDS sheets and precautionary labeling.				
111	Demonstrate proper use and inspection of equipment used for each required welding and thermal cutting process.				
112	Display familiarity with industrial and OSHA safety standards.				
113	Demonstrate knowledge of oxy-fuel safety procedures.				
114	Demonstrate knowledge of arc welding safety procedures.				
115	Demonstrate emergency action plan (all inclusive).				
200	PRINCIPLES OF WELDING	CAREER PATHWAY: Manufacturing Production Process Development The Pathway Standards that are taught in this unit are: 3, 4, and 5.	Grades 9 and 10- <u>Key Ideas and Details</u> Anchor - B <u>Craft & Structure</u> Anchor- D <u>Level of Complexity</u> Anchor - J Grades -11 and 12- <u>Key Ideas and Details</u> Anchor - B <u>Craft & Structure</u> Anchor- D <u>Level of Complexity</u> Anchor - J	Grades 9 and 10 <u>Text Type And Purposes</u> Anchor B Grades 11 and 12 <u>Text Type And Purposes</u> Anchor B Grades 9,10,11 and 12 <u>Range of Writing</u> Anchor I	
201	Identify major types of metals (ferrous and non-ferrous) used in welding.				
202	Describe the basic principles of heat				
203	Select appropriate welding technique				
204	Describe the industry accepted welding codes				
206	Clean and prepare materials for welding and/or cutting.				

Step 5 – Link Pennsylvania Core Standards for Mathematics to Units of Instruction

Collaborate with Mathematics Specialists

Step 5 in the procedure to link Pennsylvania Core Standards to Units of Instruction in Programs of Study asks CTE teachers to link standards in mathematics with their units of instruction and technical skills, where they apply. Many teachers, however, find that they are unfamiliar with high school mathematics as a subject area, and therefore may not have the knowledge needed to identify appropriate Pennsylvania Core Math Standards or to know where such standards should be linked to skills in their Program of Study. When this is the case, teachers should request school administrators to collaborate with a teacher of mathematics while they link math standards with their technical program content.

What are the Pennsylvania Core Standards for mathematics?

The Pennsylvania Core Standards in Mathematics (in grades PreK-5) were designed to lay a solid foundation in whole numbers, addition, subtraction, multiplication, division, fractions, and decimals. These elements support an elementary student's ability to learn and apply more demanding math concepts and procedures. Teachers of CTE programs are not expected to link these basic skills to their Programs of Study.

The Pennsylvania Core Math Standards for high school, were designed to help CTE students practice the application of mathematical ways of thinking about real world issues and challenges. The standards prepare students to think and reason mathematically. They also expect students to develop a depth of understanding and ability to apply mathematics to new situations in which employees and college students are required to do on a regular basis. As an instructor of a CTE program, therefore, it will be necessary to link these standards to Units of Instruction, where they apply to technical tasks and competencies. Remember, that the standards are not a curriculum or a prescribed series of activities that must be followed. Schools are expected to use the standards to develop a local school curriculum that will meet students' needs for further education and employment.

Before linking the Pennsylvania Core Standards for mathematics to Units of Instruction on a Crosswalk Chart, it will be necessary to review the Pennsylvania Core Standards for mathematics, the Keystone Exam assessment anchors, and eligible content for geometry, algebra I and algebra II. These references may be found in the Appendix. The references in the Appendix do not include standards for kindergarten through grade 8 since they do not apply to high school teachers. Complete versions of each of these documents are available on the Standards Aligned System (SAS) at www.pdesas.org.

What do the Pennsylvania Core Standards in mathematics address?

The Pennsylvania Core Standards in Mathematics (standard 2.0) address a student's ability to perform operations in mathematics, which might be encountered in a program, a college or technical school, at work, or in business and industry. It is hoped that students who achieve the mathematics standards will be able to demonstrate the following skills:

- Make sense of problems and persevere in solving them.
- Construct viable arguments and critique the reasoning of others.
- Use appropriate tools strategically.
- Look for and make use of structure.
- Reason abstractly and quantitatively.
- Model with mathematics.
- Attend to precision.
- Look for and express regularity in repeated reasoning.

The Pennsylvania Core Standards for Mathematics covers four broad curriculum areas of math content. The curriculum areas and their sub-topics follow:

- (1) Standard Area (2.1) - Curriculum Area: Numbers and Operations
 - A) Counting and Cardinality
 - B) Number and Operations in Base Ten
 - C) Number and Operations—Fractions
 - D) Ratios and Proportional Relationships
 - E) The Number System
 - F) Number and Quantity
- (2) Standard (2.2) - Curriculum Area: Algebraic Concepts
 - A) Operations and Algebra Thinking
 - B) Expressions & Equations
 - C) Functions
 - D) Algebra
- (3) Standard (2.3) - Curriculum Area: Geometry
 - A) Geometry
- (4) Standard Area (2.4) - Curriculum Area: Measurement, Data and Probability
 - A) Measurement and Data
 - B) Statistics and Probability

The development and progression of the four curriculum areas from pre-kindergarten to grade 12 in a typical school district are shown in Figure 8 below.

FIGURE 8
Mathematics curriculum development and progression from pre-kindergarten through high school

Mathematical Standards: Development and Progression												
Standards for Mathematical Practice												
<ul style="list-style-type: none"> • Make sense of problems and persevere in solving them. • Construct viable arguments and critique the reasoning of others. • Use appropriate tools strategically. • Look for and make use of structure. 						<ul style="list-style-type: none"> • Reason abstractly and quantitatively. • Model with mathematics. • Attend to precision. • Look for and express regularity in repeated reasoning. 						
	Pre K	K	1	2	3	4	5	6	7	8	HS	
2.1 Numbers and Operations	(A) Counting & Cardinality											
	(B) Number and Operations in Base Ten				(D) Ratios and Proportional Relationships				(F) Number & Quantity			
					(C) Number and Operations -Fractions				(E) The Number System			
2.2 Algebraic Concepts	(A) Operations and Algebraic Thinking						(B) Expressions and Equations				(D) Algebra	
							(C) Functions					
2.3 Geometry	(A) Geometry											
2.4 Measurement, Data and Probability	(A) Measurement and Data						(B) Statistics and Probability					

Curriculum areas in mathematics

Each of the four math curriculum areas, including (1) Numbers and Operations, (2) Algebraic Concepts, (3) Geometry, and (4) Measurement and Data/Probability (shown in Figure 8 above) contains specific standards that students must demonstrate at the high school level. A list of the standards for each of the four curriculum areas is shown in Table 1 on pages 25-26.

Teachers of CTE programs who are beginning to learn the process of linking Pennsylvania Core Standards for Mathematics to their units of instruction should review the eligible content within each of the Pennsylvania Core Math Standards. Many of the sample problems that comprise eligible content are written as common-sense, work-based applications of the math standards that teachers may choose to link to units of instruction in their Programs of Study. Practicing the kinds of problems shown as eligible content will give students the best chance for success when they encounter similar problems on various assessment instruments such as the Keystone Exams in Mathematics.

Teachers who want to review eligible content may do so by referring to the following documents located in the Appendix.

- Keystone Exams: Algebra I - Assessment Anchors and Eligible Content
- Keystone Exams: Algebra II - Assessment Anchors and Eligible Content
- Keystone Exams: Geometry - Assessment Anchors and Eligible Content

When reviewing the assessment anchors and eligible content for the Keystone Exams, it is evident that the various levels of information have been represented in table form. A careful study of the description of each level in the labeling system will assist in an understanding of the table. A portion of one of the tables for the curriculum area, Geometry, is shown in Figure 9 below, along with descriptions of each level in the labeling system that are used for the table. Figure 9 may also be found on page 8 of the Appendix, Keystone Exams Geometry Anchors and Eligible Content.

FIGURE 9
MODULE 1 - Coordinate Geometry and Measurement

ASSESSMENT ANCHOR - G.2.1 Coordinate Geometry and Right Triangles		
Anchor Descriptor	Eligible Content	PA Core Standards
G.2.1.1 Solve problems involving right triangles.	G.2.1.1.1 Use the Pythagorean theorem to write and/or solve problems involving right triangles.	2.3.HS.A.7 Apply trigonometric ratios to solve problems involving right triangles.

Descriptions of each component of the labeling system in Figure 9 are explained below.

- **Component 1 - Module:** The assessment anchors are organized into two thematic modules for each of the Keystone Exams. The module title appears at the top of each page. The module level is important because the Keystone Exams are built using a module format, with each of the Keystone Exams divided into two equal-sized test modules. Each module addresses two or more assessment anchors.
- **Component 2 - Assessment Anchor:** The assessment anchor appears in the shaded bar across the top of each assessment anchor table. Each anchor represents a category of subject matter in the Keystone Exams. Each assessment anchor is part of a module and has one or more anchor descriptors under it.
- **Component 3 - Anchor Descriptor:** Below each assessment anchor is a specific anchor descriptor. The anchor descriptor level provides further details that delineate the scope of content covered by the assessment anchor. Each anchor descriptor is part of an assessment anchor and has one or more eligible content statements unified under it.
- **Component 4 - Eligible Content:** The column to the right of the anchor descriptor contains the eligible content statements. The eligible content is the most specific description of the content that is assessed on the Keystone Exams. This level is considered the assessment limit and helps educators identify the range of the content covered on the Keystone Exams.
- **Component 5 - Pennsylvania Core Standards:** In the column to the right of each eligible content statement is a code representing a Pennsylvania Core Standard that correlates to the eligible content statement. Some eligible content statements include annotations that indicate certain clarifications about the scope of the eligible content.

TABLE 1
Math Curriculum Areas with Levels of Instruction and Pennsylvania Core Standards

MATH CURRICULUM AREA 2.1 - NUMBERS AND OPERATIONS
Level "F" For High School: - Number And Quantity
PA Core Standards In This Area
CC.2.1.HS.F.1- Apply and extend the properties of exponents to solve problems with rational exponents.
CC.2.1.HS.F.2 - Apply properties of rational and irrational numbers to solve real world or mathematical problems
CC.2.1.HS.F.3 - Apply quantitative reasoning to choose and Interpret units and scales in formulas, graphs and data displays
CC.2.1.HS.F.4 - Use units as a way to understand problems and to guide the solution of multi-step problems.
CC.2.1.HS.F.5 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
CC.2.1.HS.F.6 - Extend the knowledge of arithmetic operations and apply to complex numbers.
CC.2.1.HS.F.7 - Apply concepts of complex numbers in polynomial identities and quadratic equations to solve problems.
MATH CURRICULUM AREA: 2.2 - ALGEBRAIC CONCEPTS
Level "D" For High School: Algebra
PA Core Standards In This Area
CC.2.2.HS.D.1- Interpret the structure of expressions to represent a quantity in terms of its context.
CC.2.2.HS.D.2 -Write expressions in equivalent forms to solve problems.
CC.2.2.HS.D.3 - Extend the knowledge of arithmetic operations and apply to polynomials.
CC.2.2.HS.D.4 - Understand the relationship between zeros and factors of polynomials to make generalizations about functions and their graphs.
CC.2.2.HS.D.5 - Use polynomial identities to solve problems.
CC.2.2.HS.D.6 - Extend the knowledge of rational functions to rewrite in equivalent forms.
CC.2.2.HS.D.7 - Create and graph equations or inequalities to describe numbers or relationships.
CC.2.2.HS.D.8 - Apply inverse operations to solve equations or formulas for a given variable.
**CC.2.2.HS.D.9 - Use reasoning to solve equations and justify the solution method.
CC.2.2.HS.D.10 - Represent, solve and interpret equations/inequalities and systems of equations/inequalities algebraically and graphically
MATH CURRICULUM AREA: 2.2 - ALGEBRAIC CONCEPTS
Level "C" For High School: Functions
PA Core Standards In This Area
CC.2.2.HS.C.1 - Use the concept and notation of functions to interpret and apply them in terms of their context.
CC.2.2.HS.C.2 - Graph and analyze functions and use their properties to make connections between the different representations
CC.2.2.HS.C.3 - Write functions or sequences that model relationships between two quantities.
CC.2.2.HS.C.4 - Interpret the effects transformations have on functions and find the inverses of functions.
CC.2.2.HS.C.5 - Construct and compare linear, quadratic and exponential models to solve problems.
CC.2.2.HS.C.6 - Interpret functions in terms of the situation they model.
CC.2.2.HS.C.7 Apply radian measure of an angle and the unit circle to analyze the trigonometric functions.
CC.2.2.HS.C.8 - Choose trigonometric functions to model periodic phenomena and describe the properties of the graphs.
CC.2.2.HS.C.9 - Prove the Pythagorean identity and use it to calculate trigonometric ratios.

TABLE 1 (Continued)
Math Curriculum Areas with Levels of Instruction and Pennsylvania Core Standards

MATH CURRICULUM AREA: 2.3 - GEOMETRY
Level "A" For High School: Geometry
PA Core Standards In This Area
CC.2.3.HS.A.1 - Use geometric figures and their properties to represent transformations in the plane.
CC.2.3.HS.A.2 - Apply rigid transformations to determine and explain congruence.
C.2.3.HS.A.3 - Verify and apply geometric theorems as they relate to geometric figures.
CC.2.3.HS.A.4 Apply the concept of congruence to create geometric constructions.
CC.2.3.HS.A.5 - Create justifications based on transformations to establish similarity of plane figures.
CC.2.3.HS.A.6 - Verify and apply theorems involving similarity as they relate to plane figures.
CC.2.3.HS.A.7 - Apply trigonometric ratios to solve problems involving right triangles.
CC.2.3.HS.A.8 - Apply geometric theorems to verify properties of circles.
CC.2.3.HS.A.9 - Extend the concept of similarity to determine arc lengths and areas of sectors of circles.
CC.2.3.HS.A.10 - Translate between the geometric description and the equation for a conic section.
CC.2.3.HS.A.11 - Apply coordinate geometry to prove simple geometric theorems algebraically.
CC.2.3.HS.A.12 - Explain volume formulas and use them to solve problems.
CC.2.3.HS.A.13 - Analyze relationships between two-dimensional and three-dimensional objects.
CC.2.3.HS.A.14 - Apply geometric concepts to model and solve real world problems.
MATH CURRICULUM AREA: 2.4 - MEASUREMENT, DATA AND PROBABILITY
Level B For High School: Statistics And Probability
PA Core Standards In This Area
CC.2.4.HS.B.1 - Summarize, represent, and interpret data on a single count or measurement variable.
CC.2.4.HS.B.2 - Summarize, represent, and interpret data on two categorical and quantitative variables.
CC.2.4.HS.B.3 - Analyze linear models to make interpretations based on the data.
CC.2.4.HS.B.4 - Recognize and evaluate random processes underlying statistical experiments.
CC.2.4.HS.B.5 - Make inferences and justify conclusions based on sample surveys, experiments, and observational studies.
CC.2.4.HS.B.6 - Use the concepts of independence and conditional probability to interpret data.
CC.2.4.HS.B.7 - Apply the rules of probability to compute probabilities of compound events in a uniform probability model.

An example of the process used to link Pennsylvania Core math standards to units of instruction is explained below:

Assume that a welding instructor is reviewing math curriculum 2.2 (algebraic concepts) in table 1 (page 26), and is attempting to determine if Standard 2.2. HS. D. 9 - Use reasoning to solve equations and justify the solution method, is an appropriate standard to link to the skills in any of the units of instruction in the Welding Program of Study. The teacher would find the answer by looking at the eligible content for that particular standard in the reference document, Keystone Exams - Algebra I - assessment anchors and eligible content found in the Appendix. On page 80 of the Appendix, the teacher observes that Module 1, which is entitled Operations and Linear Equations and Inequalities, contains the information shown in Figure 10 on page 27. Figure 10 displays Standard 2.2.HS.D., with an anchor descriptor and eligible content for that standard. The anchor descriptor and the eligible content both contain a work-related sample math exercise that expect students to apply strategies for using estimation to solve problems.

The welding instructor must decide which unit of instruction in the Welding Program would expect students to practice this skill, then add Standard 2.2.HS.D.9 to the Crosswalk Chart beside each Unit of Instruction where estimation would be practiced. One unit where this takes place is Unit 300, Welding Drawing and Welding Symbol Interpretation, because tasks in this unit have students estimating physical properties of real objects, including their height, weight, width, length, volume, etc. Since this is the case, the instructor would add Standard 2.2.HS.D.9. to the column labeled Math Standards on the Crosswalk Chart. Refer to Figure 11 (Unit 300 on page 29) to see the results of this process. The welding instructor would also add Standard 2.2.HS.D.9 to other units of instruction that contain skills requiring students to apply strategies for using estimation in the welding lab or in the welding occupation. Note that no math standards were listed for Units 100 and 200 since tasks in these units do not include practice in Pennsylvania Core Standards for Mathematics.

In order to link math standards with units of instruction, use only those standards with a HS (High School) designation in their titles, as illustrated by the standards listed in Table 1 on pages 25-26.

FIGURE 10
Anchor Descriptors and Eligible Content for Pennsylvania Core Math Standard 2.2.HS.D.9
Keystone Exams - Algebra 1
Module 1 - Operations and Linear Equations and Inequalities

Anchor Descriptor	Eligible Content	PA Core Standards
A1.1.1.4 Use estimation strategies in problem-solving situations.	A1.1.1.4.1 Use estimation to solve problems.	2.2.HS.D.9 Use reasoning to solve equations and justify the solution method.

Link the standards for mathematics to Units of Instruction

After a obtaining a basic understanding of the Pennsylvania Core Math Standards, curriculum areas, anchor descriptors and eligible content, and their organization, it would be prudent to decide where the Pennsylvania Core Standards for Mathematics should be linked to Units of Instruction in a Program of Study. The reference materials in the Appendix may help to gain a better understanding of the language and the meaning of the math standards.

Explanations of anchor descriptors and eligible content that math educators use to convey the meaning of the Pennsylvania Core Standards may help to determine which math standards, if any, should be linked to tasks within Units of Instruction.

FIGURE 11
Pennsylvania Core Standards for Technical Core, Reading, Writing, and Mathematics Linked with Units of Instruction in Welding

Welding Technology/Welder (C.I.P. 48.0508) POS Task Grid Linked To Pennsylvania Core Standards					
Unit & Task	Secondary Competency Task List High School Graduation (Years: 2013, 2014 and 2015)	Common Career Technical Core Standards	PCS for reading in science and technology subjects	PCS for writing in science and technology subjects	PCS in high school mathematics
100	OCCUPATIONAL ORIENTATION AND SAFETY	CLUSTER: Manufacturing Careers CCTC Standards taught in this unit are: 3 and 6. Career Pathway: Manufacturing Production Process Development CCTC Standards taught in this unit are: 3, 4, and 5.	-Grades 9 and 10- Key Ideas and Details Anchors - B Craft & Structure Anchors- D Level of Complexity Anchor - J Grades 11 and 12- Key Ideas and Details Anchors - B Craft & Structure Anchors- D Level of Complexity Anchor - J	Grades 9 and 10 Text Type And Purposes Anchor B Grades 11 and 12 Text Type And Purposes Anchor B Grades 9,10,11 and 12 Range of Writing Anchor I	See Math Standards linked to Unit 300 on the next page.
101	Prepare and mark time or job sheet, reports or records.				
102	Perform housekeeping duties daily.				
103	Follow verbal instructions to complete work assignments and rules.				
104	Follow written instructions to complete work assignments and rules.				
105	Demonstrate proper use and inspection of Personal Protection Equipment (PPE).				
106	Demonstrate proper work area operation.				
107	Demonstrate proper use of ventilation equipment.				
108	Discuss proper Hot Zone operation.				
109	Understand proper work actions for working in confined spaces.				
110	Understand MSDS sheets and precautionary labeling.				
111	Demonstrate proper use and inspection of equipment used for each required welding and thermal cutting process.				
112	Display familiarity with industrial and OSHA safety standards.				
113	Demonstrate knowledge of oxy-fuel safety procedures.				
114	Demonstrate knowledge of arc welding safety procedures.				
115	Demonstrate emergency action plan (all inclusive).				
200	PRINCIPLES OF WELDING	CLUSTER: Manufacturing Careers CCTC Standards taught in this unit are: 3 and 6. Career Pathway: Manufacturing Production Process Development CCTC Standards taught in this unit are: 3, 4, 5.	Grades 9 and 10- Key Ideas and Details Anchors - B Craft & Structure Anchors- D Level of Complexity Anchor - J Grades 11 and 12- Key Ideas and Details Anchors - B Craft & Structure Anchors- D Level of Complexity Anchor - J	Grades 9 and 10 Text Type And Purposes Anchor B Grades 11 and 12 Text Type And Purposes Anchor B Grades 9,10,11 and 12 Range of Writing Anchor I	See Math Standards linked to Unit 300 on the next page.

FIGURE 11 (Continued)

Pennsylvania Core Standards for Technical Core, Reading, Writing, and Mathematics linked with Units of Instruction in Welding

Welding Technology/Welder (C.I.P. 48.0508) POS Task Grid Linked To Pennsylvania Core Standards					
Unit & Task	Secondary Competency Task List High School Graduation (Years: 2013, 2014 and 2015)	Common Career Technical Core Standards	PCS for Reading in Science & Tech Subjects	PCS for Writing in Science & Tech Subjects	PCS In High School Mathematics
300	WELDING DRAWING AND WELD SYMBOL INTERPRETATION	CLUSTER: Manufacturing Careers CCTC Standards taught in this unit are: 3 and 6. Career Pathway: Manufacturing Production Process Development CCTC Standards taught in this unit are: 3, 4, 5.	-Grades 9 and 10- <u>Key Ideas and Details</u> Anchors - B <u>Craft & Structure</u> Anchors- D Level of <u>Complexity</u> Anchor - J Grades 11 and 12- <u>Key Ideas and Details</u> Anchors - B <u>Craft & Structure</u> Anchors- D Level of <u>Complexity</u> Anchor - J	Grades 9 and 10 <u>Text Type And Purposes</u> Anchor B Grades 11 and 12 <u>Text Type And Purposes</u> Anchor B Grades 9,10,11 and 12 <u>Range of Writing</u> Anchor I	MATH. Standard 2.2.HS.D.9 Use reasoning to solve equations and justify the solution method. Eligible Content # A1.1.1.4.1 Use estimation to solve problems. 
301	Interpret basic elements of a drawing or sketch.				
302	Interpret welding symbol information.				
303	Fabricate parts from a drawing or sketch (class project).				
304	Identify structural metals used in the Metal Fabrication field.				
305	Demonstrate knowledge of basic metric conversion.				
400	VISUAL EXAMINATION, INSPECTION, AND TESTING	To be completed by the instructor	To be completed by the instructor	To be completed by the instructor	Place the number(s) and letters of the Pennsylvania Core Standards for Mathematics that apply to this Unit of instruction for grades 9 and 10; and, 11 and 12. NOTE: Text was added on this sample Crosswalk Chart for clarification of the example, regarding numbers and letters of math standards. Eligible Content should be added to Units of Instruction for clarification of the math standards.
401	Evaluate cut surfaces and edges of prepared base metal parts for testing.				
402	Identify and evaluate weld discontinuities as per accept/reject criteria.				
403	Demonstrate visual inspection and destructive and non destructive techniques.				

Conclusion

Linking Pennsylvania Core Standards to Units of Instruction in CTE Programs of Study

The Pennsylvania Core Standards are valuable to teachers and to students in schools. However, the standards do not define the following:

- the method by which teachers should teach.
- all that can or should be taught in a Program of Study.
- the nature of advanced work beyond core skills in a Program of Study.
- interventions needed for students who perform well below grade level in reading, writing and math.
- the full range of support for English language learners and students with special educational needs.
- everything that students in a CTE program are required to have to be ready for success in college, technical school and the work place.

The Pennsylvania Core Standards for Reading, Writing, Mathematics and Technical Careers are important standards, when incorporated in a CTE curriculum. To be effective in improving education and preparing all students for college, postsecondary technical schools, work force training and life in a global economy, the standards must be linked with a content-rich curriculum, hands-on skills, authentic assessment tools and effective teaching practices.

Appendix

The Common Career Technical Core Standards

Pennsylvania Department of Education

THE COMMON CAREER TECHNICAL CORE STANDARDS

National Association of State Directors of Career Technical Education Consortium

Introduction

The Common Career Technical Core (CCTC) is an important step forward for the Career Technical Education (CTE) community. For the first time in the history of CTE, states throughout the nation have a common benchmark for what students should know and be able to do after completing a Program of Study.

The CCTC is a state-led initiative, with 42 states, the District of Columbia and Palau participating in the development stage. Business and industry representatives, educators and others helped guide the development of the CCTC from beginning to end to ensure CTE students will have the knowledge and skills to thrive in a global economy.

The resulting CCTC is a set of rigorous, high-quality standards for CTE that states can adopt voluntarily. The CCTC includes a set of standards for each of the 16 Career Clusters™ and their corresponding Career Pathways that define what students should know and be able to do after completing instruction in a Program of Study (pages 3 - 21 of this document).

The CCTC also includes an overarching set of Career Ready Practices that apply to all programs of study. The Career Ready Practices include 12 statements that address the knowledge, skills and dispositions that are important to becoming career ready (pages 1-3 of this document).

To appropriately cite the Common Career Technical Core, including the Career Ready Practices, use the following information:

Author: National Association of State Directors of Career Technical Education Consortium/National Career Technical Education Foundation

Title: Common Career Technical Core

Publisher: National Association of State Directors of Career Technical Education Consortium/National Career Technical Education Foundation, Silver Spring, MD.

Copyright Date: 2012

Career Ready Practices

Career Ready Practices describe the career-ready skills that educators should seek to develop in their students. These practices are not exclusive to a Career Pathway, Program of Study, discipline or level of education. Career Ready Practices should be taught and reinforced in all career exploration and preparation programs with increasingly higher levels of complexity and expectation as a student advances through a Program of Study.

1. Act as a responsible and contributing citizen and employee.

Career-ready individuals understand the obligations and responsibilities of being a member of a community, and they demonstrate this understanding every day through their interactions with others. They are conscientious of the impacts of their decisions on others and the environment around them. They think about the near-term and long-term consequences of their actions and seek to act in ways that contribute to the betterment of their teams, families, community and workplace. They are reliable and consistent in going beyond the minimum expectation and in participating in activities that serve the greater good.

2. Apply appropriate academic and technical skills.

Career-ready individuals readily access and use the knowledge and skills acquired through experience and education to be more productive. They make connections between abstract concepts with real-world applications and they make correct insights about when it is appropriate to apply the use of an academic skill in a workplace situation.

3. Attend to personal health and financial well-being.

Career-ready individuals understand the relationship between personal health, workplace performance and personal well-being; they act on that understanding to regularly practice healthy diet, exercise and mental health activities. Career-ready individuals also take regular action to contribute to their personal financial well-being, understanding that personal financial security provides the peace of mind required to contribute more fully to their own career success.

4. Communicate clearly, effectively and with reason.

Career-ready individuals communicate thoughts, ideas and action plans with clarity, whether using written, verbal and/ or visual methods. They communicate in the workplace with clarity and purpose to make maximum use of their own and others' time. They are excellent writers; they master conventions, word choice and organization and use effective tone and presentation skills to articulate ideas. They are skilled at interacting with others; they are active listeners and speak clearly and with purpose. Career-ready individuals think about the audience for their communication and prepare accordingly to ensure the desired outcome.

5. Consider the environmental, social and economic impacts of decisions.

Career-ready individuals understand the interrelated nature of their actions and regularly make decisions that positively impact and/or mitigate negative impact on other people, organizations and the environment. They are aware of and utilize new technologies, understandings, procedures, materials and regulations affecting the nature of their work as it relates to the impact on the social condition, the environment and profitability of the organization.

6. Demonstrate creativity and innovation.

Career-ready individuals regularly think of ideas that solve problems in new and different ways, and they contribute those ideas in a useful and productive manner to improve their organization. They can consider unconventional ideas and suggestions as solutions to issues, tasks or problems, and they discern which ideas and suggestions will add greatest value. They seek new methods, practices and ideas from a variety of sources and seek to apply those ideas to their own workplace. They take action on their ideas and understand how to bring innovation to an organization.

7. Employ valid and reliable research strategies.

Career-ready individuals are discerning in accepting and using new information to make decisions, change practices or inform strategies. They use a reliable research process to search for new information. They evaluate the validity of sources when considering the use and adoption of external information or practices. They use an informed process to test new ideas, information and practices in their workplace situation.

8. Utilize critical thinking to make sense of problems and persevere in solving them.

Career-ready individuals readily recognize problems in the workplace, understand the nature of the problem, and devise effective plans to solve the problem. They are aware of problems when they occur and take action quickly to address the problem. They thoughtfully investigate the root cause of the problem prior to introducing solutions. They carefully consider the options to solve the problem. Once a solution is agreed upon, they follow through to ensure the problem is solved, whether through their own actions or the actions of others.

9. Model integrity, ethical leadership and effective management.

Career-ready individuals consistently act in ways that align to personal and community-held ideals and principles while employing strategies to positively influence others in the workplace. They have a clear understanding of integrity and act on this understanding in every decision. They use a variety of means to positively impact the direction and actions of a team or organization, and they apply insights into human behavior to change others' actions, attitudes and/or beliefs. They recognize the near-term and long-term effects that management's actions and attitudes can have on productivity, morale and organizational culture.

10. Plan education and career path aligned to personal goals.

Career-ready individuals take personal ownership of their own educational and career goals, and they regularly act on a plan to attain these goals. They understand their own career interests, preferences, goals and requirements. They have perspective regarding the pathways available to them and the time, effort, experience and other requirements to pursue each, including a path of entrepreneurship. They recognize the value of each step in the educational and experiential process, and they recognize that nearly all career paths require ongoing education and experience. They seek counselors, mentors and other experts to assist in the planning and execution of career and personal goals.

11. Use technology to enhance productivity.

Career-ready individuals find and maximize the productive value of existing and new technology to accomplish workplace tasks and solve workplace problems. They are flexible and adaptive in acquiring and using new technology. They are proficient with ubiquitous technology applications. They understand the inherent risks -- personal and organizational -- of technology applications, and they take actions to prevent or mitigate these risks.

12. Work productively in teams while using cultural/global competence.

Career-ready individuals positively contribute to every team whether formal or informal. They apply an awareness of cultural differences to avoid barriers to productive and positive interaction. They find ways to increase the engagement and contribution of all team members. They plan and facilitate effective team meetings.

The Common Career Technical Core Standards

Within 16 Clusters of Occupations with Various Career Pathways

CLUSTER 1: AGRICULTURE, FOOD & NATURAL RESOURCES CAREER CLUSTER™ (AG)

1. Analyze how issues, trends, technologies and public policies impact systems in the Agriculture, Food & Natural Resources Career Cluster™.
2. Evaluate the nature and scope of the Agriculture, Food & Natural Resources Career Cluster™ and the role of agriculture, food and natural resources (AFNR) in society and the economy.
3. Examine and summarize the importance of health, safety and environmental management systems in AFNR businesses.
4. Demonstrate stewardship of natural resources in AFNR activities.
5. Describe career opportunities and means to achieve those opportunities in each of the Agriculture, Food & Natural Resources Career Pathways.
6. Analyze the interaction among AFNR systems in the production, processing and management of food, fiber and fuel and the sustainable use of natural resources.

Agribusiness Systems Career Pathway (AG-BIZ)

1. Apply management planning principles in AFNR businesses.
2. Use record keeping to accomplish AFNR business objectives, manage budgets, and comply with laws and regulations.
3. Manage cash budgets, credit budgets and credit for an AFNR business using generally accepted accounting principles.
4. Develop a business plan for an AFNR business.
5. Use sales and marketing principles to accomplish AFNR business objectives.

Animal Systems Career Pathway (AG-ANI)

1. Analyze historic and current trends impacting the animal systems industry.
2. Utilize best-practice protocols based upon animal behaviors for animal husbandry and welfare.
3. Design and provide proper animal nutrition to achieve desired outcomes for performance, development, reproduction and/or economic production.
4. Apply principles of animal reproduction to achieve desired outcomes for performance, development and/or economic production.
5. Evaluate environmental factors affecting animal performance and implement procedures for enhancing performance and animal health.
6. Classify, evaluate and select animals based on anatomical and physiological characteristics.
7. Apply principles of effective animal health care.

Environmental Service Systems Career Pathway (AG-ENV)

1. Use analytical procedures and instruments to manage environmental service systems.
2. Evaluate the impact of public policies and regulations on environmental service system operations.
3. Develop proposed solutions to environmental issues, problems and applications using scientific principles of meteorology, soil science, hydrology, microbiology, chemistry and ecology.
4. Demonstrate the operation of environmental service systems (e.g., pollution control, water treatment, wastewater treatment, solid waste management and energy conservation).
5. Use tools, equipment, machinery and technology common to tasks in environmental service systems.

Food Products & Processing Systems Career Pathway (AG-FD)

1. Develop and implement procedures to ensure safety, sanitation and quality in food product and processing facilities.
2. Apply principles of nutrition, biology, microbiology, chemistry and human behavior to the development of food products.
3. Select and process food products for storage, distribution and consumption.
4. Explain the scope of the food industry and the historical and current developments of food products and processing.

Natural Resources Systems Career Pathway (AG-NR)

1. Plan and conduct natural resource management activities that apply logical, reasoned and scientifically based solutions to natural resource issues and goals.
2. Analyze the interrelationships between natural resources and humans.
3. Develop plans to ensure sustainable production and processing of natural resources.
4. Demonstrate responsible management procedures and techniques to protect or maintain natural resources.

Plant Systems Career Pathway (AG-PL)

1. Develop and implement a crop management plan for a given production goal that accounts for environmental factors.
2. Apply the principles of classification, plant anatomy and plant physiology to plant production and management.
3. Propagate, culture and harvest plants and plant products based on current industry standards.
4. Apply principles of design in plant systems to enhance an environment (e.g., floral, forest, landscape and farm).

Power, Structural & Technical Systems Career Pathway (AG-PST)

1. Apply physical science principles and engineering applications to solve problems and improve performance in AFNR power, structural and technical systems.
2. Operate and maintain AFNR mechanical equipment and power systems.
3. Service and repair AFNR mechanical equipment and power systems.
4. Plan, build and maintain AFNR structures.
5. Use control, monitoring, geospatial and other technologies in AFNR power, structural and technical systems.

CLUSTER 2: ARCHITECTURE & CONSTRUCTION CAREER CLUSTER™ (AC)

1. Use vocabulary, symbols and formulas common to architecture and construction.
2. Use architecture and construction skills to create and manage a project.
3. Comply with regulations and applicable codes to establish and manage a legal and safe workplace.
4. Evaluate the nature and scope of the Architecture & Construction Career Cluster™ and the role of architecture and construction in society and the economy.
5. Describe the roles, responsibilities and relationships found in the architecture and construction trades and professions, including labor/management relationships.
6. Read, interpret and use technical drawings, documents and specifications to plan a project.
7. Describe career opportunities and means to achieve those opportunities in each of the Architecture & Construction Career Pathways.

Construction Career Pathway (AC-CST)

1. Describe contractual relationships between all parties involved in the building process.
2. Describe the approval procedures required for successful completion of a construction project.
3. Implement testing and inspection procedures to ensure successful completion of a construction project.
4. Apply scheduling practices to ensure the successful completion of a construction project.
5. Apply practices and procedures required to maintain jobsite safety.
6. Manage relationships with internal and external parties to successfully complete construction projects.
7. Compare and contrast the building systems and components required for a construction project.
8. Demonstrate the construction crafts required for each phase of a construction project.
9. Safely use and maintain appropriate tools, machinery, equipment and resources to accomplish construction project goals.

Design/Pre-construction Career Pathway (AC-DES)

1. Justify design solutions through the use of research documentation and analysis of data.
2. Use effective communication skills and strategies (listening, speaking, reading, writing and graphic communications) to work with clients and colleagues.
3. Describe the requirements of the integral systems that impact the design of buildings.
4. Apply building codes, laws and rules in the project design.
5. Identify the diversity of needs, values and social patterns in project design, including accessibility standards.
6. Apply the techniques and skills of modern drafting, design, engineering and construction to projects.
7. Employ appropriate representational media to communicate concepts and project design.
8. Apply standards, applications and restrictions pertaining to the selection and use of construction materials, components and assemblies in the project design.

Maintenance/Operations Career Pathway (AC-MO)

1. Recognize and employ universal construction signs and symbols to function safely in the workplace.
2. Use troubleshooting procedures when solving a maintenance problem in buildings.
3. Apply construction skills when repairing, restoring or renovating existing buildings.
4. Determine work required to repair or renovate an existing building.
5. Plan and practice preventative maintenance activities to service existing buildings.
6. Maintain and inspect building systems to achieve safe and efficient operation of buildings.

CLUSTER 3: ARTS, A/V TECHNOLOGY & COMMUNICATIONS CAREER CLUSTER™ (AR)

1. Analyze the interdependence of the technical and artistic elements of various careers within the Arts, A/V Technology & Communications Career Cluster™.
2. Analyze the importance of health, safety and environmental management systems, policies and procedures common in arts, audio/video technology and communications activities and facilities.
3. Analyze the lifestyle implications and physical demands required in the arts, audio/visual technology and communications workplace.
4. Analyze the legal and ethical responsibilities required in the arts, audio/visual technology and communications workplace.
5. Describe the career opportunities and means to achieve those opportunities in each of the Arts, A/V Technology & Communications Career Pathways.
6. Evaluate technological advancements and tools that are essential to occupations within the Arts, A/V Technology & Communications Career Cluster™.

A/V Technology & Film Career Pathway (AR-AV)

1. Describe the history, terminology, occupations and value of audio, video and film technology.
2. Demonstrate the use of basic tools and equipment used in audio, video and film production.
3. Demonstrate technical support skills for audio, video and/or film productions.
4. Design an audio, video and/or film production.

Journalism & Broadcasting Career Pathway (AR-JB)

1. Describe the diversity of functions within the Journalism & Broadcasting Career Pathway.
2. Demonstrate writing processes used in journalism and broadcasting.
3. Plan and deliver a media production (e.g., broadcast, video, Internet, mobile).
4. Demonstrate technical support related to media production (e.g., broadcast, video, Internet, mobile).

Performing Arts Career Pathway (AR-PRF)

1. Describe the scope of the Performing Arts Career Pathway and the roles of various individuals in it.
2. Demonstrate the fundamental elements, techniques, principles and processes of various dance styles and traditions.

3. Perform a varied repertoire of vocal and/or instrumental music representing diverse styles, cultures and historical periods.
4. Demonstrate knowledge of music theory.
5. Explain key issues affecting the creation of characters, acting skills and roles.
6. Create stage, film, television or electronic media scripts in a variety of traditional and current formats.
7. Describe how technology and technical support enhance performing arts productions.
8. Analyze all facets of stage and performing arts production management.

Printing Technology Career Pathway (AR-PRT)

1. Manage the printing process, including customer service and sales, scheduling, production and quality control.
2. Demonstrate the production of various print, multimedia or digital media products.
3. Perform finishing and distribution operations related to the printing process.

Telecommunications Career Pathway (AR-TEL)

1. Demonstrate the use of telecommunications terminology, tools and test equipment.
2. Demonstrate telecommunication installation processes using appropriate tools, materials, schematics, diagrams, blueprints and industry specific codes and regulations.
3. Demonstrate decision making, problem-solving techniques and communication skills when providing services for customers.
4. Demonstrate the installation, repair and delivery of network systems.

Visual Arts Career Pathway (AR-VIS)

1. Describe the history and evolution of the visual arts and its role in and impact on society.
2. Analyze how the application of visual arts elements and principles of design communicate and express ideas.
3. Analyze and create two and three-dimensional visual art forms using various media.

CLUSTER 4: BUSINESS MANAGEMENT & ADMINISTRATION CAREER CLUSTER™ (BM)

1. Utilize mathematical concepts, skills and problem solving to obtain necessary information for decision-making in business.
2. Describe laws, rules and regulations as they apply to effective business operations.
3. Explore, develop and apply strategies for ensuring a successful business career.
4. Identify, demonstrate and implement solutions in managing effective business customer relationships.
5. Implement systems, strategies and techniques used to manage information in a business.
6. Implement, monitor and evaluate business processes to ensure efficiency and quality results.

Administrative Support Career Pathway (BM-ADM)

1. Plan, staff, lead and organize human resources to enhance employee productivity and satisfaction.
2. Access, evaluate and disseminate information for business decision making.
3. Plan, monitor and manage day-to-day business activities.

Business Information Management Career Pathway (BM-BIM)

1. Describe and follow laws and regulations affecting business operations and transactions.
2. Plan, monitor, manage and maintain the use of financial resources to ensure a business's financial wellbeing.
3. Access, evaluate and disseminate information for business decision making.
4. Plan, monitor and manage day-to-day business activities to sustain continued business functioning.
5. Plan, organize and manage an organization/department to achieve business goals.

General Management Career Pathway (BM-MGT)

1. Describe and follow laws and regulations affecting business operations and transactions.
2. Access, evaluate and disseminate information for business decision making.
3. Apply economic concepts fundamental to global business operations.
4. Employ and manage techniques, strategies and systems to enhance business relationships.
5. Plan, monitor, manage and maintain the use of financial resources to ensure a business's financial wellbeing.
6. Plan, monitor and manage day-to-day business activities to sustain continued business functioning.
7. Plan, organize and manage an organization/department to achieve business goals.
8. Create strategic plans used to manage business growth, profit and goals.

Human Resources Management Career Pathway (BM-HR)

1. Describe and follow laws and regulations affecting human resource operations.
2. Access, evaluate and disseminate information for human resources management decision making.
3. Motivate and supervise personnel to achieve completion of projects and business goals.
4. Plan, monitor and manage the use of financial and human resources to ensure a business's financial wellbeing.
5. Plan, staff, lead and organize human resources to enhance employee productivity and satisfaction.
6. Plan, monitor and manage day-to-day business activities to foster a healthy and safe work environment.
7. Plan, organize and implement compensation, benefits, health and safety programs.

Operations Management Career Pathway (BM-OP)

1. Describe and follow laws and regulations affecting business operations and transactions.
2. Develop and maintain positive customer relationships.
3. Apply inventory tracking systems to facilitate operational controls.
4. Plan, monitor and manage day-to-day business activities to maintain and improve operational functions.

CLUSTER 5: EDUCATION & TRAINING CAREER CLUSTER™ (ED)

1. Apply communication skills with students, parents and other groups to enhance learning and a commitment to learning.

2. Demonstrate effective oral, written and multimedia communication in multiple formats and contexts.
3. Use critical thinking to process educational communications, perspectives, policies and/or procedures.
4. Evaluate and manage risks to safety, health and the environment in education and training settings.
5. Demonstrate group collaboration skills to enhance professional education and training practice.
6. Analyze ethical and legal policies of professional education and training practice.
7. Explain legal rights that apply to individuals and practitioners within education and training settings.
8. Demonstrate ethical and legal behavior within and outside of education and training settings.
9. Describe state-specific professional development requirements to maintain employment and to advance in an education and training career.
10. Apply organizational skills and logic to enhance professional education and training practice.
11. Demonstrate group management skills that enhance professional education and training practice.

Administration & Administration Support Career Pathway (ED-ADM)

1. Use research-based practices to develop, communicate and enlist support for a vision of success for all learners.
2. Identify behaviors necessary for developing and sustaining a positive learning culture.
3. Create instructional programs to meet the learning organization's objectives.
4. Identify instructional practices that meet the learning organization's objectives.
5. Model leadership skills for personnel in order to improve the performance of the learning organization.
6. Identify operations to meet the learning organization's objectives.
7. Plan strategically to meet the learning organization's objectives.
8. Apply internal and external resources to meet the learning organization's objectives and learner needs.
9. Describe advocacy strategies to promote the learning organization's needs.

Professional Support Services Career Pathway (ED-PS)

1. Identify strategies, techniques and tools used to determine the needs of diverse learners.
2. Implement methods to enhance learner success.
3. Identify resources and support services to meet learners' needs.
4. Identify resources and support services available in the learning organization to enhance the learning environment.

Teaching/Training Career Pathway (ED-TT)

1. Use foundational knowledge of subject matter to plan and prepare effective instruction and design courses or programs.
2. Employ knowledge of learning and developmental theory to describe individual learners.
3. Use content knowledge and skills of instruction to develop standards-based goals and assessments.
4. Identify materials and resources needed to support instructional plans.
5. Establish a positive climate to promote learning.
6. Identify motivational, social and psychological practices that guide personal conduct.
7. Demonstrate organizational and relationship building skills used to manage instructional activities and related procedures.
8. Demonstrate flexibility and adaptability in instructional planning.
9. Utilize assessment and evaluation tools and data to advance learner achievement and adjust instructional plans.
10. Evaluate teaching and training performance indicators to determine and improve effectiveness of instructional practices and professional development.
11. Implement strategies to maintain relationships with others to increase support for the organization.

CLUSTER 6: FINANCE CAREER CLUSTER™ (FN)

1. Utilize mathematical concepts, skills and problem solving to obtain necessary information for decision making in the finance industry.
2. Utilize tools, strategies and systems to plan, monitor, manage and maintain the use of financial resources.
3. Plan, staff, lead and organize human resources in finance to enhance employee productivity and job satisfaction.
4. Determine effective tools, techniques and systems to communicate and deliver value to finance customers.
5. Create and maintain positive, ongoing relationships with finance customers.
6. Plan, monitor and manage day-to-day activities to ensure effective and efficient finance operations.
7. Implement safety, health and environmental controls to ensure a safe and productive finance work workplace.
8. Describe and follow laws, regulations and ethical standards that affect finance operations and transactions.
9. Plan, manage and maintain the use of financial resources to protect solvency.
10. Plan, organize and manage a finance organization/department.
11. Plan, monitor and manage day-to-day activities required to sustain continued business functioning.
12. Access, evaluate and disseminate financial information to enhance financial decision-making processes.
13. Manage a financial product or service mix in order to respond to market opportunities.
14. Employ financial risk-management strategies and techniques used to minimize business loss.

Accounting Career Pathway (FN-ACT)

1. Describe and follow laws and regulations to manage accounting operations and transactions.
2. Utilize accounting tools, strategies and systems to plan, monitor, manage and maintain the use of financial resources.
3. Process, evaluate and disseminate financial information to assist business decision making.
4. Utilize career-planning concepts, tools and strategies to explore, obtain and/or develop an accounting career.

Banking Services Career Pathway (FN-BNK)

1. Describe and follow laws and regulations to manage business operations and transactions in the banking services industry.

2. Create and maintain positive, ongoing relationships with banking customers.
3. Manage the use of financial resources to enhance banking performance.
4. Demonstrate the use of banking technology and equipment.
5. Plan, monitor and manage the day-to-day activities within a banking organization to ensure secure operations.
6. Utilize career-planning concepts, tools and strategies to explore, obtain and/or develop a career in banking services.
7. Determine client needs and wants and respond through planned, personalized communication to guide purchase decisions and enhance future business opportunities in banking services.

Business Finance Career Pathway (FN-BFN)

1. Describe and follow laws and regulations to manage business operations and transactions in corporate finance.
2. Manage the use of financial resources to ensure business stability.
3. Utilize career-planning concepts, tools and strategies to explore, obtain and/or develop in a corporate finance career.
4. Employ risk-management strategies and techniques in corporate finance to minimize business loss.

Insurance Career Pathway (FN-INS)

1. Describe and follow laws and regulations to manage business operations and transactions in the insurance industry.
2. Plan, monitor and manage day-to-day insurance organization activities.
3. Utilize career-planning concepts, tools and strategies to explore, obtain and/or develop a career in insurance.
4. Demonstrate underwriting techniques and strategies to evaluate the risk posed by potential insurance clients.
5. Determine client needs and wants and respond through planned, personalized communication to guide purchase decisions and enhance future insurance business opportunities.

Securities & Investments Career Pathway (FN-SEC)

1. Describe and follow laws and regulations to manage business operations and transactions in the securities and investments industry.
2. Manage the use of financial resources to perform key duties in the securities and investments industry.
3. Plan, monitor and manage day-to-day securities and investments operations.
4. Utilize career-planning concepts, tools and strategies to explore, obtain and/or develop in a securities and investments career.
5. Determine client needs and wants and respond through planned, personalized communication to guide purchase decisions and enhance future securities and investments opportunities.

CLUSTER 7: GOVERNMENT & PUBLIC ADMINISTRATION CAREER CLUSTER™ (GV)

1. Explain the purpose and functions of government and public administration and the application of democratic principles in the process of governmental and administrative policymaking.
2. Analyze the systemic relationships of government and public administration agencies.
3. Describe health, safety and environmental management systems, as well as policies and procedures in government and public administration agencies.
4. Describe the implementation of plans and policies to respond to public health, safety and environmental needs in government and public administration agencies.
5. Describe career opportunities and the means to achieve those opportunities in each of the Government & Public Administration Career Pathways.
6. Explain the administration of human, financial, material and information resources in government and public administration agencies.

Foreign Service Career Pathway (GV-FOR)

1. Apply the knowledge acquired from history, law, geography, science, language studies, social sciences (including economic and political science), business, foreign policy and culture to perform diplomatic functions.
2. Describe the laws, customs and current administrative practices of the United States and host countries used to manage administrative, social and policy matters.
3. Describe the application of United States and host country laws, regulations, policies and procedures used to manage consular administrative matters.
4. Describe the application of host country laws, customs and effective administrative practices used to manage the conduct of diplomatic operations.

Governance Career Pathway (GV-GOV)

1. Employ research skills to gather and document factual information, analyze data and interpret statistics applicable to matters of public policy.
2. Develop and articulate reasoned, persuasive arguments to support public policy options or positions.
3. Select and apply appropriate political processes to gain consensus for the resolution of differing opinions and positions.
4. Advocate to gain support for new laws, regulations, ordinances, programs or procedures; alternatively, advocate to gain support to reform or revoke existing laws, regulations, ordinances, programs or procedures.

National Security Career Pathway (GV-SEC)

1. Instruct persons who will perform tasks relating to national homeland security.
2. Describe the appropriate duties, responsibilities and authority of a national security agency's personnel at all levels.
3. Describe the leadership characteristics necessary to ensure compliance with rules of engagement and applicable ethical standards.
4. Collect and analyze information from within and outside the United States to assess threats and opportunities regarding national security.

5. Develop strategies to defend against and respond to the effects of chemical, biological, radiological, nuclear (CBRN) or other emergent events.

Planning Career Pathway (GV-PLN)

1. Explain the planning process used to support the development and implementation of new and updated plans, programs and regulations for government and public administration agencies.
2. Develop a comprehensive and focused strategic planning process for government and public administration agencies to manage change.
3. Formulate plans and policies that meet the social, economic and physical needs of the public.

Public Management & Administration Career Pathway (GV-MGT)

1. Describe the organization of a government or public administration department or agency.
2. Design strategies to maximize the potential of a government or public administration department or agency to meet its vision, mission and goals.
3. Utilize fiscal management skills to manage budget and allocation processes to ensure that resources are applied in a manner consistent with the department or agency's vision, mission and goals.
4. Facilitate the flow of ideas and information to keep the department or agency and its constituency informed of policies and operations.
5. Create plans that utilize department or agency expertise to help elected officials and others identify, implement, and achieve common goals and objectives.
6. Use analysis, planning and fiscal services to fund department or agency priorities.
7. Describe ethical and fiscally responsible procurement systems and procedures used to meet department or agency needs.
8. Prepare procurement requirements, procedures and solicitations for bids or proposals.
9. Evaluate bids and proposals consistent with the requirements of the procurement process.
10. Describe the oversight of awarded contracts to ensure the ethical and optimal use of public funds.
11. Describe laws and policies that are used to protect or disclose information.
12. Develop strategies that encourage a creative and innovative environment in a government or public administration department or agency.

Regulation Career Pathway (GV-REG)

1. Describe enforcement of compliance with legal requirements and regulatory standards.

Revenue & Taxation Career Pathway (GV-REV)

1. Examine evidence and ensure revenue compliance by interpreting applicable laws, applying appropriate investigative principles and following relevant procedures.
2. Acquire, analyze and disseminate information to facilitate clear and accurate communication with revenue and taxation stakeholders.
3. Design, develop, operate and review data analysis systems and procedures to minimize and eliminate revenue-related financial problems.

CLUSTER 8: HEALTH SCIENCE CAREER CLUSTER™ (HL)

1. Determine academic subject matter, in addition to high school graduation requirements, necessary for pursuing a health science career.
2. Explain the healthcare worker's role within their department, their organization, and the overall healthcare system.
3. Identify existing and potential hazards to clients, coworkers, visitors, and self in the healthcare workplace.
4. Evaluate the roles and responsibilities of individual members as part of the healthcare team and explain their role in promoting the delivery of quality health care.
5. Analyze the legal and ethical responsibilities, limitations and implications of actions within the healthcare workplace.
6. Evaluate accepted ethical practices with respect to cultural, social and ethnic differences within the healthcare workplace.

Biotechnology Research & Development Career Pathway (HL-BRD)

1. Summarize the goals of biotechnology research and development within legal and ethical protocols.
2. Apply the fundamentals of biochemistry, cell biology, genetics, mathematical concepts, microbiology, molecular biology, organic chemistry and statistics to conduct effective biotechnology research and development of products.
3. Demonstrate basic knowledge of recombinant DNA, genetic engineering, bioprocessing, monoclonal antibody production, nanotechnology, bioinformatics, genomics, proteomics and transcriptomics to conduct biotechnology research and development.
4. Demonstrate the principles of solution preparation, sterile techniques, contamination control, and measurement and calibration of instruments used in biotechnology research.
5. Determine processes for product design and production and how that work contributes to an understanding of the biotechnology product development process.
6. Summarize and explain the larger ethical, moral and legal issues related to biotechnology research, product development and use in society.

Diagnostic Services Career Pathway (HL-DIA)

1. Communicate key diagnostic information to healthcare workers and patients in an accurate and timely manner.
2. Assess and report patient's/client's health status in order to monitor and document patient progress.
3. Demonstrate the principles of body mechanics for positioning, transferring and transporting of patients/clients, and perform them without injury to the patient/client or self.

4. Explain procedures and goals to the patient/client accurately and effectively, using strategies to respond to questions and concerns.
5. Select, demonstrate and interpret diagnostic procedures.

Health Informatics Career Pathway (HL-HI)

1. Communicate health information accurately and within legal and regulatory guidelines, upholding the strictest standards of confidentiality.
2. Describe the content and diverse uses of health information.
3. Demonstrate the use of systems used to capture, retrieve and maintain confidential health information from internal and external sources.

Support Services Career Pathway (HL-SUP)

1. Describe, differentiate and safely perform the responsibilities of healthcare support services roles.
2. Demonstrate work practices that maintain a clean and healthy healthcare facility to reduce or eliminate pathogenic organisms.
3. Follow established internal and external guidelines in order to provide high-quality, effective support services in the healthcare facility.
4. Maximize available resources for proper care and use of healthcare equipment and materials.
5. Implement healthcare facility standards in order to maintain high-quality healthcare facilities.

Therapeutic Services Career Pathway (HL-THR)

1. Utilize communication strategies to answer patient/client questions and concerns on planned procedures and goals.
2. Communicate patient/client information among healthcare team members to facilitate a team approach to patient care.
3. Utilize processes for assessing, monitoring and reporting patient's/clients' health status to the treatment team within protocol and scope of practice.
4. Evaluate patient/client needs, strengths and problems in order to determine if treatment goals are being met.

CLUSTER 9: HOSPITALITY & TOURISM CAREER CLUSTER™ (HT)

1. Describe the key components of marketing and promoting hospitality and tourism products and services.
2. Evaluate the nature and scope of the Hospitality & Tourism Career Cluster™ and the role of hospitality and tourism in society and the economy.
3. Demonstrate hospitality and tourism customer service skills that meet customers' needs.
4. Describe employee rights and responsibilities and employers' obligations concerning occupational health and safety in the hospitality and tourism workplace.
5. Identify potential, real and perceived hazards and emergency situations and determine the appropriate safety and security measures in the hospitality and tourism workplace.
6. Describe career opportunities and means to attain those opportunities in each of the Hospitality & Tourism Career Pathways.

Lodging Career Pathway (HT-LOD)

1. Use various communication technologies to accomplish work tasks in lodging facilities.
2. Explain the role and importance of housekeeping operations to lodging facility.
3. Allocate staff positions to meet the needs of various lodging departments.
4. Describe the role and responsibilities of lodging managers.
5. Compare the advantages and disadvantages of independently owned and chain-affiliated lodging facilities.
6. Analyze the departmental interrelationships of a lodging facility.
7. Explain various check-in and check-out procedures used in the lodging industry.
8. Understand reservation procedures used in the lodging industry.
9. Explain how room access policies and procedures ensure guest safety and minimize risks to the lodging facility.
10. Explain how cash control procedures are used in the lodging industry.
11. Explain how guests and property are protected to minimize losses or liabilities in the lodging facility.
12. Explain the basic legal issues in lodging management.

Recreation, Amusements & Attractions Career Pathway (HT-REC)

1. Describe career opportunities in the Recreation, Amusements & Attractions Career Pathway.
2. Explain admission and traffic control procedures used to manage and control individuals, groups and vehicles in recreation, amusement and attraction venues.
3. Determine the maintenance and technology needs for various recreation, amusement and attraction venues.
4. Describe safety and security issues unique to the Recreation, Amusements & Attractions Career Pathway.
5. Compile a resource base to manage emergency situations in recreation, amusement and attraction venues.
6. Identify safety and security issues for recreation, amusement and attraction venues that might require customer education.
7. Compare different ticket sales options to maximize revenue for recreation, amusement and attraction venues.
8. Describe the types of information and directions a guest would need at a recreation, amusement and attraction entry point.
9. Develop marketing strategies for recreation, amusement and attractions venues.
10. Analyze the merchandising, program and product potential for different recreation, amusement and attraction venues.
11. Compare and contrast various types of recreation, amusement and attraction venues.

Restaurants & Food/ Beverage Services Career Pathway (HT-RFB)

1. Describe ethical and legal responsibilities in food and beverage service facilities.

2. Demonstrate safety and sanitation procedures in food and beverage service facilities.
3. Use information from cultural and geographical studies to guide customer service decisions in food and beverage service facilities.
4. Demonstrate leadership qualities and collaboration with others.
5. Research costs, pricing, market demands and marketing strategies to manage profitability in food and beverage service facilities.
6. Explain the benefits of the use of computerized systems to manage food service operations and guest service.
7. Utilize technical resources for food services and beverage operations to update or enhance present practice.
8. Implement standard operating procedures related to food and beverage production and guest service.
9. Describe career opportunities and qualifications in the restaurant and food service industry.
10. Apply listening, reading, writing and speaking skills to enhance operations and customer service in food and beverage service facilities.

Travel & Tourism Career Pathway (HT-TT)

1. Apply information about time zones, seasons and domestic and international maps to create or enhance travel.
2. Apply unit and time conversion skills to develop travel schedules and compute cost, distance and time (including travel time) factors.
3. Analyze cultural diversity factors to enhance travel planning.
4. Assess the potential (real and perceived) hazards related to multiple environments, and recommend appropriate safety, health and security measures for travelers.
5. Develop a safety and security plan containing proactive and reactive solutions to manage emergency situations for travelers and staff.
6. Use common travel and tourism terminology used to communicate within the industry.
7. Customize travel with diverse transportation, lodging, cruise and food options.
8. Compare and contrast services and products from related industries to understand and evaluate how they impact the delivery of travel and tourism products and services to customers.
9. Identify the community elements necessary to maintain cooperative tourism development efforts.
10. Develop a travel product that matches customer needs, wants and expectations.
11. Design promotional packages to effectively market travel and tourism.
12. Select the most effective communication technique and media venue to convey travel marketing information to a target audience.

CLUSTER 10: HUMAN SERVICES CAREER CLUSTER™ (HU)

1. Evaluate principles of planning, development, implementation and evaluation to accomplish long-range goals in the human services.
2. Evaluate the role of the family, community and human services in society and the economy.
3. Use effective communication with human services clients and their families.
4. Demonstrate ethical and legal conduct in human services settings.
5. Evaluate career opportunities in each of the Human Services Career Pathways.
6. Explain how human development principles enhance the wellbeing of individuals and families.

Consumer Services Career Pathway (HU-CSM)

1. Summarize necessary credentials, licensures or state-specific requirements to prepare for a career in consumer services.
2. Communicate product or equipment features that meet the needs of clients and consumers.
3. Make consumer services recommendations meeting the needs of clients or customers.
4. Analyze financial/economic situations when making recommendations about consumer services.
5. Use standard business processes or procedures to create consumer service information and facilitate client interactions.
6. Use a variety of methods to educate audiences about consumer services.
7. Demonstrate knowledge of ethical and legal responsibilities associated with providing consumer services.
8. Apply business procedures and utilize equipment and facilities to produce satisfying client outcomes.

Counseling & Mental Health Services Career Pathway (HU-CMH)

1. Use clear written, spoken and nonverbal messages when communicating with clients about mental health services and the counseling process.
2. Utilize functional and specialized assessments to evaluate needs and solutions for counseling and mental health.
3. Evaluate client motivation, strengths and weaknesses to develop a client treatment program.
4. Demonstrate knowledge of an operational mental health or counseling program that meets organizational goals.
5. Demonstrate the ethical and legal responsibilities of counseling and mental health services.
6. Choose appropriate counseling and therapy techniques to serve identified needs.

Early Childhood Development & Services Career Pathway (HU-EC)

1. Demonstrate communication techniques with children to facilitate ongoing development and enhance learning.
2. Communicate effectively with fellow staff members to facilitate child development activities.
3. Maintain working knowledge of child development licensing and certification organizations to keep abreast of current procedures and changes.
4. Create and maintain relationships between staff and parents/family members to encourage involvement and facilitate child development and learning.
5. Evaluate safety and sanitation procedures associated with the early childhood education environment to assure compliance and prevent potential hazards.
6. Adhere to ethical and legal responsibilities, laws and regulations to protect children and families.

7. Apply principles of child growth and development, including social, emotional, physical and cognitive milestones, to provide comprehensive program offerings.
8. Evaluate curriculum for inclusiveness of children with special needs.

Family & Community Services Career Pathway (HU-FAM)

1. Use formal and informal assessment practices to create and evaluate a prevention and/or treatment plan.
2. Identify community resources to provide family and community services.
3. Communicate effectively to gain support from the client's family and other support groups.
4. Comply with laws and procedures that govern abuse, neglect, confidentiality and other health and safety situations.
5. Evaluate crisis prevention, intervention and resolution techniques to formulate emergency plans.

Personal Care Services Career Pathway (HU-PC)

1. Analyze basic principles of biology, chemistry and human anatomy for safe and effective utilization and selection of personal care products and services.
2. Evaluate an individualized personal care plan that reflects client preferences, needs and interests for a course of treatment/action.
3. Utilize data and information to maintain electronic records of client services and make recommendations for personal care services.
4. Demonstrate policies and procedures to achieve a safe and healthy environment for personal care services.
5. Develop organizational policies, procedures and regulations that establish personal care organization priorities, accomplish the mission, and provide high-quality service to a diverse set of clients and families.
6. Identify personal care business opportunities enhanced by community involvement, self-improvement and current trends.
7. Apply methods of obtaining feedback to understand expectations and promote high-quality personal care services standards.

CLUSTER 11: INFORMATION TECHNOLOGY CAREER CLUSTER™ (IT)

1. Demonstrate effective professional communication skills and practices that enable positive customer relationships.
2. Use product or service design processes and guidelines to produce a quality information technology (IT) product or service.
3. Demonstrate the use of cross-functional teams in achieving IT project goals.
4. Demonstrate positive cyber citizenry by applying industry accepted ethical practices and behaviors.
5. Explain the implications of IT on business development.
6. Describe trends in emerging and evolving computer technologies and their influence on IT practices.
7. Perform standard computer backup and restore procedures to protect IT information.
8. Recognize and analyze potential IT security threats to develop and maintain security requirements.
9. Describe quality assurance practices and methods employed in producing and providing quality IT products and services.
10. Describe the use of computer forensics to prevent and solve information technology crimes and security breaches.
11. Demonstrate knowledge of the hardware components associated with information systems.
12. Compare key functions and applications of software and determine maintenance strategies for computer systems.

Information Support & Services Career Pathway (IT-SUP)

1. Provide technology support to maintain service.
2. Manage operating systems and software applications, including maintenance of upgrades, patches and service packs.
3. Apply appropriate troubleshooting techniques in resolving computer hardware, software and configuration problems.
4. Perform installation, configuration and maintenance of operating systems.
5. Demonstrate the use of networking concepts to develop a network.
6. Evaluate the effectiveness of an information system.
7. Employ system installation and maintenance skills to setup and maintain an information system.
8. Employ system administration and control skills to monitor the performance of an information system.
9. Employ technical writing and documentation skills in support of an information system.
10. Apply quality assurance processes to maximize information system operation.

Network Systems Career Pathway (IT-NET)

1. Analyze customer or organizational network system needs and requirements.
2. Analyze wired and wireless network systems to determine if they meet specifications (e.g., IEEE, power, security).
3. Design a network system using technologies, tools and standards.
4. Perform network system installation and configuration.
5. Perform network administration, monitoring and support to maintain a network system.

Programming & Software Development Career Pathway (IT-PRG)

1. Analyze customer software needs and requirements.
2. Demonstrate the use of industry standard strategies and project planning to meet customer specifications.
3. Analyze system and software requirements to ensure maximum operating efficiency.
4. Demonstrate the effective use of software development tools to develop software applications.
5. Apply an appropriate software development process to design a software application.
6. Program a computer application using the appropriate programming language.
7. Demonstrate software testing procedures to ensure quality products.
8. Perform quality assurance tasks as part of the software development cycle.

9. Perform software maintenance and customer support functions.
10. Design, create and maintain a database.

Web & Digital Communications Career Pathway (IT-WD)

1. Analyze customer requirements to design and develop a Web or digital communication product.
2. Apply the design and development process to produce user-focused Web and digital communications solutions.
3. Write product specifications that define the scope of work aligned to customer requirements.
4. Demonstrate the effective use of tools for digital communication production, development and project management.
5. Develop, administer and maintain Web applications.
6. Design, create and publish a digital communication product based on customer needs.
7. Evaluate the functionality of a digital communication product using industry accepted techniques and metrics.
8. Implement quality assurance processes to deliver quality digital communication products and services.
9. Perform maintenance and customer support functions for digital communication products.
10. Comply with intellectual property laws, copyright laws and ethical practices when creating Web/digital communications.

CLUSTER 12: LAW, PUBLIC SAFETY, CORRECTIONS & SECURITY CAREER CLUSTER™ (LW)

1. Analyze the nature and scope of the Law, Public Safety, Corrections & Security Career Cluster and the role law, public safety, corrections and security play in society and the economy.
2. Formulate ideas, proposals and solutions to ensure effective and efficient delivery of law, public safety, corrections and/or security services.
3. Assess and implement measures to maintain safe and healthy working conditions in a law, public safety, corrections and/or security environment.
4. Conduct law, public safety, corrections and security work tasks in accordance with employee and employer rights, obligations and responsibilities, including occupational safety and health requirements.
5. Analyze the various laws, ordinances, regulations and organizational rules that apply to careers in law, public safety, corrections and security.
6. Describe various career opportunities and means to those opportunities in each of the Law, Public Safety, Corrections & Security Career Pathways.

Correction Services Career Pathway (LW-EFM)

1. Evaluate the correctional environment for signs of potential problems and/or danger.
2. Demonstrate leadership roles, responsibilities and collaboration in correctional environments.
3. Analyze the impact of federal, state and local laws on correctional facilities.
4. Describe the various roles and impacts of forensics and computer forensics in the resolution of crime in the correctional environment.
5. Describe the legal, regulatory and organizational guidelines governing the correction services.
6. Compare and contrast different career fields in the correction services.
7. Demonstrate effective communication skills (e.g., writing, speaking, active listening and nonverbal communication) in the correctional environment.
8. Analyze the techniques used to manage crisis situations and resolve conflicts in correctional environments.
9. Demonstrate the protocols regarding the reduction or elimination of sexual harassment or abuse in the correctional environment.
10. Analyze situations that require the use of force, including deadly force, to determine when varying degrees of force should be utilized in correctional facilities.
11. Analyze the impact of the Fourth, Fifth, Sixth and Fourteenth Amendments in the correction services environment.
12. Apply the ethical and legal responsibilities of correctional staff to various situations in the correction services environment.
13. Describe the knowledge and technical skills needed to carry out the day-to-day operations at a correctional facility.

Emergency & Fire Management Services Career Pathway (LW-COR)

1. Demonstrate effective communication skills (e.g., writing, speaking, listening and nonverbal communication) while utilizing communications equipment and platforms common to emergency and fire management services.
2. Manage an incident scene as the first responder using emergency response skills.
3. Utilize up-to-date technology equipment and applications to facilitate the management of emergency and fire management situations.
4. Demonstrate an understanding of the objectives and a commitment to the mission of emergency and fire management services.
5. Execute safety procedures and protocols associated with local, state and federal regulations.
6. Develop an organizational professional growth plan including the development of team building and leadership skills within the emergency and fire management environment.
7. Describe the legal, regulatory and organizational guidelines governing emergency and fire management services.
8. Compare and contrast the different career fields in fire and emergency management services.
9. Execute protocols for handling emergency situations that range from minor medical and fire emergencies to area-wide incidents.
10. Demonstrate the use and various applications of the equipment commonly used in emergency and fire management services.
11. Implement an appropriate Incident Command System to effectively manage an incident scene.
12. Use common codes and icons to properly handle and transport potentially hazardous substances in fire and medical emergency scenes.
13. Implement public relations plans to enhance public awareness and safety in fire and emergency situations.

14. Describe the elements and issues involved in using the preparedness and response systems available to manage large-scale disasters.
15. Analyze the key functions and techniques of critical infrastructure protection in cases of terrorism and/or natural disasters.

Law Enforcement Services Career Pathway (LW-ENF)

1. Demonstrate effective communication skills (e.g., writing, speaking, listening and nonverbal communication) required in law enforcement.
2. Demonstrate proficiency in the operation of communication equipment used in an emergency telecommunications center.
3. Utilize anger and conflict management strategies to resolve problems in law enforcement settings.
4. Model behaviors that exhibit integrity and commitment to a code of conduct and ethics for law enforcement professionals.
5. Analyze the impact of federal, state and local laws on law enforcement procedures.
6. Execute established procedures to avoid the violation of the rights guaranteed by the Fourth, Fifth, Sixth and Fourteenth Amendments.
7. Manage crime and loss prevention programs in collaboration with the community.
8. Explain the appropriate techniques for managing crisis situations in order to maintain public safety.
9. Evaluate for the signs of domestic violence, child abuse and neglect.
10. Demonstrate the routine day-to-day tasks conducted by various law enforcement agencies.
11. Describe law enforcement protocols and procedures designed to handle incidents related to homeland security, terrorism and other disaster situations.
12. Demonstrate the procedures to properly protect, document and process the crime scene and all related evidence.
13. Demonstrate procedures to assist individuals requiring special assistance from law enforcement personnel.
14. Describe the behavioral symptoms of drug use and the inherent dangers associated with handling dangerous drugs.

Legal Services Career Pathway (LW-LEG)

1. Demonstrate effective communication skills (writing, speaking, listening and nonverbal communication) in the legal services environment.
2. Interpret nonverbal communication cues in order to discern facts from fabrication.
3. Produce written legal materials using writing strategies applicable to the legal services environment.
4. Apply information technology tools to perform daily tasks assigned to legal services professionals.
5. Analyze the role forensics plays in preventing and solving crimes.
6. Use legal terminology to communicate within the legal services community.
7. Compare and contrast different career fields in the legal services.
8. Analyze the influence of the three branches of the U.S. Government (judicial, legislative and executive) on the legal services.
9. Analyze the impact of the Fourth, Fifth, Sixth and Fourteenth Amendments on the provision of legal services.

Security & Protective Services Career Pathway (LW-SEC)

1. Demonstrate effective communications skills (e.g., writing, speaking, listening and nonverbal communication) when communicating security-related directives, technical concepts and other information.
2. Utilize conflict resolution skills to resolve conflicts among individuals.
3. Compare and contrast the roles, responsibilities, tools and techniques of the criminal justice and security fields.
4. Describe the legal, regulatory and organizational guidelines governing the security and protective services.
5. Analyze the impact of federal, state and local laws on the security and protective services field.
6. Apply ethical and legal responsibilities of security and protective services personnel to various situations in the security and protective services field.
7. Analyze the impact of the Fourth, Fifth, Sixth and Fourteenth Amendments on the security and protective services.
8. Compare and contrast the different career fields in the security and protective services.
9. Evaluate the application and relevance of crime prevention concepts and security assessments to security and protective services functions.
10. Explain the application of risk management principles to the protection of assets in various settings.
11. Describe the importance of utilizing good public relations techniques and building relationships in security and crisis situations.
12. Describe the role of security systems in an overall security strategy.
13. Explain the duties of security and protective services personnel in terrorism, homeland security and disaster preparedness.
14. Apply basic management principles for the effective supervision and management of a security force or an organization's security program.
15. Perform the roles and responsibilities of a security officer, including basic incident response.
16. Compare types and techniques of security approaches within the public and private sectors.
17. Demonstrate the concepts and techniques used to ensure the security of information-based and intangible assets.
18. Summarize the importance and roles of intelligence analysis in crime prevention and homeland security.

CLUSTER 13: MANUFACTURING CAREER CLUSTER™ (MN)

1. Evaluate the nature and scope of the Manufacturing Career Cluster™ and the role of manufacturing in society and in the economy.
2. Analyze and summarize how manufacturing businesses improve performance.
3. Comply with federal, state and local regulations to ensure worker safety and health and environmental work practices.
4. Describe career opportunities and means to achieve those opportunities in each of the Manufacturing Career Pathways.
5. Describe government policies and industry standards that apply to manufacturing.
6. Demonstrate workplace knowledge and skills common to manufacturing.

Health, Safety, & Environmental Assurance Career Pathway (MN-HSE)

1. Demonstrate the safe use of manufacturing equipment.
2. Develop safety plans for production processes that meet health, safety and environmental standards.
3. Demonstrate a safety inspection process to assure a healthy and safe manufacturing environment.
4. Evaluate a system of health, safety and/or environmental programs, projects, policies or procedures to determine compliance.
5. Evaluate continuous improvement protocols and techniques in health, safety and/or environmental practices.
6. Conduct job safety and health analysis for manufacturing jobs, equipment and processes.
7. Develop the components of a training program based on environmental health and safety regulations.

Logistics & Inventory Control Career Pathway (MN-LOG)

1. Demonstrate positive customer service skills in regard to logistics and inventory control issues.
2. Demonstrate proper handling of products and materials in a manufacturing facility.
3. Develop a safety inspection process to assure a healthy and safe manufacturing facility.
4. Manage inventory using logistics and control processes and procedures.

Maintenance, Installation, & Repair Career Pathway (MN-MIR)

1. Demonstrate maintenance skills and proficient operation of equipment to maximize manufacturing performance.
2. Demonstrate the safe use of manufacturing equipment to ensure a safe and healthy environment.
3. Diagnose equipment problems and effectively repair manufacturing equipment.
4. Investigate and employ techniques to maximize manufacturing equipment performance.
5. Implement a preventative maintenance schedule to maintain manufacturing equipment, tools and workstations.
6. Implement an effective, predictive and preventive manufacturing equipment maintenance program.

Manufacturing Production Process Development Career Pathway (MN-PPD)

1. Produce quality products that meet manufacturing standards and exceed customer satisfaction.
2. Research, design and implement alternative manufacturing processes to manage production of new and/or improved products.
3. Monitor, promote and maintain a safe and productive workplace using techniques and solutions that ensure safe production of products.
4. Implement continuous improvement processes in order to maintain quality within manufacturing production.
5. Develop procedures to create products that meet customer needs.

Production Career Pathway (MN-PRO)

1. Diagnose production process problems and take corrective action to meet production quality standards.
2. Manage safe and healthy production working conditions and environmental risks.
3. Make continuous improvement recommendations based on results of production process audits and inspections.
4. Coordinate work teams when producing products to enhance production process and performance.
5. Demonstrate the safe use of manufacturing equipment.

Quality Assurance Career Pathway (MN-QA)

1. Evaluate production operations for product and process quality.
2. Recommend and implement continuous improvement in manufacturing processes.
3. Coordinate work teams to create a product that meets quality assurance standards.
4. Employ project management processes using data and tools to deliver quality, value-added products.
5. Perform safety inspections and training to ensure a safe and healthy workplace.
6. Implement continuous improvement processes to maintain quality products.
7. Identify inspection processes that ensure products meet quality specifications.

CLUSTER 14: MARKETING CAREER CLUSTER™ (MK)

1. Describe the impact of economics, economics systems and entrepreneurship on marketing.
2. Implement marketing research to obtain and evaluate information for the creation of a marketing plan.
3. Plan, monitor, manage and maintain the use of financial resources for marketing activities.
4. Plan, monitor and manage the day-to-day activities required for continued marketing business operations.
5. Describe career opportunities and the means to achieve those opportunities in each of the Marketing Career Pathways.
6. Select, monitor and manage sales and distribution channels.
7. Determine and adjust prices to maximize return while maintaining customer perception of value.
8. Obtain, develop, maintain and improve a product or service mix in response to market opportunities.
9. Communicate information about products, services, images and/or ideas to achieve a desired outcome.
10. Use marketing strategies and processes to determine and meet client needs and wants.

Marketing Communications Career Pathway (MK-COM)

1. Apply techniques and strategies to convey ideas and information through marketing communications.
2. Plan, manage and monitor day-to-day activities of marketing communications operations.
3. Access, evaluate and disseminate information to enhance marketing decision-making processes.
4. Obtain, develop, maintain and improve a marketing communications product or service mix to respond to market opportunities.
5. Communicate information about products, services, images and/or ideas to achieve a desired outcome.

Marketing Management Career Pathway (MK-MGT)

1. Plan, organize and lead marketing staff to achieve business goals.
2. Plan, manage and monitor day-to-day marketing management operations.

3. Plan, manage and organize to meet the requirements of the marketing plan.
4. Access, evaluate and disseminate information to aid in making marketing management decisions.
5. Determine and adjust prices to maximize return and meet customers' perceptions of value.
6. Obtain, develop, maintain and improve a product or service mix in response to market opportunities.
7. Communicate information about products, services, images and/or ideas.

Marketing Research Career Pathway (MK-RES)

1. Plan, organize and manage day-to-day marketing research activities.
2. Design and conduct research activities to facilitate marketing business decisions.
3. Use information systems and tools to make marketing research decisions.

Merchandising Career Pathway (MK-MER)

1. Plan, organize and lead merchandising staff to enhance selling and merchandising skills.
2. Plan, manage and monitor day-to-day merchandising activities.
3. Move, store, locate and/or transfer ownership of retail goods and services.
4. Access, evaluate and disseminate marketing information to facilitate merchandising decisions and activities.
5. Determine and adjust prices to maximize return and meet customers' perceptions of value.
6. Obtain, develop, maintain and improve a product or service mix to respond to market opportunities.
7. Communicate information about retail products, services, images and/or ideas.
8. Create and manage merchandising activities that provide for client needs and wants.

Professional Sales Career Pathway (MK-SAL)

1. Access, evaluate and disseminate sales information
2. Apply sales techniques to meet client needs and wants.
3. Plan, organize and lead sales staff to enhance sales goals.

CLUSTER 15: SCIENCE, TECHNOLOGY, ENGINEERING & MATHEMATICS CAREER CLUSTER™ (ST)

1. Apply engineering skills in a project that requires project management, process control and quality assurance.
2. Use technology to acquire, manipulate, analyze and report data.
3. Describe and follow safety, health and environmental standards related to science, technology, engineering and mathematics (STEM) workplaces.
4. Understand the nature and scope of the Science, Technology, Engineering & Mathematics Career Cluster™ and the role of STEM in society and the economy.
5. Demonstrate an understanding of the breadth of career opportunities and means to those opportunities in each of the Science, Technology, Engineering & Mathematics Career Pathways.
6. Demonstrate technical skills needed in a chosen STEM field.

Engineering & Technology Career Pathway (ST-ET)

1. Use STEM concepts and processes to solve problems involving design and/or production.
2. Display and communicate STEM information.
3. Apply processes and concepts for the use of technological tools in STEM.
4. Apply the elements of the design process.
5. Apply the knowledge learned in STEM to solve problems.
6. Apply the knowledge learned in the study of STEM to provide solutions to human and societal problems in an ethical and legal manner.

Science & Mathematics Career Pathway (ST-SM)

1. Apply science and mathematics to provide results, answers and algorithms for engineering and technological activities.
2. Apply science and mathematics concepts to the development of plans, processes and projects that address real world problems.
3. Analyze the impact that science and mathematics has on society.
4. Apply critical thinking skills to review information, explain statistical analysis, and to translate, interpret and summarize research and statistical data.

CLUSTER 16: TRANSPORTATION, DISTRIBUTION & LOGISTICS CAREER CLUSTER™ (TD)

1. Describe the nature and scope of the Transportation, Distribution & Logistics Career Cluster™ and the role of transportation, distribution and logistics in society and the economy.
2. Describe the application and use of new and emerging advanced techniques to provide solutions for transportation, distribution and logistics problems.
3. Describe the key operational activities required of successful transportation, distribution and logistics facilities.
4. Identify governmental policies and procedures for transportation, distribution and logistics facilities.
5. Describe transportation, distribution and logistics employee rights and responsibilities and employers' obligations concerning occupational safety and health.
6. Describe career opportunities and means to achieve those opportunities in each of the Transportation, Distribution & Logistics Career Pathways.

Facility & Mobile Equipment Maintenance Career Pathway (TD-MTN)

1. Develop preventative maintenance plans and systems to keep facility and mobile equipment inventory in operation.
2. Design ways to improve facility and equipment system performance.

Health, Safety, & Environmental Management Career Pathway (TD-HSE)

1. Describe the health, safety and environmental rules and regulations in transportation, distribution and logistics workplaces.

2. Develop solutions to improve performance of health, safety and environmental management services.

Logistics Planning & Management Services Career Pathway (TD-LOG)

1. Develop solutions to provide and manage logistics services for the company and customers.
2. Analyze and improve performance of logistics systems to provide logistics planning and management services.

Sales & Service Career Pathway (TD-SAL)

1. Analyze the ongoing performance of transportation, logistics and distribution-related sales and service operations.
2. Demonstrate the use of sales and ongoing service of products and services that are transportation related to promote development of existing and future clients and customers.

Transportation Operations Career Pathway (TD-OPS)

1. Develop and evaluate transportation plans to move people and/or goods to meet customer requirements.
2. Analyze performance of transportation operations in order to improve quality and service levels and increase efficiency.
3. Comply with policies, laws and regulations in order to maintain safety, security and health and mitigate the economic and environmental risk of transportation operations.

Transportation Systems / Infrastructure Planning, Management & Regulation Career Pathway (TD-SYS)

1. Develop plans to maintain and/or improve the transportation infrastructure.
2. Assess, plan and manage the implementation of transportation services.
3. Describe ways to improve the system utilization, flow, safety and environmental performance of transportation systems.

Warehousing & Distribution Center Operations Career Pathway (TD-WAR)

1. Demonstrate efficient and effective warehouse and distribution center operations.
2. Describe ways to improve the performance of warehouse and distribution operations.
3. Analyze compliance with company policies and government laws and regulations in warehouse and distribution operations.

The CCTC is being coordinated by the National Association of State Directors of Career Technical Education Consortium (NASDCTEc), which represents the state and territory heads of secondary, postsecondary and adult CTE programs across the nation.

Appendix

Academic Standards for Reading in Science and Technology

Grades 6 – 12

Pennsylvania Department of Education

**PENNSYLVANIA CORE STANDARDS
(GRADES 6 - 12)**

Reading in Science and Technical Subjects

August 2012

VII. TABLE OF CONTENTS

Reading..... 3.5
Students read, understand, and respond to informational text – with an emphasis on comprehension, vocabulary acquisition, and making connections among ideas and between texts with a focus on textual evidence.

- Key Ideas and Details
- Craft and Structure
- Integration of Knowledge and Ideas
- Range and Level of Complex Texts

**PENNSYLVANIA CORE STANDARDS
(GRADES 6 - 12)**

Reading in Science and Technical Subjects

INTRODUCTION

These standards describe what students in the science classroom should know and be able to do with the English language in reading, grades 6 through 12. The standards provide the targets for instruction and student learning essential for success in all academic areas, not just language arts classrooms.

Although the standards are not a curriculum or a prescribed series of activities, school entities will use them to develop a local school curriculum that will meet local students' needs.

The standards below begin at grade 6; standards for K–5 reading in history/social studies, science, and technical subjects are integrated into the K–5 Reading standards. The English Language Arts Standards for Science and Technical Subjects also provide parents and community members with information about what students should know and be able to do as they progress through the educational program and at graduation.

With a clearly defined target provided by the standards, parents, students, educators and community members become partners in learning. Each standard implies an end of year goal – with the understanding that exceeding the standard is an even more desirable end goal.

**PENNSYLVANIA CORE STANDARDS
GRADES 6-12
Reading in Science and Technical Subjects**

3.5 Reading Informational Text Students read, understand and respond to information text - with emphasis on comprehension, making connections among ideas and between texts with focus on textual evidence.			
	GRADE 6-8	GRADE 9-10	GRADE 11-12
Key Ideas and Details	Please Refer to S.A.S. for Grade 6-8 Standards	CC.3.5.9-10.A. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.	CC.3.5.11-12.A. Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
		CC.3.5.9-10.B. Determine the central ideas or conclusions of a text; trace the text’s explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.	CC.3.5.11-12.B. Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
		CC.3.5.9-10.C. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.	CC.3.5.11-12.C. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
Craft and Structure	Please Refer to S.A.S. for Grade 6-8 Standards	CC.3.5.9-10.D. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to <i>grades 9–10 texts and topics</i> .	CC.3.5.11-12.D. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to <i>grades 11–12 texts and topics</i> .
		CC.3.5.9-10.E. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., <i>force, friction, reaction force, energy</i>).	CC.3.5.11-12.E. Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
		CC.3.5.9-10.F. Analyze the author’s purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.	CC.3.5.11-12.F. Analyze the author’s purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.

**PENNSYLVANIA CORE STANDARDS
GRADES 6-12
Reading in Science and Technical Subjects**

3.5 Reading Informational Text Students read, understand and respond to information text - with emphasis on comprehension, making connections among ideas and between texts with focus on textual evidence.			
	GRADE 6-8	GRADE 9-10	GRADE 11-12
Integration of Knowledge and Ideas	Please Refer to S.A.S. for Grade 6-8 Standards	<p>CC.3.5.9-10.G. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.</p>	<p>CC.3.5.11-12.G. Integrate and evaluate multiple sources of information presented in diverse formats and media(e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.</p>
		<p>CC.3.5.9-10.H. Assess the extent to which the reasoning and evidence in a text support the author’s claim or a recommendation for solving a scientific or technical problem.</p>	<p>CC.3.5.11-12.H. Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.</p>
		<p>CC.3.5.9-10.I. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.</p>	<p>CC.3.5.11-12.I. Synthesize information from a range of sources(e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.</p>
Range and Level of Complex Texts	Please Refer to S.A.S. for Grade 6-8 Standards	<p>CC.3.5.9-10.J. By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently.</p>	<p>CC.3.5.11-12.J. By the end of grade 12, read and comprehend science/technical texts in the grades 11–12 text complexity band independently and proficiently.</p>

Appendix

Academic Standards for Writing in Science and Technical Subjects

Grades 6 – 12

Pennsylvania Department of Education

**PENNSYLVANIA CORE STANDARDS
(GRADES 6 - 12)**

Writing in Science and Technical Subjects

VII. TABLE OF CONTENTS

Writing.....8.6
Students write for different purposes and audiences. Students write clear and focused text to convey a well-defined perspective and appropriate content.

- Text Types and Purposes
- Production and Distribution of Writing
- Research to Build and Present Knowledge
- Range of Writing

**PENNSYLVANIA CORE STANDARDS
(GRADES 6 - 12)**

Writing in Science and Technical Subjects

INTRODUCTION

These standards describe what students in the social studies classroom should know and be able to do with the English language in writing, grade 6 through 12. The standards provide the targets for instruction and student learning essential for success in all academic areas, not just language arts classrooms.

Although the standards are not a curriculum or a prescribed series of activities, school entities will use them to develop a local school curriculum that will meet local students' needs. The standards below begin at grade 6; standards for K–5 reading in history/social studies, science, and technical subjects are integrated into the K–5 Writing standards.

The English Language Arts Standards for History and Social Studies also provide parents and community members with information about what students should know and be able to do as they progress through the educational program and at graduation. With a clearly defined target provided by the standards, parents, students, educators and community members become partners in learning.

Each standard implies an end of year goal – with the understanding that exceeding the standard is an even more desirable end goal.

**PENNSYLVANIA CORE STANDARDS
(GRADES 6-12)
Writing In Science and Technical Subjects**

3.6 Writing Students write for different purposes and audiences. Students write clear and focused text to convey a well-defined perspective and appropriate content.			
	GRADE 6-8	GRADE 9-10	GRADE 11-12
Text Types and Purposes	Please Refer to S.A.S. for Grade 6-8 Standards	<p>CC3.6.9-10 A Write arguments focused on <i>discipline-specific content</i>.</p> <ul style="list-style-type: none"> • Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence. • Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience’s knowledge level and concerns. • Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims. • Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. • Provide a concluding statement or section that follows from or supports the argument presented. 	<p>CC.3.6.11-12.A Write arguments focused on <i>discipline-specific content</i>.</p> <ul style="list-style-type: none"> • Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence. • Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline appropriate form that anticipates the audience’s knowledge level, concerns, values, and possible biases. • Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims. • Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. • Provide a concluding statement or section that follows from or supports the argument presented.

**PENNSYLVANIA CORE STANDARDS
(GRADES 6-12)
Writing In Science and Technical Subjects**

3.6 Writing Students write for different purposes and audiences. Students write clear and focused text to convey a well-defined perspective and appropriate content.			
	GRADE 6-8	GRADE 9-10	GRADE 11-12
Text Types and Purposes	Please Refer to S.A.S. for Grade 6-8 Standards	<p>CC.3.6.9-10.B. *</p> <p>Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.</p> <ul style="list-style-type: none"> • Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. • Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience’s knowledge of the topic. • Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts. • Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers. • Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. • Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic). 	<p>CC.3.6.11-12.B. *</p> <p>Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.</p> <ul style="list-style-type: none"> • Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. • Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience’s knowledge of the topic. • Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts. • Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers. • Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

**PENNSYLVANIA CORE STANDARDS
(GRADES 6-12)
Writing In Science and Technical Subjects**

3.6 Writing Students write for different purposes and audiences. Students write clear and focused text to convey a well-defined perspective and appropriate content.			
	GRADE 6-8	GRADE 9-10	GRADE 11-12
Production and Distribution of Writing	Please Refer to S.A.S. for Grade 6-8 Standards	CC.3.6.9-10.C. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.	CC.3.6.11-12.C. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
		CC.3.6.9-10.D. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.	CC.3.6.11-12.D. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
		CC.3.6.9-10.E. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology’s capacity to link to other information and to display information flexibly and dynamically.	CC.3.6.11-12.E. Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information
Research to Build and Present Knowledge	Please Refer to S.A.S. for Grade 6-8 Standards	CC.3.6.9-10.F. Conduct short as well as more sustained research projects to answer a question (including a self generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.	CC.3.6.11-12.F. Conduct short as well as more sustained research projects to answer a question (including a self generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
		CC.3.6.9-10.G. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.	CC.3.6.11-12.G. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.
		CC.3.6.9-10.H. Draw evidence from informational texts to support analysis, reflection, and research.	CC.3.6.11-12.H. Draw evidence from informational texts to support analysis, reflection, and research.

**PENNSYLVANIA CORE STANDARDS
(GRADES 6-12)
Writing In Science and Technical Subjects**

3.6 Writing Students write for different purposes and audiences. Students write clear and focused text to convey a well-defined perspective and appropriate content.			
	GRADE 6-8	GRADE 9-10	GRADE 11-12
Range of Writing	Please Refer to S.A.S. for Grade 6-8 Standards	CC.3.6.9-10.I. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.	CC.3.6.11-12.I. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Appendix

Academic Standards for Mathematics

April 19, 2012

Pennsylvania Department of Education

NOTE: This Instructor's Guide contains standards for grade 8 through high school. Please refer to the Standards Aligned System on the web for standards regarding pre-K through grade 7.

**Pennsylvania Core Standards
Mathematics**

DRAFT date: 4-19-12

INTRODUCTION

The Pennsylvania Core Standards in Mathematics in grades PreK-5 form a solid foundation in whole numbers, addition, subtraction, multiplication, division, fractions, and decimals. Taken together, these elements support a student’s ability to learn and apply more demanding math concepts and procedures. The middle school and high school standards call on students to practice applying mathematical ways of thinking to real world issues and challenges. These standards prepare students to think and reason mathematically.

Additionally, the standards set a rigorous definition of college and career readiness by demanding that students develop a depth of understanding and ability to apply mathematics to novel situations, as college students and employees regularly do. Although the standards are not a curriculum or a prescribed series of activities, school entities will use them to develop a local school curriculum that will meet local students’ needs.

This document includes Pennsylvania Core Standards for Mathematics Content and Mathematical Practice. The mathematics standards define what students should understand and be able to do. Mathematical Practice Standards describes the habits of mind required to reach a level of mathematical proficiency.

Pennsylvania Core Standards Mathematical Content and Mathematical Practice	
Standards for Mathematical Content	Standards for Mathematical Practice
<p>2.1 Numbers and Operations A) Counting and Cardinality B) Number and Operations in Base Ten C) Number and Operations—Fractions D) Ratios and Proportional Relationships E) The Number System F) Number and Quantity</p>	<ul style="list-style-type: none"> • Make sense of problems and persevere in solving them. • Reason abstractly and quantitatively. • Construct viable arguments and critique the reasoning of others. • Model with mathematics. • Use appropriate tools strategically. • Attend to precision. • Look for and make use of structure. • Look for and make sense of regularity in repeated reasoning.
<p>2.2 Algebraic Concepts A) Operations and Algebra Thinking B) Expressions & Equations C) Functions D) Algebra</p>	
<p>2.3 Geometry A) Geometry</p>	
<p>2.4 Measurement, Data and Probability A) Measurement and Data B) Statistics and Probability</p>	

Standards cannot be viewed or addressed in isolation, as the standards depend upon each other, or they may lead into multiple standards across grades; thus, it is imperative that educators are familiar with both the standards that come before and those that follow a particular grade level. These revised standards reflect instructional shifts that occur with the integrated emphasis on content and practice.

Standards are overarching statements of what a proficient math student should know and be able to do. The Pennsylvania assessment anchors and eligible content closely align with the revised standards and are an invaluable source for greater detail.

Key points in mathematics

The standards stress both procedural skills and conceptual understanding to ensure students are learning and applying the critical information they need to succeed at higher levels.

K-5 standards provide students with a solid foundation in whole numbers, addition, subtraction, multiplication, division, fractions, and decimals—which help young students build the foundation to successfully apply more demanding math concepts and procedures, and move into application. The standards also provide detailed guidance to teachers on how to navigate through topics such as fractions, negative numbers, and geometry by maintaining a continuous progression from grade to grade.

Having built a strong foundation at K-5, students can do hands on learning in geometry, algebra, and probability and statistics. Students who have mastered the content and skills through the seventh grade will be well-prepared for algebra in grade 8.

High school standards emphasize practicing how to apply mathematical ways of thinking to real world issues and challenges.

**Pennsylvania Core Standards
Mathematics
DRAFT Date 4-19-12**

The Pennsylvania Core Standards for Mathematics detail four standard areas: Numbers and Operations, Algebraic Concepts, Geometry, and Data Analysis and Probability. These standard areas are reflective of the reporting categories in the Pennsylvania Core Assessment Anchors and Eligible Content. The intent of this document is to provide a useful tool for designing curriculum, instruction, and assessment. The grade level curriculum and instructional shifts in mathematics occur with an integrated emphasis on content and practice. The chart below illustrates the four standard areas and the development and progression of the strands, with an understanding that all is framed around the Standards for Mathematical Practice.

Mathematical Standards: Development and Progression											
Standards for Mathematical Practice											
Make sense of problems and persevere in solving them. Construct viable arguments and critique the reasoning of others. Use appropriate tools strategically. Look for and make use of structure.						Reason abstractly and quantitatively. Model with mathematics. Attend to precision. Look for and express regularity in repeated reasoning.					
	Pre K	K	1	2	3	4	5	6	7	8	HS
2.1 Numbers and Operations	(A) Counting & Cardinality										
		(B) Number and Operations in Base Ten					(D) Ratios and Proportional Relationships			(F) Number & Quantity	
					(C) Number and Operations - Fractions			(E) The Number System			
2.2 Algebraic Concepts	(A) Operations and Algebraic Thinking						(B) Expressions and Equations			(D) Algebra	
										(C) Functions	
2.3 Geometry	(A) Geometry										
2.4 Measurement, Data and Probability	(A) Measurement and Data						(B) Statistics and Probability				

**Pennsylvania Core Standards
Mathematics**

2.1 Numbers and Operations				
The Standards for Mathematical Practice				
Make sense of problems and persevere in solving them. Construct viable arguments and critique the reasoning of others. Use appropriate tools strategically. Look for and make use of structure.			Reason abstractly and quantitatively. Model with mathematics. Attend to precision. Look for and express regularity in repeated reasoning.	
	2.1.6 Grade 6	2.1.7 Grade 7	2.1.8 Grade 8	2.1.HS High School
Pennsylvania’s public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:				
(D) Ratios & Proportional relationships	Please Refer to S.A.S. for Grade 6 Standards	Please Refer to S.A.S. for Grade 7 Standards	Intentionally Blank	(F) Number and Quantity
(E) The Number System			CC.2.1.8.E.1 Distinguish between rational and irrational numbers using their properties. M08.A-N.1.1.1 M08.A-N.1.1.2	(F) Number and Quantity
			Intentionally Blank	
				CC.2.1.HS.F.1 Apply and extend the properties of exponents to solve problems with rational exponents.- A1.1.1.1.1, A1.1.1.1.2, A1.1.1.3.1, A2.1.2.1.1, A2.1.2.1.2, A2.1.2.1.3, A2.1.2.1.4 CC.2.1.HS.F.2 Apply properties of rational and irrational numbers to solve real world or mathematical problems. A1.1.1.1.1, A1.1.1.1.2, A1.1.1.3.1 CC.2.1.HS.F.3 Apply quantitative reasoning to choose and Interpret units and scales in formulas, graphs and data displays. A1.1.2.1.1, A1.1.2.1.2, A1.1.2.1.3, A1.2.1.2.1, A1.2.1.2.2, A2.2.2.1.1, A2.2.2.1.2, A2.2.2.1.3, A2.2.2.1.4, A2.2.3.1.1, A2.2.3.1.2 CC.2.1.HS.F.4 Use units as a way to understand problems and to guide the solution of multi-step problems. A1.1.2.1.1, A1.1.2.1.2, A1.1.2.1.3, A1.2.1.2.1, A1.2.1.2.2, A2.2.2.1.1, A2.2.2.1.2, A2.2.2.1.3, A2.2.2.1.4 CC.2.1.HS.F.5 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. A1.1.2.1.1, A1.1.2.1.2, A1.1.2.1.3, A1.1.2.2.1, A1.1.2.2.2, A1.1.3.1.1, A1.1.3.1.2, A1.1.3.1.3, A1.1.3.2.1, A1.1.3.2.2, A2.2.3.1.1, A2.2.3.1.2 CC.2.1.HS.F.6 Extend the knowledge of arithmetic operations and apply to complex numbers. A2.1.1.1.1, A2.1.1.1.2, A2.1.1.2.1, A2.1.1.2.2 CC.2.1.HS.F.7 Apply concepts of complex numbers in polynomial identities and quadratic equations to solve problems. A2.2.1.1.1, A2.2.1.1.2, A2.2.1.1.3, A2.2.1.1.4

**Pennsylvania Core Standards
Mathematics**

2.1 Numbers and Operations (Continued)					
The Standards for Mathematical Practice					
Make sense of problems and persevere in solving them. Construct viable arguments and critique the reasoning of others. Use appropriate tools strategically. Look for and make use of structure.			Reason abstractly and quantitatively. Model with mathematics. Attend to precision. Look for and express regularity in repeated reasoning.		
	2.1.6 Grade 6	2.1.7 Grade 7	2.1.8 Grade 8		2.1.HS High School
Pennsylvania’s public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:					
(D) Ratios & Proportional relationships	Please Refer to S.A.S. for Grade 6 Standards	Please Refer to S.A.S. for Grade 7 Standards		(F) Number and Quantity	
			CC.2.1.8.E.4 Estimate irrational numbers by comparing them to rational numbers. M08.A-N.1.1.3 M08.A-N.1.1.4 M08.A-N.1.1.5		
(E) The Number System					

**Pennsylvania Core Standards
Mathematics**

2.2 Algebraic Concepts					
The Standards for Mathematical Practice					
Make sense of problems and persevere in solving them. Construct viable arguments and critique the reasoning of others. Use appropriate tools strategically. Look for and make use of structure.			Reason abstractly and quantitatively. Model with mathematics. Attend to precision. Look for and express regularity in repeated reasoning.		
	2.2.6 Grade 6	2.2.7 Grade 7	2.2.8 Grade 8	2.2.HS High School	
Pennsylvania’s public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:					
(B) Expressions and Equations	Please Refer to S.A.S. for Grade 6 Standards	Please Refer to S.A.S. for Grade 7 Standards	CC.2.2.8.B.1 Apply concepts of radicals and integer exponents to generate equivalent expressions. M08.B-E.1.1.1 M08.B-E.1.1.2 M08.B-E.1.1.3 M08.B-E.1.1.4	(D) Algebra	CC.2.2.HS.D.1 Interpret the structure of expressions to represent a quantity in terms of its context. A1.1.1.5.1, A1.1.1.5.2, A1.1.1.5.3, A2.1.2.2.1, A2.1.2.2.2 CC.2.2.HS.D.2 Write expressions in equivalent forms to solve problems. A1.1.1.5.1, A1.1.1.5.2, A1.1.1.5.3, A2.1.2.1.1, A2.1.2.1.2, A2.1.2.1.3, A2.1.2.1.4, A2.1.2.2.1, A2.1.2.2.2 CC.2.2.HS.D.3 Extend the knowledge of arithmetic operations and apply to polynomials. A1.1.1.5.1, A1.1.1.5.2, A1.1.1.5.3, A2.1.2.2.1, A2.1.2.2.2 CC.2.2.HS.D.4 Understand the relationship between zeros and factors of polynomials to make generalizations about functions and their graphs. A2.1.2.2.1, A2.1.2.2.2
			CC.2.2.8.B.2 Understand the connections between proportional relationships, lines, and linear equations. M08.B-E.2.1.1 M08.B-E.2.1.2 M08.B-E.2.1.3		CC.2.2.HS.D.5 Use polynomial identities to solve problems. A1.1.1.5.1, A1.1.1.5.2, A1.1.1.5.3, A2.1.2.2.1, A2.1.2.2.2, A2.1.3.1.1, A2.1.3.1.2, A2.1.3.1.3, A2.1.3.1.4 CC.2.2.HS.D.6 Extend the knowledge of rational functions to rewrite in equivalent forms. A1.1.1.5.1, A1.1.1.5.2, A1.1.1.5.3, A2.1.3.1.1, A2.1.3.1.2, A2.1.3.1.3, A2.1.3.1.4 CC.2.2.HS.D.7 Create and graph equations or inequalities to describe numbers or relationships. A1.1.2.1.1, A1.1.2.1.2, A1.1.2.1.3, A1.1.3.1.1, A1.1.3.1.2, A1.1.3.1.3, A2.1.3.1.1, A2.1.3.1.2, A2.1.3.1.3, A2.1.3.1.4, A2.2.2.1.1, A2.2.2.1.2, A2.2.2.1.3, A2.2.2.1.4

**Pennsylvania Core Standards
Mathematics**

2.2 Algebraic Concepts					
The Standards for Mathematical Practice					
Make sense of problems and persevere in solving them. Construct viable arguments and critique the reasoning of others. Use appropriate tools strategically. Look for and make use of structure.			Reason abstractly and quantitatively. Model with mathematics. Attend to precision. Look for and express regularity in repeated reasoning.		
	2.2.6 Grade 6	2.2.7 Grade 7	2.2.8 Grade 8	2.2.HS High School	
Pennsylvania’s public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:					
(B) Expressions and Equations	Please Refer to S.A.S. for Grade 6 Standards	Please Refer to S.A.S. for Grade 7 Standards	CC.2.2.8.B.3 Analyze and solve linear equations and pairs of simultaneous linear equations. M08.B-E.3.1.1 M08.B-E.3.1.2 M08.B-E.3.1.3 M08.B-E.3.1.4 M08.B-E.3.1.5	(D) Algebra	CC.2.2.HS.D.8 Apply inverse operations to solve equations or formulas for a given variable. A1.1.2.1.1, A1.1.2.1.2, A1.1.2.1.3, A2.1.3.1.1, A2.1.3.1.2, A2.1.3.1.3, A2.1.3.1.4 CC.2.2.HS.D.9 Use reasoning to solve equations and justify the solution method. A1.1.1.4.1, A1.1.2.1.1, A1.1.2.1.2, A1.1.2.1.3, A1.1.2.2.1, A1.1.2.2.2, A1.1.3.1.1, A1.1.3.1.2, A1.1.3.1.3, A2.1.3.1.1, A2.1.3.1.2, A2.1.3.1.3, A2.1.3.1.4, A2.1.3.2.1, A2.1.3.2.2 CC.2.2.HS.D.10 Represent, solve and interpret equations/inequalities and systems of equations/inequalities algebraically and graphically. A1.1.2.1.1, A1.1.2.1.2, A1.1.2.1.3, A1.1.2.2.1, A1.1.2.2.2, A1.1.3.1.1, A1.1.3.1.2, A1.1.3.1.3, A2.1.3.2.1, A2.1.3.2.2, A2.1.3.1.1, A2.1.3.1.2, A2.1.3.1.3, A2.1.3.1.4
			<u>CC.2.2.8.C.1</u> Define, evaluate, and compare functions. M08.B-F.1.1.1 M08.B-F.1.1.2 M08.B-F.1.1.3		<u>CC.2.2.HS.C.1</u> - Use the concept and notation of functions to interpret and apply them in terms of their context. A1.2.1.1.1, A1.2.1.1.2, A1.2.1.1.3, A1.2.2.1.1, A1.2.2.1.2, A1.2.2.1.3, A1.2.2.1.4, A2.2.1.1.1, A2.2.1.1.2, A2.2.1.1.3, A2.2.1.1.4, G.2.2.2.1, G.2.2.2.2, G.2.2.2.3, G.2.2.2.4, G.2.2.2.5

**Pennsylvania Core Standards
Mathematics**

2.2 Algebraic Concepts (continued)				
The Standards for Mathematical Practice				
Make sense of problems and persevere in solving them. Construct viable arguments and critique the reasoning of others. Use appropriate tools strategically. Look for and make use of structure.			Reason abstractly and quantitatively. Model with mathematics. Attend to precision. Look for and express regularity in repeated reasoning.	
	2.2.6 Grade 6	2.2.7 Grade 7	2.2.8 Grade 8	2.2.HS High School
Pennsylvania’s public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:				
(C) Functions	Please Refer to S.A.S. for Grade 6 Standards (none)	Please Refer to S.A.S. for Grade 7 Standards (none)	<u>CC.2.2.8.C.1</u> Define, evaluate, and compare functions. M08.B-F.1.1.1 M08.B-F.1.1.2 M08.B-F.1.1.3	<u>CC.2.2.HS.C.2</u> - Graph and analyze functions and use their properties to make connections between the different representations. A1.2.1.1.1, A1.2.1.1.2, A1.2.1.1.3, A1.2.1.2.1, A1.2.1.2.2, A2.1.3.2.1, A2.1.3.2.2, A2.2.1.1.1, A2.2.1.1.2, A2.2.1.1.3, A2.2.1.1.4 <u>CC.2.2.HS.C.3</u> - Write functions or sequences that model relationships between two quantities. A1.1.2.1.1, A1.1.2.1.2, A1.1.2.1.3, A1.2.1.1.1, A1.2.1.1.2, A1.2.1.1.3, A1.2.1.2.1, A1.2.1.2.2, A1.2.2.1.1, A1.2.2.1.2, A1.2.2.1.3, A1.2.2.1.4, A2.1.3.1.1, A2.1.3.1.2, A2.1.3.1.3, A2.1.3.1.4, A2.1.3.2.1, A2.1.3.2.2, A2.2.1.1.1, A2.2.1.1.2, A2.2.1.1.3, A2.2.1.1.4, A2.2.2.1.1, A2.2.2.1.2, A2.2.2.1.3, A2.2.2.1.4 <u>CC.2.2.HS.C.4</u> - Interpret the effects transformations have on functions and find the inverses of functions. A1.2.1.2.1, A1.2.1.2.2, A2.1.3.1.1, A2.1.3.1.2, A2.1.3.1.3, A2.1.3.1.4, A2.2.2.1.1, A2.2.2.1.2, A2.2.2.1.3, A2.2.2.1.4 <u>CC.2.2.HS.C.5</u> - Construct and compare linear, quadratic and exponential models to solve problems. A1.2.2.1.1, A1.2.2.1.2, A1.2.2.1.3, A1.2.2.1.4, A2.1.3.1.1, A2.1.3.1.2, A2.1.3.1.3, A2.1.3.1.4, A2.2.1.1.1, A2.2.1.1.2, A2.2.1.1.3, A2.2.1.1.4, A2.2.2.1.1, A2.2.2.1.2, A2.2.2.1.3, A2.2.2.1.4 <u>CC.2.2.HS.C.6</u> - Interpret functions in terms of the situation they model. A1.2.1.2.1, A1.2.1.2.2, A1.2.2.2.1, A2.2.1.1.1, A2.2.1.1.2, A2.2.1.1.3, A2.2.1.1.4, A2.2.2.2.1 <u>CC.2.2.HS.C.7</u> - Apply radian measure of an angle and the unit circle to analyze the trigonometric functions. <u>CC.2.2.HS.C.8</u> - Choose trigonometric functions to model periodic phenomena and describe the properties of the graphs. <u>CC.2.2.HS.C.9</u> - Prove the Pythagorean identity and use it to calculate trigonometric ratios. G.1.3.2.1, G.2.1.1.1, G.2.1.1.2
			<u>CC.2.2.8.C.2</u> Use concepts of functions to model relationships between quantities. M08.B-F.2.1.1 M08.B-F.2.1.2	

**Pennsylvania Core Standards
Mathematics**

2.3 Geometry				
The Standards for Mathematical Practice				
Make sense of problems and persevere in solving them. Construct viable arguments and critique the reasoning of others. Use appropriate tools strategically. Look for and make use of structure.			Reason abstractly and quantitatively. Model with mathematics. Attend to precision. Look for and express regularity in repeated reasoning.	
	2.3.6 Grade 6	2.3.7 Grade 7	2.3.8 Grade 8	2.3.HS High School
Pennsylvania’s public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:				
(A) Geometry	Please Refer to S.A.S. for Grade 6 Standards	Please Refer to S.A.S. for Grade 7 Standards	CC.2.3.8.A.1 Apply the concepts of volume of cylinders, cones, and spheres to solve real world and mathematical problems. M08.C-G.3.1.1	(A) Geometry
			CC.2.3.8.A.2 Understand and apply congruence, similarity, and geometric transformations using various tools. M08.C-G.1.1.1 M08.C-G.1.1.2 M08.C-G.1.1.3 M08.C-G.1.1.4	
				<u>CC.2.3.HS.A.1-</u> Use geometric figures and their properties to represent transformations in the plane. <u>CC.2.3.HS.A.2-</u> Apply rigid transformations to determine and explain congruence. G.1.3.1.1, G.1.3.1.2 <u>CC.2.3.HS.A.3</u> Verify and apply geometric theorems as they relate to geometric figures. G.1.2.1.1, G.1.2.1.2, G.1.2.1.3, G.1.2.1.4, G.1.2.1.5, <u>CC.2.3.HS.A.4</u> Apply the concept of congruence to create geometric constructions. <u>CC.2.3.HS.A.5</u> Create justifications based on transformations to establish similarity of plane figures. G.1.3.1.1, G.1.3.1.2 <u>CC.2.3.HS.A.6</u> Verify and apply theorems involving similarity as they relate to plane figures. G.1.3.1.1, G.1.3.1.2, G.1.3.2.1 <u>CC.2.3.HS.A.7</u> Apply trigonometric ratios to solve problems involving right triangles. G.2.1.1.1, G.2.1.1.2 <u>CC.2.3.HS.A.8</u> Apply geometric theorems to verify properties of circles. G.1.1.1.1, G.1.1.1.2, G.1.1.1.3, G.1.1.1.4, G.1.3.2.1 <u>CC.2.3.HS.A.9</u> Extend the concept of similarity to determine arc lengths and areas of sectors of circles. G.1.1.1.1, G.1.1.1.2, G.1.1.1.3, G.1.1.1.4, G.2.1.4.1,

**Pennsylvania Core Standards
Mathematics**

2.3 Geometry (continued)					
The Standards for Mathematical Practice					
Make sense of problems and persevere in solving them. Construct viable arguments and critique the reasoning of others. Use appropriate tools strategically. Look for and make use of structure.			Reason abstractly and quantitatively. Model with mathematics. Attend to precision. Look for and express regularity in repeated reasoning.		
	2.3.6 Grade 6	2.3.7 Grade 7	2.3.8 Grade 8		2.3.HS High School
Pennsylvania’s public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:					
(A) Geometry	Please Refer to S.A.S. for Grade 6 Standards	Please Refer to S.A.S. for Grade 7 Standards	CC.2.3.8.A.2 Understand and apply congruence, similarity, and geometric transformations using various tools. M08.C-G.1.1.1 M08.C-G.1.1.2 M08.C-G.1.1.3 M08.C-G.1.1.4	(A) Geometry	<u>CC.2.3.HS.A.10</u> Translate between the geometric description and the equation for a conic section. G.2.1.4.1 <u>CC.2.3.HS.A.11</u> Apply coordinate geometry to prove simple geometric theorems algebraically. G.2.1.2.1, G.2.1.2.2, G.2.1.2.3, G.2.1.3.1 <u>CC.2.3.HS.A.12</u> Explain volume formulas and use them to solve problems. G.2.3.1.1, G.2.3.1.2, G.2.3.1.3 <u>CC.2.3.HS.A.13</u> Analyze relationships between two-dimensional and three-dimensional objects. G.1.1.1.1, G.1.1.1.2, G.1.1.1.3, G.1.1.1.4, G.1.2.1.1, G.1.2.1.2, G.1.2.1.3, G.1.2.1.4, G.1.2.1.5, G.2.3.2.1 <u>CC.2.3.HS.A.14</u> Apply geometric concepts to model and solve real world problems. G.2.2.4.1, G.2.3.1.1, G.2.3.1.2, G.2.3.1.3
			<u>CC.2.3.8.A.3</u> Understand and apply the Pythagorean Theorem to solve problems. M08.C-G.2.1.1 M08.C-G.2.1.2 M08.C-G.2.1.3		

**Pennsylvania Core Standards
Mathematics**

2.4 Measurement, Data and Probability				
The Standards for Mathematical Practice				
Make sense of problems and persevere in solving them. Construct viable arguments and critique the reasoning of others. Use appropriate tools strategically. Look for and make use of structure.			Reason abstractly and quantitatively. Model with mathematics. Attend to precision. Look for and express regularity in repeated reasoning.	
	Grade 6 2.4.6	Grade 7 2.4.7	Grade 8 2.4.8	High School 2.4.HS
Pennsylvania’s public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:				
(B) Statistics and Probability	Please Refer to S.A.S. for Grade 6 Standards	Please Refer to S.A.S. for Grade 7 Standards	CC.2.4.8.B.1 Analyze and/or interpret bivariate data displayed in multiple representations. M08.D-S.1.1.1 M08.D-S.1.1.2 M08.D-S.1.1.3	(B) Statistics and Probability
			CC.2.4.8.B.2 Understand that patterns of association can be seen in bi-variate data utilizing frequencies. M08.D-S.1.2.1	
			Intentionally Blank	
<p><u>CC.2.4.HS.B.1</u> Summarize, represent, and interpret data on a single count or measurement variable. A1.2.3.1.1, A1.2.3.2.1, A1.2.3.2.2, A1.2.3.2.3</p> <p><u>CC.2.4.HS.B.2</u> Summarize, represent, and interpret data on two categorical and quantitative variables. A1.2.1.1.1, A1.2.1.1.2, A1.2.1.1.3, A1.2.1.2.1, A1.2.1.2.2, A1.2.2.2.1, A2.2.1.1.1, A2.2.1.1.2, A2.2.1.1.3, A2.2.1.1.4, A2.2.3.1.1, A2.2.3.1.2</p> <p><u>CC.2.4.HS.B.3</u> Analyze linear models to make interpretations based on the data. A1.2.2.2.1, A1.2.3.1.1, A1.2.3.2.1, A1.2.3.2.2, A1.2.3.2.3, A2.2.3.1.1, A2.2.3.1.2</p> <p><u>CC.2.4.HS.B.4</u> Recognize and evaluate random processes underlying statistical experiments. A1.2.3.3.1, A2.2.3.2.1, A2.2.3.2.2, A2.2.3.2.3</p> <p><u>CC.2.4.HS.B.5</u> Make inferences and justify conclusions based on sample surveys, experiments, and observational studies. A1.2.3.2.1, A1.2.3.2.2, A1.2.3.2.3, A2.2.3.2.1, A2.2.3.2.2, A2.2.3.2.3</p> <p><u>CC.2.4.HS.B.6</u> Use the concepts of independence and conditional probability to interpret data. A2.2.3.2.1, A2.2.3.2.2, A2.2.3.2.3</p> <p><u>CC.2.4.HS.B.7</u> Apply the rules of probability to compute probabilities of compound events in a uniform probability model. A1.2.3.3.1, A2.2.3.2.1, A2.2.3.2.2, A2.2.3.2.3</p>				

**Pennsylvania Core Standards
Mathematics**

Draft date April 19, 2012

Key terms for this document

1. Standards for mathematical content - these standards define what students should know and be able to do in their study of mathematics.
2. Standards for mathematical practice - these standards describe the processes and proficiencies in which all students from grades K-12 should engage. Educators must instill these standards of practice in their students so that they become habitual. The standards for mathematical practice should be used as the vehicle to deliver the standards of mathematical content.
3. Standard algorithm - a locally agreed upon method of computation which is conventionally taught for solving mathematical problems.
4. Decimal fraction - a fraction whose denominator is a power of ten (examples: $2/100$, $8/10$). These fractions are commonly expressed as decimals.
5. Unit fraction – a rational number written as a fraction where the numerator is one and the denominator is a positive integer (example: $1/20$).
6. Bivariate data – this data involves two variables and is usually represented as a scatter plot.
7. Rule – a single operation (example: add 5 or multiply by 2).

Appendix

Keystone Exams: Algebra I Assessment Anchors and Eligible Content 2012

Pennsylvania Department of Education
www.education.state.pa.us

PENNSYLVANIA DEPARTMENT OF EDUCATION

General Introduction to the Keystone Exam Assessment Anchors

Introduction

Since the introduction of the Keystone Exams, the PDE has been working to create a set of tools designed to help educators improve instructional practices and better understand the Keystone Exams. The assessment anchors, as defined by the eligible content, are one of the many tools PDE believes will better align curriculum, instruction, and assessment practices throughout the Commonwealth. Without this alignment, it will not be possible to significantly improve student achievement across the Commonwealth.

How were the Keystone Exam Assessment Anchors developed?

Prior to the development of the assessment anchors, multiple groups of Pennsylvania educators convened to create a set of standards for each of the Keystone Exams. Enhanced standards, derived from a review of existing standards, focused on what students need to know and be able to do in order to be college and career ready. Since that time, Pennsylvania Core Standards have replaced the enhanced standards and reflect the college and career ready focus. Additionally, the assessment anchors and eligible content statements were created by other groups of educators charged with the task of clarifying the standards assessed on the Keystone Exams. The assessment anchors, as defined by the eligible content, have been designed to hold together, or anchor, the state assessment system and the curriculum/instructional practices in schools. Assessment anchors, as defined by the eligible content, were created with the following design parameters:

1. **Clear:** The assessment anchors are easy to read and are user friendly; they clearly detail which standards are assessed on the Keystone Exams.
2. **Focused:** The assessment anchors identify a core set of standards that could be reasonably assessed on a large scale assessment; this will keep educators from having to guess which standards are critical.
3. **Rigorous:** The assessment anchors support the rigor of the state standards by assessing higher order and reasoning skills.
4. **Manageable:** The assessment anchors define the standards in a way that can be easily incorporated into a course to prepare students for success.

How can teachers, administrators, schools, and districts use these assessment anchors?

The assessment anchors, as defined by the eligible content, can help focus teaching and learning because they are clear, manageable, and closely aligned with the Keystone Exams. Teachers and administrators will be better informed about which standards will be assessed. The assessment anchors and eligible content should be used along with the Standards and the Curriculum Framework of the Standards Aligned System (SAS) to build curriculum, design lessons, and support student achievement.

The assessment anchors and eligible content are designed to enable educators to determine when they feel students are prepared to be successful in the Keystone Exams. An evaluation of current course offerings, through the lens of what is assessed on those particular Keystone Exams, may provide an opportunity for an alignment to ensure student preparedness.

How are the assessment anchors organized?

The assessment anchors, as defined by the eligible content, are organized into cohesive blueprints, each structured with a common labeling system that can be read like an outline. This framework is organized first by module, then by assessment anchor, followed by anchor descriptor, and then finally, at the greatest level of detail, by an eligible content statement. The common format of this outline is followed across the Keystone Exams.

A description of each level in the labeling system for the Keystone Exams is found below:

1. **Module:** The assessment anchors are organized into two thematic modules for each of the Keystone Exams. The module title appears at the top of each page. The module level is important because the Keystone Exams are built using a module format, with each of the Keystone Exams divided into two equal-sized test modules. Each module is made up of two or more assessment anchors.
2. **Assessment Anchor:** The assessment anchor appears in the shaded bar across the top of each assessment anchor table. The assessment anchors represent categories of subject matter that anchor the content of the Keystone Exams. Each assessment anchor is part of a module and has one or more anchor descriptors unified under it.
3. **Anchor Descriptor:** Below each assessment anchor is a specific anchor descriptor. The anchor descriptor level provides further details that delineate the scope of content covered by the assessment anchor. Each anchor descriptor is part of an assessment anchor and has one or more eligible content unified under it.
4. **Eligible Content:** The column to the right of the anchor descriptor contains the eligible content statements. The eligible content is the most specific description of the content that is assessed on the Keystone Exams. This level is considered the assessment limit and helps educators identify the range of the content covered on the Keystone Exams.
5. **Pennsylvania Core Standard:** In the column to the right of each eligible content statement is a code representing one or more Pennsylvania Core Standards that correlate to the eligible content statement. Some eligible content statements include annotations that indicate certain clarifications about the scope of an eligible content.
 - a. e.g. (for example)—sample approach, but not a limit to the eligible content.
 - b. i.e. (that is)—specific limit to the eligible content.
 - c. Note—content exclusions or definable range of the eligible content.

How do the K–12 Pennsylvania Core Standards affect this document?

Assessment anchor and eligible content statements are aligned to the Pennsylvania Core Standards; thus, the former enhanced standards no longer are necessary. Within this document, all standard references reflect the Pennsylvania Core Standards.

The following addresses may be helpful:

Standards Aligned System: www.pdesas.org.

Pennsylvania Department of Education: www.education.state.pa.us.

KEYSTONE EXAMS - ALGEBRA 1
MODULE 1 - Operations and Linear Equations and Inequalities
FINAL - April 6, 2012

ASSESSMENT ANCHOR - A1.1.1 Operations with Real Numbers and Expressions		
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
A1.1.1.1 Represent and/or use numbers in equivalent forms (e.g., integers, fractions, decimals, percents, square roots, and exponents).	A1.1.1.1.1 Compare and/or order any real numbers. Note: Rational and irrational may be mixed.	2.1.8.E.1 Distinguish between rational and irrational numbers using their properties. 2.1.8.E.4 Estimate irrational numbers by comparing them to rational numbers.
	A1.1.1.1.2 Simplify square roots	2.1.HS.F.1 Apply and extend the properties of exponents to solve problems with rational exponents. 2.1.HS.F.2 Apply properties of rational and irrational numbers to solve real world or mathematical problems.
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
A1.1.1.2 Apply number theory concepts to show relationships between real numbers in problem solving settings.	A1.1.1.2.1 Find the Greatest Common Factor (GCF) and/or the Least Common Multiple (LCM) for sets of monomials.	2.1.6.E.3 Develop and/or apply number theory concepts to find common factors and multiples.
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
A1.1.1.3 Use exponents, roots, and/or absolute values to solve problems.	A1.1.1.3.1 Simplify/evaluate expressions involving properties/laws of exponents, roots, and/or absolute values to solve problems. Note: Exponents should be integers from -10 to 10.	2.1.HS.F.1 Apply and extend the properties of exponents to solve problems with rational exponents. 2.1.HS.F.2 Apply properties of rational and irrational numbers to solve real world or mathematical problems. 2.2.8.B.1 Apply concepts of radicals and integer exponents to generate equivalent expressions.

Eligible Content may be assessed using problem-solving situations.

KEYSTONE EXAMS - ALGEBRA 1
MODULE 1 - Operations and Linear Equations and Inequalities
FINAL - April 6, 2012

Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
A1.1.1.4 Use estimation strategies in problem-solving situations.	A1.1.1.4.1 Use estimation to solve problems.	2.2.7.B.3 Model and solve real-world and mathematical problems by using and connecting numerical, algebraic, and/or graphical representations. 2.2.HS.D.9 Use reasoning to solve equations and justify the solution method.
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
A1.1.1.5 Simplify expressions involving polynomials.	A1.1.1.5.1 Add, subtract, and/or multiply polynomial expressions (express answers in simplest form). Note: Nothing larger than a binomial multiplied by a trinomial.	2.2.HS.D.1 Interpret the structure of expressions to represent a quantity in terms of its context. 2.2.HS.D.2 Write expressions in equivalent forms to solve problems.
	A1.1.1.5.2 Factor algebraic expressions, including difference of squares and trinomials. Note: Trinomials are limited to the form ax^2+bx+c where a is equal to 1 after factoring out all monomial factors.	2.2.HS.D.3 Extend the knowledge of arithmetic operations and apply to polynomials.
	A1.1.1.5.3 Simplify/reduce a rational algebraic expression.	2.2.HS.D.5 Use polynomial identities to solve problems. 2.2.HS.D.6 Extend the knowledge of rational functions to rewrite in equivalent forms.

Eligible Content may be assessed using problem-solving situations.

KEYSTONE EXAMS - ALGEBRA 1
MODULE 1 - Operations and Linear Equations and Inequalities
FINAL - April 6, 2012

ASSESSMENT ANCHOR - 1.1.2 Linear Equations		
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
<p>A1.1.2.1 Write, solve, and/or graph linear equations using various methods.</p>	<p>A1.1.2.1.1 Write, solve, and/or apply a linear equation (including problem situations).</p>	<p>2.2.8.B.3 Analyze and solve linear equations and pairs of simultaneous linear equations.</p> <p>2.1.HS.F.3 Apply quantitative reasoning to choose and interpret units and scales in formulas, graphs and data displays.</p> <p>2.1.HS.F.4 Use units as a way to understand problems and to guide the solution of multi-step problems.</p> <p>2.1.HS.F.5 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p> <p>2.2.HS.D.7 Create and graph equations or inequalities to describe numbers or relationships.</p> <p>2.2.HS.D.8 Apply inverse operations to solve equations or formulas for a given variable.</p> <p>2.2.HS.D.9 Use reasoning to solve equations and justify the solution method.</p> <p>2.2.HS.D.10 Represent, solve and interpret equations/inequalities and systems of equations/inequalities algebraically and graphically.</p> <p>2.2.HS.C.3 Write functions or sequences that model relationships between two quantities.</p>
	<p>A1.1.2.1.2 Use and/or identify an algebraic property to justify any step in an equation-solving process. Note: Linear equations only.</p>	
	<p>A1.1.2.1.3 Interpret solutions to problems in the context of the problem situation. Note: Linear equations only.</p>	

Eligible Content may be assessed using problem-solving situations.

KEYSTONE EXAMS - ALGEBRA 1
MODULE 2 - Operations and Linear Equations and Inequalities
FINAL - April 6, 2012

Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
<p>A1.1.2.2 Write, solve, and/or graph systems of linear equations using various methods.</p>	<p>A1.1.2.2.1 Write and/or solve a system of linear equations (including problem situations) using graphing, substitution, and/or elimination. Note: Limit systems to two linear equations.</p>	<p>2.2.8.B.3 Analyze and solve linear equations and pairs of simultaneous linear equations. 2.2.HS.D.9 Use reasoning to solve equations and justify the solution method.</p>
	<p>A1.1.2.2.2 Interpret solutions to problems in the context of the problem situation. Note: Limit systems to two linear equations.</p>	<p>2.2.HS.D.10 Represent, solve and interpret equations/inequalities and systems of equations/inequalities algebraically and graphically. 2.1.HS.F.5 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p>

Eligible Content may be assessed using problem-solving situations.

KEYSTONE EXAMS - ALGEBRA 1
MODULE 1 - Operations and Linear Equations and Inequalities
FINAL - April 6, 2012

ASSESSMENT ANCHOR - A1.1.3 - Linear Equalities		
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
A1.1.3.1 Write, solve, and/or graph linear inequalities using various methods.	A1.1.3.1.1 Write or solve compound inequalities and/or graph their solution sets on a number line (may include absolute value inequalities).	2.2.HS.D.7 Create and graph equations or inequalities to describe numbers or relationships. 2.2.HS.D.9 Use reasoning to solve equations and justify the solution method. 2.2.HS.D.10 Represent, solve and interpret equations/inequalities and systems of equations/inequalities algebraically and graphically. 2.1.HS.F.5 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
	A1.1.3.1.2 Identify or graph the solution set to a linear inequality on a number line.	
	A1.1.3.1.3 Interpret solutions to problems in the context of the problem situation. Note: Limit to linear inequalities.	
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
A1.1.3.2 Write, solve, and/or graph systems of linear inequalities using various methods.	A1.1.3.2.1 Write and/or solve a system of linear inequalities using graphing. Note: Limit systems to two linear inequalities.	2.2.HS.D.10 Represent, solve and interpret equations/inequalities and systems of equations/inequalities algebraically and graphically. 2.1.HS.F.5 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
	A1.1.3.2.2 Interpret solutions to problems in the context of the problem situation. Note: Limit systems to two linear inequalities.	

Eligible Content may be assessed using problem-solving situations.

KEYSTONE EXAMS - ALGEBRA 1
MODULE 2 - Linear Functions and Data Organizations
FINAL - April 6, 2012

ASSESSMENT ANCHOR - A.1.2.1. - Functions		
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
A1.2.1.1 Analyze and/or use patterns or relations.	A1.2.1.1.1 Analyze a set of data for the existence of a pattern and represent the pattern algebraically and/or graphically.	2.2.HS.C.2 Graph and analyze functions and use their properties to make connections between the different representations.
	A1.2.1.1.2 Determine whether a relation is a function, given a set of points or a graph.	2.2.HS.C.1 Use the concept and notation of functions to interpret and apply them in terms of their context.
	A1.2.1.1.3 Identify the domain or range of a relation (may be presented as ordered pairs, a graph, or a table).	2.2.HS.C.3 Write functions or sequences that model relationships between two quantities. 2.4.HS.B.2 Summarize, represent, and interpret data on two categorical and quantitative variables.

Eligible Content may be assessed using problem-solving situations.

KEYSTONE EXAMS - ALGEBRA 1
MODULE 2 - Linear Functions and Data Organizations
FINAL - April 6, 2012

Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
A1.2.1.2 Interpret and/or use linear functions and their equations, graphs, or tables.	A1.2.1.2.1 Create, interpret, and/or use the equation, graph, or table of a linear function.	2.2.8.B.2 Understand the connections between proportional relationships, lines, and linear equations. 2.4.HS.B.2 Summarize, represent, and interpret data on two categorical and quantitative variables. 2.1.HS.F.3 Apply quantitative reasoning to choose and interpret units and scales in formulas, graphs and data displays. 2.1.HS.F.4 Use units as a way to understand problems and to guide the solution of multi-step problems. 2.2.HS.C.2 Graph and analyze functions and use their properties to make connections between the different representations. 2.2.HS.C.3 Write functions or sequences that model relationships between two quantities. 2.2.HS.C.4 Interpret the effects transformations have on functions and find the inverses of functions. 2.2.HS.C.6 Interpret functions in terms of the situation they model.
	A1.2.1.2.2 Translate from one representation of a linear function to another (i.e., graph, table, and equation).	

Eligible Content may be assessed using problem-solving situations.

KEYSTONE EXAMS - ALGEBRA 1
MODULE 2 - Linear Functions and Data Organizations
FINAL - April 6, 2012

ASSESSMENT ANCHOR - A.1.2.2 Coordinate Geometry		
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
A1.2.2.1 Describe, compute, and/or use the rate of change (slope) of a line.	A1.2.2.1.1 Identify, describe, and/or use constant rates of change.	2.2.8.C.1 Define, evaluate, and compare functions.
	A1.2.2.1.2 Apply the concept of linear rate of change (slope) to solve problems.	2.2.8.C.2 Use concepts of functions to model relationships between quantities.
	A1.2.2.1.3 Write or identify a linear equation when given •• the graph of the line, •• two points on the line, or •• the slope and a point on the line. Note: Linear equation may be in point-slope, standard, and/or slope-intercept form.	2.2.HS.C.1 Use the concept and notation of functions to interpret and apply them in terms of their context.
	A1.2.2.2.1 Draw, identify, find, and/or write an equation for a line of best fit for a scatter plot.	2.2.HS.C.3 Write functions or sequences that model relationships between two quantities.
		2.2.HS.C.5 Construct and compare linear, quadratic and/or exponential models to solve problems.
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
A1.2.2.2 Analyze and/or interpret data on a scatter plot.	A1.2.2.2.1 Draw, identify, find, and/or write an equation for a line of best fit for a scatter plot.	2.4.HS.B.2 Summarize, represent, and interpret data on two categorical and quantitative variables.
		2.4.HS.B.3 Analyze linear models to make interpretations based on the data.
		2.2.HS.C.6 Interpret functions in terms of the situation they model.

Eligible Content may be assessed using problem-solving situations.

KEYSTONE EXAMS - ALGEBRA 1
MODULE 2 - Linear Functions and Data Organizations
FINAL - April 6, 2012

ASSESSMENT ANCHOR - A.1.2.3 - Data Analysis		
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
A1.2.3.1 Use measures of dispersion to describe a set of data.	A1.2.3.1.1 Calculate and/or interpret the range, quartiles, and interquartile range of data.	2.4.HS.B.1 Summarize, represent, and interpret data on a single count or measurement variable. 2.4.HS.B.3 Analyze linear models to make interpretations based on the data.
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
A1.2.3.2 Use data displays in problem solving settings and/or to make predictions.	A1.2.3.2.1 Estimate or calculate to make predictions based on a circle, line, bar graph, measures of central tendency, or other representations.	2.4.HS.B.1 - Summarize, represent, and interpret data on a single count or measurement variable. 2.4.HS.B.3 Analyze linear models to make interpretations based on the data. 2.4.HS.B.5 Make inferences and justify conclusions based on sample surveys, experiments, and observational studies.
	A1.2.3.2.2 Analyze data, make predictions, and/or answer questions based on displayed data (box-and-whisker plots, stem-and-leaf plots, scatter plots, measures of central tendency, or other representations).	
	A1.2.3.2.3 Make predictions using the equations or graphs of best-fit lines of scatter plots.	
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
A1.2.3.3 Apply probability to practical situations.	A1.2.3.3.1 - Find probabilities for compound events (e.g., find probability of red and blue, find probability of red or blue) and represent as a fraction, decimal, or percent.	2.4.HS.B.4 - Recognize and evaluate random processes underlying statistical experiments. 2.4.HS.B.7 - Apply the rules of probability to compute probabilities of compound events in a uniform probability model.

Eligible Content may be assessed using problem-solving situations.

Appendix

Keystone Exams: Algebra II Assessment Anchors and Eligible Content 2012

Pennsylvania Department of Education
www.education.state.pa.us

PENNSYLVANIA DEPARTMENT OF EDUCATION

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A description of each level in the labeling system for the Keystone Exams is found below:

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3. **Anchor Descriptor:** Below each assessment anchor is a specific anchor descriptor. The anchor descriptor level provides further details that delineate the scope of content covered by the assessment anchor. Each anchor descriptor is part of an assessment anchor and has one or more eligible content unified under it.
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Pennsylvania Department of Education: www.education.state.pa.us.

KEYSTONE EXAMS - ALGEBRA II page 4
MODULE 1 - Number Systems and Non-Linear Expressions and Equations
FINAL - April 6, 2012

ASSESSMENT ANCHOR - A2.1.1		
Operations with Complex Numbers		
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
A2.1.1.1 Represent and/or use imaginary numbers in equivalent forms (e.g., square roots and exponents).	A2.1.1.1.1 Simplify/write square roots in terms of $\sqrt{\quad}$ I (e.g., $\sqrt{-24} = 2i\sqrt{6}$).	2.1.HS.F.6 Extend the knowledge of arithmetic operations and apply to complex numbers .
	A2.1.1.1.2 Simplify/evaluate expressions involving powers of i (e.g., $i^6 + i^3 = -1 - i$).	
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
A2.1.1.2 Apply the order of operations in computation and in problem-solving situations.	A2.1.1.2.1 Add and subtract complex numbers (e.g., $(7 - 3i) - (2 + i) = 5 - 4i$).	2.1.HS.F.6 Extend the knowledge of arithmetic operations and apply to complex numbers.
	A2.1.1.2.2 Multiply and divide complex numbers (e.g., $(7 - 3i)(2 + i) = 17 + i$).	

Eligible Content may be assessed using problem-solving situations.

KEYSTONE EXAMS - ALGEBRA II page 5
MODULE 1 - Number Systems and Non-Linear Expressions and Equations
FINAL - April 6, 2012

ASSESSMENT ANCHOR - A2.1.2 Non-Linear Expressions		
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
A2.1.2.1 Use exponents, roots, and/or absolute values to represent equivalent forms or to solve problems.	A2.1.2.1.1 Use exponential expressions to represent rational numbers.	2.1.HS.F.1 Apply and extend the properties of exponents to solve problems with rational exponents. 2.2.HS.D.2 Write expressions in equivalent forms to solve problems.
	A2.1.2.1.2 Simplify/evaluate expressions involving positive and negative exponents and/or roots (may contain all types of real numbers—exponents should not exceed power of 10).	
	Simplify/evaluate expressions involving multiplying with exponents (e.g., $x^6 \cdot x^7 = x^{13}$), powers of powers (e.g., $(x^6)^7 = x^{42}$) and powers of products (e.g., $(2x^2)^3 = 8x^6$) Note: Limit to rational exponents.	
	A2.1.2.1.4 Simplify or evaluate expressions involving logarithms and exponents (e.g., $\log_2 8 = 3$ or $\log_4 2 = \frac{1}{2}$).	

Eligible Content may be assessed using problem-solving situations.

KEYSTONE EXAMS - ALGEBRA II page 6
MODULE 1 - Number Systems and Non-Linear Expressions and Equations
FINAL - April 6, 2012

ASSESSMENT ANCHOR - A2.1.2 Non-Linear Expressions		
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
A2.1.2.2 Simplify expressions involving polynomials.	A2.1.2.2.1 Factor algebraic expressions, including difference of squares and trinomials. Note: Trinomials limited to the form ax^2+bx+c where a is not equal to 0.	2.2.HS.D.1 Interpret the structure of expressions to represent a quantity in terms of its context. 2.2.HS.D.2 Write expressions in equivalent forms to solve problems. 2.2.HS.D.3 Extend the knowledge of arithmetic operations and apply to polynomials.
	A2.1.2.2.2 Simplify rational algebraic expressions.	2.2.HS.D.4 Understand the relationship between zeros and factors of polynomials to make generalizations about functions and their graphs. 2.2.HS.D.5 Use polynomial identities to solve problems.

Eligible Content may be assessed using problem-solving situations.

KEYSTONE EXAMS - ALGEBRA II page 7
MODULE 1 - Number Systems and Non-Linear Expressions and Equations
FINAL - April 6, 2012

ASSESSMENT ANCHOR - A2.1.3 Non-Linear Equations		
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
A2.1.3.1 Write and/or solve non-linear equations using various methods.	A2.1.3.1.1 Write and/or solve quadratic equations (including factoring and using the Quadratic Formula).	2.2.HS.D.5 Use polynomial identities to solve problems. 2.2.HS.D.6 Extend the knowledge of rational functions to rewrite in equivalent forms.
	A2.1.3.1.2 Solve equations involving rational and/or radical expressions (e.g., $10/(x + 3) + 12/(x - 2) = 1$ or $x^2 + 21x = 14$).	2.2.HS.D.7 Create and graph equations or inequalities to describe numbers or relationships. 2.2.HS.D.8 Apply inverse operations to solve equations or formulas for a given variable.
	A2.1.3.1.3 Write and/or solve a simple exponential or logarithmic equation (including common and natural logarithms).	2.2.HS.D.9 Use reasoning to solve equations and justify the solution method. 2.2.HS.D.10 Represent, solve and interpret equations/inequalities and systems of equations/inequalities algebraically and graphically.
	A2.1.3.1.4 Write, solve, and/or apply linear or exponential growth or decay (including problem situations).	2.2.HS.C.3 Write functions or sequences that model relationships between two quantities. 2.2.HS.C.4 Interpret the effects transformations have on functions and find the inverses of functions. 2.2.HS.C.5 Construct and compare linear, quadratic and exponential models to solve problems.

Eligible Content may be assessed using problem-solving situations.

KEYSTONE EXAMS - ALGEBRA II page 8
MODULE 1 - Number Systems and Non-Linear Expressions and Equations
FINAL - April 6, 2012

ASSESSMENT ANCHOR - A2.1.3 Non-Linear Equations		
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
A2.1.3.2 Describe and/or determine change.	A2.1.3.2.1 Determine how a change in one variable relates to a change in a second variable (e.g., $y = 4/x$; if x doubles, what happens to y ?).	2.2.HS.C.2 Graph and analyze functions and use their properties to make connections between the different representations. 2.2.HS.C.3 Write functions or sequences that model relationships between two quantities. 2.2.HS.D.9 Use reasoning to solve equations and justify the solution method.
	A2.1.3.2.2 Use algebraic processes to solve a formula for a given variable (e.g., solve $d = rt$ for r).	

Eligible Content may be assessed using problem-solving situations.

KEYSTONE EXAMS - ALGEBRA II page 9
MODULE 2 - Functions and Data Analysis
FINAL - April 6, 2012

ASSESSMENT ANCHOR - A2.2.1 Patterns, Relations, and Functions		
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
A2.2.1.1 Analyze and/or use patterns or relations.	A2.2.1.1.1 Analyze a set of data for the existence of a pattern and represent the pattern with a rule algebraically and/or graphically.	2.1.HS.F.7 Apply concepts of complex numbers in polynomial identities and quadratic equations to solve problems.
	A2.2.1.1.2 Identify and/or extend a pattern as either an arithmetic or geometric sequence (e.g., given a geometric sequence, find the 20th term).	2.2.HS.C.1 Use the concept and notation of functions to interpret and apply them in terms of their context.
	A2.2.1.1.3 Determine the domain, range, or inverse of a relation.	2.2.HS.C.2 Graph and analyze functions and use their properties to make connections between the different representations.
	A2.2.1.1.4 Identify and/or determine the characteristics of an exponential, quadratic, or polynomial function (e.g., intervals of increase/decrease, intercepts, zeros, and asymptotes).	2.2.HS.C.3 Write functions or sequences that model relationships between two quantities. 2.2.HS.C.5 Construct and compare linear, quadratic and exponential models to solve problems. 2.2.HS.C.6 Interpret functions in terms of the situation they model. 2.4.HS.B.2 Summarize, represent, and interpret data on two categorical and quantitative variables.

Eligible Content may be assessed using problem-solving situations.

KEYSTONE EXAMS - ALGEBRA II page 10
MODULE 2 - Functions and Data Analysis
FINAL - April 6, 2012

ASSESSMENT ANCHOR - A2.2.2 Applications of Functions		
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
A2.2.2.1 Create, interpret, and/or use polynomial, exponential, and/or logarithmic functions and their equations, graphs, or tables.	A2.2.2.1.1 Create, interpret, and/or use the equation, graph, or table of a polynomial function (including quadratics).	2.1.HS.F.3 Apply quantitative reasoning to choose and interpret units and scales in formulas, graphs and data displays. 2.1.HS.F.4 Use units as a way to understand problems and to guide the solution of multi-step problems. 2.2.HS.C.3 Write functions or sequences that model relationships between two quantities. 2.2.HS.C.4 Interpret the effects transformations have on functions and find the inverses of functions. 2.2.HS.C.5 Construct and compare linear, quadratic and exponential models to solve problems. 2.2.HS.D.7 Create and graph equations or inequalities to describe numbers or relationships.
	A2.2.2.1.2 Create, interpret, and/or use the equation, graph, or table of an exponential or logarithmic function (including common and natural logarithms).	
	A2.2.2.1.3 Determine, use, and/or interpret minimum and maximum values over a specified interval of a graph of a polynomial, exponential, or logarithmic function.	
	A2.2.2.1.4 Translate a polynomial, exponential, or logarithmic function from one representation of a function to another (graph, table, and equation).	
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
A2.2.2.2 Describe and/or determine families of functions.	A2.2.2.2.1 Identify or describe the effect of changing parameters within a family of functions. (e.g., $y = x^2$ and $y = x^2 + 3$, or $y = x^2$ and $y = 3x^2$).	2.2.HS.C.6 Interpret functions in terms of the situation they model.

Eligible Content may be assessed using problem-solving situations.

KEYSTONE EXAMS - ALGEBRA II page II
MODULE 2 - Functions and Data Analysis
FINAL April6, 2012

ASSESSMENT ANCHOR - A2.2.3 Data Analysis		
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
A2.2.3.1 Analyze and/or interpret data on a scatter plot and/or use a scatter plot to make predictions.	A2.2.3.1.1 Draw, identify, find, interpret, and/or write an equation for a regression model (lines and curves of best fit) for a scatter plot.	2.4.HS.B.2 Summarize, represent, and interpret data on two categorical and quantitative variables. 2.4.HS.B.3 Analyze linear models to make interpretations based on the data. 2.1.HS.F.3 Apply quantitative reasoning to choose and interpret units and scales in formulas, graphs and data displays. 2.1.HS.F.5 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
	A2.2.3.1.2 Make predictions using the equations or graphs of regression models (lines and curves of best fit) of scatter plots.	
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
A2.2.3.2 Apply probability to practical situations.	A2.2.3.2.1 Use combinations, permutations, and the fundamental counting principle to solve problems involving probability.	2.4.HS.B.4 Recognize and evaluate random processes underlying statistical experiments. 2.4.HS.B.5 Make inferences and justify conclusions based on sample surveys, experiments, and observational studies. 2.4.HS.B.6 Use the concepts of independence and conditional probability to interpret data. 2.4.HS.B.7 Apply the rules of probability to compute probabilities of compound events in a uniform probability model.
	A2.2.3.2.2 Use odds to find probability and/or use probability to find odds.	
	A2.2.3.2.3 Use probability for independent, dependent, or compound events to predict outcomes.	

Eligible Content may be assessed using problem-solving situations.

Appendix

Keystone Exams: Geometry Assessment Anchors and Eligible Content 2012

Pennsylvania Department of Education
www.education.state.pa.us

PENNSYLVANIA DEPARTMENT OF EDUCATION

General Introduction to the Keystone Exam Assessment Anchors

Introduction

Since the introduction of the Keystone Exams, the PDE has been working to create a set of tools designed to help educators improve instructional practices and better understand the Keystone Exams. The assessment anchors, as defined by the eligible content, are one of the many tools that PDE believes will better align curriculum, instruction, and assessment practices throughout the Commonwealth. Without this alignment, it will not be possible to significantly improve student achievement across the Commonwealth.

How were Keystone Exam Assessment Anchors developed?

Prior to the development of the assessment anchors, multiple groups of Pennsylvania educators convened to create a set of standards for each of the Keystone Exams. Enhanced standards, derived from a review of existing standards, focused on what students need to know and be able to do in order to be college and career ready. Since that time, Pennsylvania Core Standards have replaced the enhanced standards and reflect the college and career ready focus. Additionally, the assessment anchors and eligible content statements were created by other groups of educators charged with the task of clarifying the standards assessed on the Keystone Exams. The assessment anchors, as defined by the eligible content, have been designed to hold together, or anchor, the state assessment system and the curriculum/instructional practices in schools. Assessment anchors, as defined by the eligible content, were created with the following design parameters:

1. **Clear:** The assessment anchors are easy to read and are user friendly; they clearly detail which standards are assessed on the Keystone Exams.
2. **Focused:** The assessment anchors identify a core set of standards that could be reasonably assessed on a large scale assessment; this will keep educators from having to guess which standards are critical.
3. **Rigorous:** The assessment anchors support the rigor of the state standards by assessing higher order and reasoning skills.
4. **Manageable:** The assessment anchors define the standards in a way that can be easily incorporated into a course to prepare students for success.

How can teachers, administrators, schools, and districts use these assessment anchors?

The assessment anchors, as defined by the eligible content, can help focus teaching and learning because they are clear, manageable, and closely aligned with the Keystone Exams. Teachers and administrators will be better informed about which standards will be assessed. The assessment anchors and eligible content should be used along with the Standards and the Curriculum Framework of the Standards Aligned System (SAS) to build curriculum, design lessons, and support student achievement.

The assessment anchors and eligible content are designed to enable educators to determine when they feel students are prepared to be successful in the Keystone Exams. An evaluation of current course offerings, through the lens of what is assessed on those particular Keystone Exams, may provide an opportunity for an alignment to ensure student preparedness.

How are the assessment anchors organized?

The assessment anchors, as defined by the eligible content, are organized into cohesive blueprints, each structured with a common labeling system that can be read like an outline. This framework is organized first by module, then by assessment anchor, followed by anchor descriptor, and then finally, at the greatest level of detail, by an eligible content statement. The common format of this outline is followed across the Keystone Exams.

A description of each level in the labeling system for the Keystone Exams is found below:

1. **Module:** The assessment anchors are organized into two thematic modules for each of the Keystone Exams. The module title appears at the top of each page. The module level is important because the Keystone Exams are built using a module format, with each of the Keystone Exams divided into two equal-sized test modules. Each module is made up of two or more assessment anchors.
2. **Assessment Anchor:** The assessment anchor appears in the shaded bar across the top of each assessment anchor table. The assessment anchors represent categories of subject matter that anchor the content of the Keystone Exams. Each assessment anchor is part of a module and has one or more anchor descriptors unified under it.
3. **Anchor Descriptor:** Below each assessment anchor is a specific anchor descriptor. The anchor descriptor level provides further details that delineate the scope of content covered by the assessment anchor. Each anchor descriptor is part of an assessment anchor and has one or more eligible content unified under it.
4. **Eligible Content:** The column to the right of the anchor descriptor contains the eligible content statements. The eligible content is the most specific description of the content that is assessed on the Keystone Exams. This level is considered the assessment limit and helps educators identify the range of the content covered on the Keystone Exams.
5. **Pennsylvania Core Standard:** In the column to the right of each eligible content statement is a code representing one or more Pennsylvania Core Standards that correlate to the eligible content statement. Some eligible content statements include annotations that indicate certain clarifications about the scope of an eligible content.
 - a. e.g. (for example)—sample approach, but not a limit to the eligible content.
 - b. i.e. (that is)—specific limit to the eligible content.
 - c. Note—content exclusions or definable range of the eligible content.

How do the K–12 Pennsylvania Core Standards affect this document?

Assessment anchor and eligible content statements are aligned to the Pennsylvania Core Standards; thus, the former enhanced standards no longer are necessary. Within this document, all standard references reflect the Pennsylvania Core Standards.

The following addresses may be helpful:

Standards Aligned System: www.pdesas.org.

Pennsylvania Department of Education: www.education.state.pa.us.

KEYSTONE EXAMS - GEOMETRY page 4
MODULE 1 - Geometric Properties and Reasoning
FINAL April 6, 2012

ASSESSMENT ANCHOR - G.1.1 Properties of Circles, Spheres, and Cylinders		
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
G.1.1.1 Identify and/or use parts of circles and segments associated with circles, spheres, and cylinders.	G.1.1.1.1 Identify, determine, and/or use the radius, diameter, segment, and/or tangent of a circle.	2.3.HS.A.8 Apply geometric theorems to verify properties of circles.
	G.1.1.1.2 Identify, determine, and/or use the arcs, semicircles, sectors, and/or angles of a circle.	2.3.HS.A.9 Extend the concept of similarity to determine arc lengths and areas of sectors of circles.
	G.1.1.1.3 Use chords, tangents, and secants to find missing arc measures or missing segment measures.	2.3.HS.A.13 Analyze relationships between two-dimensional and three-dimensional objects.
	G.1.1.1.4 Identify and/or use the properties of a sphere or cylinder.	

Eligible Content may be assessed using problem-solving situations.

KEYSTONE EXAMS – GEOMETRY page 5
MODULE 1 - Geometric Properties and Reasoning
FINAL April 6, 2012

ASSESSMENT ANCHOR - G.1.2 Properties of Polygons and Polyhedra		
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
G.1.2.1 Recognize and/or apply properties of angles, polygons, and polyhedra.	G.1.2.1.1 Identify and/or use properties of triangles.	2.3.HS.A.3 Verify and apply geometric theorems as they relate to geometric figures. 2.3.HS.A.13 Analyze relationships between two-dimensional and three-dimensional objects.
	G.1.2.1.2 Identify and/or use properties of quadrilaterals.	
	G.1.2.1.3 Identify and/or use properties of isosceles and equilateral triangles.	
	G.1.2.1.4 Identify and/or use properties of regular polygons.	
	G.1.2.1.5 Identify and/or use properties of pyramids and prisms.	

Eligible Content may be assessed using problem-solving situations.

KEYSTONE EXAMS – GEOMETRY page 6
MODULE 1 - Geometric Properties and Reasoning
FINAL April 6, 2012

ASSESSMENT ANCHOR - G.1.3 Congruence, Similarity, and Proofs		
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
G.1.3.1 Use properties of congruence, correspondence, and similarity in problem-solving settings involving 2- and 3-dimensional figures.	G.1.3.1.1 Identify and/or use properties of congruent and similar polygons or solids.	2.3.HS.A.2 Apply rigid transformations to determine and explain congruence. 2.3.HS.A.5 Create justifications based on transformations to establish similarity of plane figures. 2.3.HS.A.6 Verify and apply theorems involving similarity as they relate to plane figures.
	G.1.3.1.2 Identify and/or use proportional relationships in similar figures.	
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
G.1.3.2 Write formal proofs and/or use logic statements to construct or validate arguments.	G.1.3.2.1 Write, analyze, complete, or identify formal proofs (e.g., direct and/or indirect proofs/proofs by contradiction).	2.3.HS.A.3 Verify and apply geometric theorems as they relate to geometric figures. 2.3.HS.A.6 Verify and apply theorems involving similarity as they relate to plane figures. 2.3.HS.A.8 Apply geometric theorems to verify properties of circles. 2.2.HS.C.9 Prove the Pythagorean Theorem.

Eligible Content may be assessed using problem-solving situations.

KEYSTONE EXAMS - GEOMETRY page 6
MODULE 1 - Geometric Properties and Reasoning
FINAL April 6, 2012

ASSESSMENT ANCHOR - G.1.3 Congruence, Similarity, and Proofs		
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
G.1.3.1 Use properties of congruence, correspondence, and similarity in problem-solving settings involving 2- and 3-dimensional figures.	G.1.3.1.1 Identify and/or use properties of congruent and similar polygons or solids.	2.3.HS.A.2 Apply rigid transformations to determine and explain congruence. 2.3.HS.A.5 Create justifications based on transformations to establish similarity of plane figures. 2.3.HS.A.6 Verify and apply theorems involving similarity as they relate to plane figures.
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Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
G.1.3.2 Write formal proofs and/or use logic statements to construct or validate arguments.	G.1.3.2.1 Write, analyze, complete, or identify formal proofs (e.g., direct and/or indirect proofs/proofs by contradiction).	2.3.HS.A.3 Verify and apply geometric theorems as they relate to geometric figures. 2.3.HS.A.6 Verify and apply theorems involving similarity as they relate to plane figures. 2.3.HS.A.8 Apply geometric theorems to verify properties of circles. 2.2.HS.C.9 Prove the Pythagorean Theorem.

Eligible Content may be assessed using problem-solving situations.

KEYSTONE EXAMS – GEOMETRY page 7
MODULE 1 - Coordinate Geometry and Measurement
FINAL April 6, 2012

ASSESSMENT ANCHOR G.2.1 Coordinate Geometry and Right Triangles		
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
G.2.1.1 Solve problems involving right triangles.	G.2.1.1.1 Use the Pythagorean theorem to write and/or solve problems involving right triangles.	2.3.HS.A.7 Apply trigonometric ratios to solve problems involving right triangles. 2.2.HS.C.9 Prove the Pythagorean identity and use it to calculate trigonometric ratios.
	G.2.1.1.2 Use trigonometric ratios to write and/or solve problems involving right triangles.	
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
G.2.1.2 Solve problems using analytic geometry.	G.2.1.2.1 Calculate the distance and/or midpoint between two points on a number line or on a coordinate plane.	2.3.HS.A.11 Apply coordinate geometry to prove simple geometric theorems algebraically.
	G.2.1.2.2 Relate slope to perpendicularity and/or parallelism (limit to linear algebraic equations).	
	G.2.1.2.3 Use slope, distance, and/or midpoint between two points on a coordinate plane to establish properties of a 2-dimensional shape.	

Eligible Content may be assessed using problem-solving situations.

KEYSTONE EXAMS – GEOMETRY page 8
MODULE 1 - Coordinate Geometry and Measurement
FINAL April 6, 2012

ASSESSMENT ANCHOR G.2.2 Measurements of Two-Dimensional Shapes and Figures		
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
G.2.2.1 Use and/or compare measurements of angles.	G.2.2.1.1 Use properties of angles formed by intersecting lines to find the measures of missing angles.	2.3.HS.A.3 Verify and apply geometric theorems as they relate to geometric figures.
	G.2.2.1.2 Use properties of angles formed when two parallel lines are cut by a transversal to find the measures of missing angles.	
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
G.2.2.2 Use and/or develop procedures to determine or describe measures of perimeter, circumference, and/or area. (May require conversions within the same system.)	G.2.2.2.1 Estimate area, perimeter, or circumference of an irregular figure.	2.3.HS.A.3 Verify and apply geometric theorems as they relate to geometric figures.
	G.2.2.2.2 Find the measurement of a missing length, given the perimeter, circumference, or area.	
	G.2.2.2.3 Find the side lengths of a polygon with a given perimeter to maximize the area of the polygon.	2.2.HS.C.1 Use the concept and notation of functions to interpret and apply them in terms of their context.
	G.2.2.2.4 Develop and/or use strategies to estimate the area of a compound/composite figure.	
	G.2.2.2.5 Find the area of a sector of a circle.	

Eligible Content may be assessed using problem-solving situations.

KEYSTONE EXAMS - GEOMETRY page 9
MODULE 1 - Coordinate Geometry and Measurement
FINAL April 6, 2012

ASSESSMENT ANCHOR G.2.2 Measurements of Two-Dimensional Shapes and Figures (continued)		
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
G.2.2.3 Describe how a change in one dimension of a 2-dimensional figure affects other measurements of that figure.	G.2.2.3.1 Describe how a change in the linear dimension of a figure affects its perimeter, circumference, and area (e.g., How does changing the length of the radius of a circle affect the circumference of the circle?).	2.3.HS.A.9 Extend the concept of similarity to determine arc lengths and areas of sectors of circles. 2.3.HS.A.8 Apply geometric theorems to verify properties of circles.
	G.2.2.4.1 Use area models to find probabilities.	
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
G.2.2.4 Apply probability to practical situations.	G.2.2.4.1 Use area models to find probabilities.	2.3.HS.A.14 Apply geometric concepts to model and solve real world problems.

Eligible Content may be assessed using problem-solving situations.

KEYSTONE EXAMS - GEOMETRY page 10
MODULE 1 - Coordinate Geometry and Measurement
FINAL April 6, 2012

ASSESSMENT ANCHOR G.2.3 Measurements of Three-Dimensional Shapes and Figures		
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
G.2.3.1 Use and/or develop procedures to determine or describe measures of surface area and/or volume. (May require conversions within the same system.)	G.2.3.1.1 Calculate the surface area of prisms, cylinders, cones, pyramids, and/or spheres. Formulas are provided on a reference sheet.	2.3.HS.A.14 Apply geometric concepts to model and solve real world problems. 2.3.HS.A.12 Explain volume formulas and use them to solve problems.
	G.2.3.1.2 Calculate the volume of prisms, cylinders, cones, pyramids, and/or spheres. Formulas are provided on a reference sheet.	
	G.2.3.1.3 Find the measurement of a missing length, given the surface area or volume.	
Anchor Descriptor	Eligible Content	Pennsylvania Core Standards
G.2.3.2 Describe how a change in one dimension of a 3-dimensional figure affects other measurements of that figure.	G.2.3.2.1 Describe how a change in the linear dimension of a figure affects its surface area or volume (e.g., How does changing the length of the edge of a cube affect the volume of the cube?).	2.3.HS.A.13 Analyze relationships between two-dimensional and three-dimensional objects.

Eligible Content may be assessed using problem-solving situations.