Mississippi Secondary Curriculum Frameworks in Career and Technical Education, Agriculture, Food & Natural Resources

2020 Agricultural Technology and Mechanical Systems (Core)

Mississippi Department of Education

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The Research and Curriculum Unit (RCU), located in Starkville as part of Mississippi State University (MSU), was established to foster educational enhancements and innovations. In keeping with the land-grant mission of MSU, the RCU is dedicated to improving the quality of life for Mississippians. The RCU enhances the intellectual and professional development of Mississippi students and educators while applying knowledge and educational research to the lives of the people of the state. The RCU works within the contexts of curriculum development and revision, research, assessment, professional development, and industrial training.

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Acknowledgments

The agriculture technology and mechanical systems (ATMS) curriculum was presented to the Mississippi State Board of Education on January 16, 2020. The following persons are serving on the State Board at this time:

Brad Skelton, curriculum manager for the RCU at MSU

Standards

Standards for each unit are referenced in the appendices. Standards in the ATMS (Core) curriculum framework and supporting materials are based on the following:

National Agriculture, Food, and Natural Resources (AFNR) Career Cluster Content Standards
The national *AFNR Career Cluster Content Standards* were developed by the National Council on Agricultural Education (NCAE) to serve as a guide for what students should know or be able to do through a study of agriculture in Grades 9-12 and two-year postsecondary programs. The standards were extensively researched and reviewed by leaders in the agricultural industry, secondary and postsecondary instructors, and university specialists. The standards consist of a pathway content standard for each of the eight career pathways. For each content standard, performance elements representing major topic areas with accompanying performance indicators were developed. Measurements of assessment of the performance elements and performance indicators were developed at the basic, intermediate, and advanced levels. A complete copy of the standards can be accessed at thecouncil.ffa.org/afnr/. The national AFNR Career Cluster Content Standards are copyrighted to the NCAE and are used by permission.

College- and Career-Ready Standards
College- and career-readiness standards emphasize critical thinking, teamwork, and problem-solving skills. Students will learn the skills and abilities demanded by the workforce of today and the future. Mississippi adopted *Mississippi College and Career Ready Standards* (*MCCRS*) to provide a consistent, clear understanding of what students are expected to learn so teachers and parents know what they need to do to help them.
http://mdek12.org/OAE/college-and-career-readiness-standards

International Society for Technology in Education (ISTE) Standards
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Framework for 21st Century Learning
In defining 21st century learning, the Partnership for 21st Century Skills has embraced key themes and skill areas that represent the essential knowledge for the 21st century: global awareness; financial, economic, business, and entrepreneurial literacy; civic literacy; health literacy; environmental literacy; learning and innovation skills; information, media, and technology skills; and life and career skills. *21 Framework Definitions*. Published 2015.
p21.org/storage/documents/docs/P21_Framework_Definitions_New_Logo_2015.pdf

Preface

Secondary career and technical education (CTE) programs in Mississippi face many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing true learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments. This document provides information, tools, and solutions that will aid students, teachers, and schools in creating and implementing applied, interactive, and innovative lessons. Through best practices, alignment with national standards and certifications, community partnerships, and a hands-on, student-centered concept, educators will be able to truly engage students in meaningful and collaborative learning opportunities.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, Mississippi Code of 1972, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, ch. 487, §14; Laws, 1991, ch. 423, §1; Laws, 1992, ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act IV, 2007; and Every Student Succeeds Act, 2015).

Mississippi Teacher Professional Resources

The following are resources for Mississippi teachers:

Curriculum, Assessment, Professional Learning
Program resources can be found at the RCU's website: rcu.msstate.edu.

Learning management system: An Online Resource
> Learning management system information can be found at the RCU's website, under Professional Learning.

Should you need additional instructions, call 662.325.2510.

Executive Summary

Pathway Description

ATMS (Core) is an instructional program designed to provide basic skills for students to become employed in the industry of agricultural power mechanics or to continue their education at postsecondary institutions. Skills taught in this pathway relate to the selection, operation, maintenance, service and repair of a variety of agricultural power units and agricultural machinery and equipment. Students in the pathway will participate in active learning exercises, including integral activities of the National FFA Organization and supervised experiences.

College, Career, and Certifications

NCCER Learning Series—Core Standards Credential

Grade Level and Class Size Recommendations

It is recommended that students enter this program as a 10th grader. Exceptions to this are a district-level decision based on class size, enrollment numbers, and maturity of student. The classroom and lab are designed to accommodate a maximum of 15 students.

Student Prerequisites

For students to be able to experience success in the ATMS program, the following student prerequisites are suggested:

1. C or higher in English (the previous year)

2. C or higher in math (last course taken or the instructor can specify the math)

3. Instructor approval and TABE reading score (eighth grade or higher)

   or

1. TABE reading score (eighth grade or higher)

2. Instructor approval

   or

1. Instructor approval

Assessment

The latest assessment blueprint for the curriculum can be found at
rcu.msstate.edu/Curriculum/CurriculumDownload.aspx.
If there are questions regarding assessment of this program, please contact the RCU at 662.325.2510.

Applied Academic Credit

The latest academic credit information can be found at
mdek12.org/ESE/Approved-Course-for-the-Secondary-Schools.

Teacher Licensure

The latest teacher licensure information can be found at mdek12.org/OTL/OEL.

Professional Learning

If you have specific questions about the content of each training session provided, please contact the RCU at 662.325.2510 and ask for a professional learning specialist.

Course Outlines

To complete the pathway, students must complete 4 Carnegie Credits.

CORE—2 Carnegie Credits: ATMS (Core)

Option 1—Two, 1-Carnegie Unit Courses
This curriculum consists of two 1-credit courses, which should be completed in the following sequence:

1. **Introduction to ATMS—Course Code: 991302**

2. **Basic Equipment Systems, Maintenance, and Repair—Course Code: 991303**

Course Description: Introduction to ATMS
This course focuses on introducing students to leadership and career preparation, supervised agricultural work experience, safety, measurements, and basic oxyfuel cutting skills. Students will leave the class with a firm foundation of knowledge in the areas of employability skills, safety, and basic tool knowledge. Additionally, students will learn about the FFA and supervised agricultural experiences (SAE).

Introduction to ATMS—Course Code: 991302

Unit	Unit Name	Hours
1	Introduction to Leadership and Career Preparation	10
2	Introduction to Experiential Learning	4
3	Safety	40
4	Measurement and Industry-Related Math Skills	20
5	Oxyfuel Cutting	26
Total		100

Course Description: Basic Equipment Systems, Maintenance, and Repair
This course introduces students to basic welding, compact engines, and equipment and systems maintenance. Students will master skills related to the safe operation, maintenance, and repair of these systems.

Basic Equipment Systems, Maintenance and Repair —Course Code: 991303

Unit	Unit Name	Hours
6	Shielded Metal Arc Welding (SMAW)	40
7	Compact Engine Inspection, Service, and Repair	60
8	Equipment and Systems Maintenance	10
Total		110

Option 2—One 2-Carnegie Unit Course
This curriculum consists of the following 2-Carnegie unit course:

CORE—2 Carnegie Credits: ATMS (Core) (Course Code: 991300)

Course Description: ATMS
This course focuses on introducing students to leadership and career preparation, supervised agricultural work experience, safety, measurements, and basic oxyfuel cutting skills. Students will leave the class with a firm foundation of knowledge in the areas of employability skills, safety, and basic tool knowledge. Additionally, students will learn about the National FFA Organization and Supervised Agricultural Experience (SAE). Additionally, this course will also introduce students to basic welding, compact engines, and equipment and systems maintenance. Students will master skills related to the safe operation, maintenance, and repair of these systems.

ATMS (Course Code: 991300)

Unit	Unit Name	Hours
1	Introduction to Leadership and Career Preparation	10
2	Introduction to Experiential Learning	4
3	Safety	40
4	Measurement and Industry-Related Math Skills	20
5	Oxyfuel Cutting	26
6	Shielded Metal Arc Welding (SMAW)	40
7	Compact Engine Inspection, Service, and Repair	60
8	Equipment and Systems Maintenance	10
Total		210

Research Synopsis

By implementing the ATMS core, students who successfully master the core should have the skills required to earn the NCCER Learning Series—Core Standards Credential and will be eligible to enter the second-year pathway. These skills are based on industry-validated performance indicators. The pathway will include applied instruction designed to articulate with programs offered in Mississippi's community and junior colleges.

Needs of the Future Workforce
Data for this synopsis were compiled from the Mississippi Department of Employment Security. Employment opportunities for each of the occupations listed below are:

Table 1.1: Current and Projected Occupation Report

Occupation	Employment		Projected Growth 2016-2026		Average Wage 2016	
	Current (2016)	Projected (2026)	Number	Percent	Weekly	Annual
Agricultural Equipment Operators	800	850	50	6.3	$747	$38,818
Outdoor Power Equipment and Other Small Engine Mechanics	190	210	20	10.5	$550	$28,600
Maintenance Workers, Machinery	1,480	1660	180	12.2	$957	$49,743
Maintenance and Repair Workers, General	12,960	13,820	860	6.6	$957	$49,743
Career and Technical Education Teachers	1,220	1,310	90	7.4	640	$33,254
Logging Equipment Operators	1,680	1,740	60	3.6	$705	$36,662
Farm Equipment Mechanics and Service Technicians	1,030	1,100	70	6.8	$849	$44,123
Support Activities for Agriculture and Forestry	4,780	4,980	200	4.2	$747	$38,818
Primary Metal Manufacturing	3,370	3,490	120	3.6	$923	$47,980

Source: Mississippi Department of Employment Security; mdes.ms.gov (accessed May 7, 2019).

Perkins IV Requirements
The ATMS curriculum meets Perkins IV requirements of exposing students to these skills/occupations to prepare them for the workforce. It also offers students a program of study including secondary, postsecondary, and IHL courses that will prepare them for occupations in these fields. Additionally, the ATMS curriculum is integrated with academic Mississippi's College- and Career-Ready Standards. Lastly, the ATMS curriculum focuses on ongoing and meaningful professional development for teachers, as well as building relationships with industry.

Curriculum Content
Summary of Standards
- Opportunities to enter careers in agriculture power and machinery on a full-scale commercial enterprise basis exist and are expected to increase as agriculture machinery manufacturers continue to locate their production facilities in our state. Career opportunities are also expected to increase for specialized technicians who can maintain and repair equipment.
- There was general agreement among all interviewed that students need to better develop soft skills related to leadership; teamwork; communication; and work ethic, habits, and values. All respondents also indicated that a basic knowledge of economics, recordkeeping, budgeting, and business decision-making skills will be essential in today's competitive environment.
- Opportunities for high school graduates with specialization of skills in agriculture power and machinery are growing for those who want to pursue further specialized skill development, especially training offered by the manufacturer of the equipment. Availability of basic entry-level positions is determined by geographic location and the predominant type of agricultural enterprises in the area. More abundant opportunities exist for students who have received advanced training at the community college or university level.

Academic Infusion
The ATMS (Core) curriculum is tied to the Mississippi College- and Career-Ready Standards. The curriculum provides multiple opportunities to enhance and reinforce academic skills. Because students will be required to communicate effectively in the classroom and in the workforce, there is a considerable amount of reading and writing in this curriculum. Overall, the ATMS (Core) curriculum requires students to make presentations, read technical manuals, and use strategic and critical-thinking skills to solve real-world problems. The location of the college- and career-ready standards for each unit is located in Appendices D-E.

Transition to Postsecondary Education
The latest articulation information for the transition from secondary to postsecondary can be found at the Mississippi Community College Board (MCCB) website, mccb.edu/.

Best Practices
The premise of the success of all school-based, agricultural-education programs is focused on the implementation of the three-circle model, which depicts the three major components of the program interlocked and working together as one. The three components are classroom and laboratory instruction, experiential learning through SAE programs for individual students and participation in the CTE student organization for agriculture education, the National FFA Organization.

Classroom and Laboratory Instruction
The classroom and laboratory component of the school-based, agricultural-education three-circle model is the foundation of the success of the other two components, SAE and National FFA Organization. Through contextual learning, students in agricultural education can learn the science, business, and technology of modern agriculture through innovative instructional technologies, differentiated instruction, and cooperative learning.

Innovative Instructional Technologies
Recognizing that today's students are digital learners, the classroom should be equipped with tools that will teach them in the way they need to learn. The ATMS (Core) curriculum teacher's goal should be to include teaching strategies that incorporate current technology. It is suggested each classroom house a classroom set of smart tablets and one teacher laptop. To make use of the latest online communication tools, such as wikis, blogs, and podcasts, the classroom teacher is encouraged to use a learning-management system that introduces students to teaching and learning strategies in an online environment and places the responsibility of learning on the student.

Differentiated Instruction
All students are unique and possess an individualized learning style. Differentiated instruction is an approach to teaching that addresses the differences in learning styles by providing alternative teaching and assessment methods that reach across the spectrum of student needs in the classroom. By differentiating instruction in ATMS (Core), teachers can more effectively reach students and address their strengths and weaknesses, therefore increasing student success. The implementation of various forms of technology; use of alternative assessments, such as rubrics and problem-based assessment; and utilizing hands-on and work-based learning opportunities in the program of instruction truly enhance the quality of the curriculum presentation.

Cooperative Learning
Cooperative learning can help students understand topics when independent learning cannot. Therefore, you will see several opportunities in the ATMS (Core) curriculum for group work. To function in today's workforce, students need to be able to work collaboratively with others and solve problems without excessive conflict. The ATMS (Core) curriculum provides opportunities for students to work together and help each other complete complex tasks.

Experiential Learning
The experiential learning, or SAE, component has long been an integral part of the school-based, agricultural-education three-component model. Each student is encouraged to explore their career interests and plan an experiential, service, and/or work-based learning program to guide them to their career goals. This SAE program guides the student as they maintain a record-keeping system of time and money invested, and the skills gained from their experiences. The experiential-learning projects can be used in a variety of situations to reinforce and complement classroom theory and content. The experiential-learning project consists of entrepreneurship, placement, research/experimentation, and exploratory discovery and spans the duration of program enrollment.

CTE Student Organizations
As the third part of the school-based, agricultural-education program, the National FFA Organization component is the showcase of leadership, growth, and development for students. The National FFA Organization is the student organization for the ATMS (Core) curriculum. It offers many opportunities for student success, such as leadership development, career-development events, degrees of attainment, awards and scholarships, and community service. The organization provides students with growth opportunities and competitive events. It also opens the doors to the world of agriculture and scholarship opportunities.

Conclusion
The ATMS (Core) curriculum is designed to prepare students for the agriculture power machinery workforce. It is a systematic program of instruction, and students who complete this program are well equipped for a variety of careers and have the basic skills in agricultural mechanics that will serve as a catalyst to further develop according to specific industry skill standards. Instructors are urged to encourage ATMS (Core) students to pursue postsecondary educational opportunities at community colleges and universities in Mississippi.

Professional Organizations

Agricultural Education Division of the Association for Career and Technical Education
acteonline.org/

American Association for Agricultural Education
aaaeonline.org/

Mississippi ACTE
mississippiacte.com/

Mississippi Association of Vocational Agriculture Teachers
mississippiffa.org

National Association of Agricultural Educators
naae.org/

National Association of Supervisors of Agricultural Education
ffa.org/thecouncil/nasae/

National FFA Alumni Association
ffa.org/getinvolved/alumni/

National FFA Foundation, Inc.
ffa.org/support/foundation/

National Farm and Ranch Business Management Education Association
nfrbmea.org/

National Postsecondary Agricultural Student Organization.
nationalpas.org/

National Young Farmer Educational Association.
nyfea.org

Using This Document

Suggested Time on Task
An estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75-80% of the time in the course. The remaining percentage of class time will include instruction in non-tested material, review for end of course testing, and special projects.

Competencies and Suggested Objectives
A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies. The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.

Integrated Academic Topics, 21st Century Skills and Information and Communication Technology Literacy Standards, ACT College Readiness Standards, and Technology Standards for Students
This section identifies related academic topics as required in the Subject Area Testing Program (SATP) in Algebra I, Biology I, English II, and U.S. History From 1877, which are integrated into the content of the unit. Research-based teaching strategies also incorporate ACT College Readiness standards. This section also identifies the 21st Century Skills and Information and Communication Technology Literacy skills. In addition, national technology standards for students associated with the competencies and suggested objectives for the unit are also identified.

References
A list of suggested references is provided for each unit within the accompanying teacher resource document. The list includes some of the primary instructional resources that may be used to teach the competencies and suggested objectives. Again, these resources are suggested, and the list may be modified or enhanced based on needs and abilities of students and on available resources.

Unit 1: Introduction to Leadership and Career Preparation

Competencies and Suggested Objectives

1. Describe the ATMS industry. [DOK1]
   a. Describe employment opportunities in the ATMS industry.
   b. Describe educational, training, and certification requirements for employment in the ATMS industry.
   c. Describe earning and working conditions in the ATMS industry.
   d. Practice filling out a job application.

2. Explain the local school rules and regulations. [DOK1]
   a. Describe local school rules found in the student handbook.
   b. Describe attendance policies.
   c. Describe laboratory and facilities associated with the program.
   d. Compare and contrast school and industry expectations.

3. Explore the integral relationship between the FFA and agricultural education. [DOK 1]
   a. Examine historical events that shaped school-based agricultural education.
      • Smith-Hughes Act (1917)
      • Establishment of the National FFA Organization (1928)
      • Mississippi FFA Association chartered (1934)
      • Establishment of the New Farmers of America (1935)
      • Public Law 740 (1950)
      • Merger of the FFA and the NFA (1965)
      • Female membership (1969)
      • Organizational name change (1988)
   b. Identify types of FFA membership.
      • Active
      • Collegiate
      • Alumni
      • Honorary
   c. Distinguish among the degree levels of FFA membership and describe the requirements for each.
      • Discovery FFA degree
      • Greenhand FFA degree
      • Chapter FFA degree
      • State FFA degree
      • American FFA degree

4. Explore the role of the FFA in promoting leadership, personal growth, and career success through 21st Century Skills Standards. DOK 2
   a. Explain the role of effective leadership.
   b. Have students self-evaluate their personal leadership traits and develop a plan for improvement.
   c. Identify and put into practice FFA activities that promote personal and career development, teamwork, and leadership skills.
      - Public speaking and communication skills
      - Career-development events
      - Proficiency awards
      - Community service activities
      - Conventions and leadership conferences
   d. Demonstrate basic parliamentary procedures.
      - Conducting a meeting
      - Stating a main motion
      - Voting on a motion
      - Understanding the use of the gavel
      - Distinguish between types of motions: main, subsidiary, incidental, and privileged

5. Describe the role of 21st Century Skills, work ethic, and values in establishing and building a successful career. DOK 2
   a. Define and describe universally accepted work ethics and values as applied to agricultural, food, and natural resources careers.
      - Trustworthiness
      - Respect
      - Responsibility
      - Fairness
      - Caring
      - Citizenship
   b. Identify career-related values and ethics promoted through National FFA Organization activities.
      - Attendance
      - Attitude
      - Achievement
      - Relationships
      - Vision
      - Character
      - Awareness
      - Continuous improvement

- Personal growth   - Time management   - Communication   - Decision-making   - Flexibility/adaptability   c. Practice work ethic and values in the ATMS classroom and laboratory, student organization activities, and in experiential learning projects.
6. Investigate careers associated with the agricultural industry and write a report with details about a career. DOK2   - Description of the career   - Educational/training requirements   - Salary range   - Job outlook

Unit 2: Introduction to Experiential Learning

Competencies and Suggested Scenarios
1. Describe the purposes and requirements of the SAE program. [DOK 1]
a. Establish objectives for the SAE program.
• Personal growth
• Career development
• Responsible citizenship
• Practical application of work experience and/or skill attainment
b. Determine the benefits of participation in an SAE program.
• Assist with career and personal choices.
• Apply business practices, such as record keeping and money management.
• Nurture individual talents and develop a cooperative attitude.
• Build character and encourage citizenship and volunteerism.
• Provide an environment for practical learning.
c. Describe the types of SAE programs:
• Exploratory
• Research
o Experimental
o Analytical
o Invention
• Placement/internship
• Entrepreneurship/ownership
• School-based enterprise
• Service learning
• Improvement project
2. Develop a personal plan for the SAE program. [DOK2]
a. Determine the availability of time and money/resources to invest.
b. Set short-range goals for the SAE program.
c. Project long-range goals for the SAE program.
d. Complete a training agreement for an SAE project.
e. Establish requirements for student, parents, supervisor, and/or employer.

3. Develop a record-keeping system for an individual student's SAE program. [DOK3]
   a. Determine types of records to keep.
       - Hours worked/spent on a project or enterprise
       - Inventory of assets
       - Expenses
       - Income
       - Skills attained during a project or enterprise
       - Leadership record
       - Community service record
       - Journal of experiences
   b. Maintain records using an electronic/computer-based system of record keeping for the SAE program.

Unit 3: Safety

Competencies and Suggested Objectives

1. Explain the general laboratory safety requirements for ATMS. [DOK1]
   a. Describe personal safety rules for working in the laboratory and/or ATMS industry, including the eye safety law.
      • Eye safety law
      • Protective clothing and equipment (PPE)
      • Behavior in the shop/lab environment and liability related to others
      • Maintaining shop/lab cleanliness and organization
   b. Describe general workplace safety rules per safety organizations standards.
      • Procedures for materials handling, including lifting heavy objects and storage
      • Procedures for shop equipment operation
      • Safe work requirements for elevated work, including fall-prevention guidelines
      • How to avoid struck-by hazards
      • How to identify common energy-related hazards and how to avoid them
      • Other specific job safety procedures (fires, environmental extremes, etc.)
   c. Identify standard industry safety color code scheme.
      • Red
      • Orange
      • Yellow
      • Green
      • Blue
      • White
      • Magenta and yellow or black and yellow
   d. Describe accident reporting procedures.

2. Identify hazardous materials that may be found in the laboratory or on a job site and describe procedures for handling/avoidance or removal of materials. [DOK2]
   a. Explain the purpose and use of MSDS/SDS sheets.
   b. Review an MSDS/SDS form to identify safe handling and disposal procedures for hazardous materials.
   c. Demonstrate procedures for posting and filing MSDS/SDS forms.
   d. Describe the approved storage procedures for flammable materials found in the ATMS laboratory.
   e. Describe approved procedures for disposal of hazardous materials.
   f. Demonstrate safe procedures for the use and storage of batteries.

3. Explain procedures for applying fire safety in the ATMS shop. [DOK2]
   a. Identify location of firefighting equipment.
   b. Identify classes of fires and associated equipment for each class.
   c. Identify exit locations in case of emergency.

4. Demonstrate the selection and use of hand tools in ATMS. [DOK2]
   a. Identify basic hand tools, including metric and standard where applicable, used in ATMS.
      - Wrenches
      - Sockets and accessories
      - Screwdrivers
      - Pliers
      - Hammers
      - Punches
      - Chisels
   b. Demonstrate the selection and use of hand tools in ATMS.

5. Demonstrate the proper use of portable power tools found in the ATMS laboratory. [DOK2]
   a. Identify types of portable power tools used in ATMS.
      - Grinders (portable angle or detail)
      - Drills or drivers (hammer, electric, etc.)
      - Saws (circular, reciprocating, portable band saw, and abrasive [miter/cutoff] saw)
      - Presses
      - Pneumatic tools (ratchets, nail gun, impact)
      - Pneumatic nail gun
      - Pavement breaker (pneumatic or air)
   b. Demonstrate safety procedures for use of portable power tools used in ATMS.
   c. Demonstrate the use of portable power tools used in the ATMS laboratory.

6. Demonstrate the proper use of stationary tools used in ATMS. [DOK2]
   a. Identify stationary tools used in the ATMS laboratory.
      - Band saws
      - Drill presses
      - Hydraulic shears
      - Pedestal or bench grinders
      - Abrasive cut-off saws
      - Hydraulic benders
   b. Describe the functions of stationary power tools used in ATMS.
   c. Describe safety rules of stationary power tools used in ATMS.
   d. Demonstrate use of each stationary power tool used in ATMS.
   e. Perform maintenance procedures on each stationary power tool used in ATMS.

7. Demonstrate the proper use of lifting, hoisting, and supporting equipment. [DOK2]
    a. Identify lifting, hoisting, and supporting equipment.
        - Jacks
        - Jack stands
        - Hoists
        - Floor cranes
        - Overhead cranes
        - Chains and slings
    b. Demonstrate safety rules for using lifting, hoisting, and supporting equipment.
    c. Demonstrate use of lifting, hoisting, and supporting equipment.

Note: Safety is to be taught as an ongoing part of the program. Students are required to complete the written safety test with 100% accuracy before entering the shop for lab simulations and projects. This test should be documented in each student's file.

Unit 4: Measurement and Industry-Related Math Skills

Competencies and Suggested Objectives

1. Identify types of measuring devices. ^{DOK1}
    a. Identify types of measuring devices.
       • Tape measures
       • Rules and squares
       • Micrometers
       • Calipers
       • Dial indicators
       • Torque wrenches
       • Thickness gauges
       • Laser RPM reader
       • Sliding T-bevel
       • Laser thermometer
    b. Demonstrate an ability to use measuring devices.
       • Tape measures
       • Rules and squares
       • Micrometers
       • Calipers
       • Dial indicators
       • Torque wrenches
       • Thickness gauges

2. Apply math skills related to the industry. ^{DOK1}
    a. Describe English and metric units for measuring distance, area, weight, temperature, and volume.
    b. Convert measurements from metric to English units.
       • Decimals to fractions
       • Fractions to decimals
    c. Calculate the area of 2-D shapes.
    d. Calculate the volume of 3-D shapes.

3. Read and interpret technical plans for constructing a project. [DOK3]
   a. Describe the significance of the drawing elements in the plan.
      - Lines of construction
      - Symbols
      - Grid lines
      - Views
      - Legend
      - Title block
   b. Apply information from the plan to selecting project materials.
   c. Construct the project based on the plan details.

Unit 5: Oxyfuel Cutting

Competencies and Suggested Objectives

1. Assemble and handle oxyfuel cutting equipment. DOK2
    a. Discuss safety procedures for set up of oxyfuel cutting equipment.
    b. Identify parts of the oxyfuel cutting equipment.
        • Regulators
        • Hoses
        • Fittings
        • Torch body
        • Cutting tips
        • Accessories
        • Fashback arrestor
    c. Assemble oxyfuel cutting equipment, purge lines, and test for leaks.
    d. Demonstrate procedures for safe handling and storing of oxyfuel cylinders and equipment.

2. Operate oxyfuel cutting equipment. DOK3
    a. Demonstrate safety procedures for operating oxyfuel cutting equipment.
    b. Demonstrate procedures for lighting an oxyfuel torch and setting regulator pressures.
    c. Adjust the flame to produce oxidizing, carburizing, and neutral flames.
    d. Demonstrate procedures to make a cut in mild steel.
    e. Adjust the cutting flame related to the appearance of drag lines on the metal.

Unit 6: Sheilded Metal Arc Welding (SMAW)

Competencies and Suggested Objectives
1. Set up SMAW equipment. DOK2

1. Set up SMAW equipment. DOK2
   a. Identify equipment and tools used in arc welding.
      - Safety glasses
      - Helmet
      - Leather gauntlet gloves
      - Skull caps
      - Wire brush
      - Chipping hammer
      - 100% cotton or wool long-sleeve shirts
      - Boots
   b. Describe safety procedures used in arc welding.
   c. Identify different electrodes and the meanings of the numbers in the electrode classification system.
   d. Identify the basic types of weld joints.
      - Butt
      - Fillet
   e. Identify the types of weld positions.
      - 1-4G, 1-4F
   f. Identify the parts of a weld, both groove, and fillet.
      - Toe
      - Face
      - Root
      - Throat
      - Leg

2. Demonstrate procedures for SMAW. DOK3
   a. Demonstrate safety procedures for arc welding.
   b. Demonstrate the process for initiating an arc weld (striking an arc).
   c. Demonstrate procedures to lay a stringer bead and develop a pad.
   d. Demonstrate procedures to construct a butt weld in the flat position.
   e. Demonstrate procedures to construct a fillet weld in the flat position.

Unit 7: Compact Engine Inspection, Service, and Repair

Competencies and Suggested Objectives

1. Investigate the applications of small engines. [DOK2]
    a. Discuss the use of compact engines in the agriculture and outdoor recreation industry, including on all-terrain vehicle (ATVs) and utility terrain vehicle (UTVs).
    b. Discuss the use of compact engines in the marine industry.
    c. Discuss the use of compact engines in lawn, garden and timber industry.
      • Mowers
      • Weed eaters
      • Chainsaws
      • Tillers
      • Blowers
      • Limb saws
    d. Discuss the use of compact engines in the specialty recreation industry.
      • Go-karts
      • Pulling/competition tractors
      • Motorcycles

2. Describe the operation of the four-cycle engine. [DOK2]
    a. Identify the major components of a four-cycle engine.
    b. Describe the events occurring in each stroke of a four-cycle engine.
      • Intake
      • Compression
      • Power
      • Exhaust

3. Describe the operation of the two-cycle engine. [DOK2]
    a. Identify the components of a two-cycle engine.
    b. Describe the events occurring in each stroke of a two-cycle engine.
    c. Calculate ratios of oil and gasoline and mix fuel for a two-cycle engine.

4. Perform compact gasoline engine service. [DOK2]
    a. Demonstrate how to find and use information in operator's manuals and manufacturer's specifications.
    b. Describe the functions of engine oil.
    c. Describe the Society of Automotive Engineers viscosity rating system.
    d. Describe the American Petroleum Institute classifications.
    e. Select compact engine oil viscosity according to seasonal temperature.
    f. Identify the components of the lubrication system on a compact engine.
    g. Identify the components of the cooling system of an air-cooled and liquid-cooled engine.
    h. Identify the components of a gasoline fuel system on a compact engine.
    i. Identify the types of carburetors and fuel systems on a compact engine.

j. Identify the types of air filters on compact engines.
k. Identify the types of governor systems used on compact engines.
l. Perform preventative maintenance on compact engines.
m. Identify the model, serial, type, and code numbers found on compact engines.
n. Describe the uses of the various codes and numbers found on compact engines.

5. Read and interpret an operator's manual to determine daily maintenance on compact gasoline engines. [DOK2]
   a. Select correct manuals to determine daily maintenance required on equipment.
   b. Obtain manufacturer's specifications for daily maintenance requirements on equipment.

6. Describe the basic operation and service of electrical systems. [DOK2]
   a. Understand the basic concept of Ohm's Law.
   b. Define common terms used in the electrical system.
      - DC
      - Volts
      - Amps
      - Ohms
   c. Identify the common sources of electricity.
      - Battery
      - Alternator
   d. Identify the parts of a basic circuit.
      - Power source
      - Fuse link/breaker
      - Toggle
      - Conductor
      - Lights/electric motor
   e. Identify the instruments used in checking electrical circuits.
   f. Measure voltage, amperage, and resistance of the electrical circuits.
   g. Service the ignition circuit on a compact gas engine.

7. Select typical fasteners. [DOK2]
   a. Identify common fasteners.
      - Screws
      - Bolts
      - Nuts
      - Washers
      - Keys
      - Snap rings
      - Pins
      - Studs
   b. Identify bolt types.

- Hex head bolt
- Torx head bolt
- Recessed Allen bolt
- Inverted torx bolt

c. Classify bolts according to metric or standard grades.

d. Understand thread measuring terms.
- Pitch
- Thread

e. Measure bolt and nut length, diameter, and thread type using a screw pitch gauge.

f. Discuss tools and procedures for extracting broken bolts and restoring internal and external threads.

g. Identify tools and equipment used to create internal and external threads.

h. Create internal and external threads using specified tools.

8. Disassemble, inspect, and reassemble a compact gasoline engine. [DOK3]

a. Disassemble, clean, and inspect the parts of a compact engine for wear or damage.

b. Assemble a compact engine to manufacturer's specifications.

c. Conduct a performance test and adjust a compact engine.

Unit 8: Equipment and Systems Maintenance

Competencies and Suggested Objectives

1. Read and interpret an operator's manual to determine daily maintenance on equipment. DOK2
 	
   a. Select correct manuals to determine daily maintenance required on equipment.
   b. Obtain manufacturer's specifications for daily maintenance requirements on equipment.

2. Perform daily maintenance on tractors and equipment. DOK3
   a. Check tires for air pressure.
   b. Check fluid levels (engine oil, coolant, and hydraulic system).
   c. Lubricate the chassis and steering linkage.
   d. Inspect brakes for correct adjustment.
   e. Check safety equipment and gauges.

3. Identify the different types of equipment used in agricultural operations and describe their operation and key maintenance procedures. DOK1
   a. Identify types of planting and tillage equipment and describe their operation and key maintenance procedures.
   b. Identify types of lawn turf equipment and describe their operation and key maintenance procedures.
   c. Identify types of harvesting equipment and describe their operation and key maintenance procedures.
   d. Identify types of forage equipment and describe their operation and key maintenance procedures.
   e. Identify types of irrigation equipment and describe their operation and key maintenance procedures.
   f. Identify types of poultry equipment and describe their operation and key maintenance procedures.
   g. Identify types of forestry equipment and describe their operation and key maintenance procedures.

Student Competency Profile

Student's Name: _____

This record is intended to serve as a method of noting student achievement of the competencies in each unit. It can be duplicated for each student, and it can serve as a cumulative record of competencies achieved in the course.

In the blank before each competency, place the date on which the student mastered the competency.

Unit 1: Introduction, Leadership, and Career Preparation		
	1.	Describe the ATMS industry.
	2.	Explain the local school rules and regulations.
	3.	Explore the integral relationship between the National FFA Organization and agricultural education.
	4.	Explore the role of the National FFA Organization in promoting leadership, personal growth, and career success through 21st Century Skills Standards.
	5.	Describe the role of 21st Century Skills, work ethic, and values in establishing and building a successful career.
	6.	Investigate careers associated with the agricultural industry and write a report with details about a career.
Unit 2: Introduction to Experiential Learning (SAE)		
	1.	Describe the purposes and requirements of the supervised agricultural experience (SAE) program.
	2.	Develop a personal plan for the SAE program.
	3.	Develop a record-keeping system for an individual student's SAE program.
Unit 3: Safety		
	1.	Explain the general laboratory safety requirements for ATMS.
	2.	Identify hazardous materials that may be found in the laboratory or on a job site and describe procedures for handling/avoidance or removal of materials.
	3.	Explain procedures for applying fire safety in the ATMS shop.
	4.	Demonstrate the selection and use of hand tools in ATMS.
	5.	Demonstrate the proper use of portable power tools found in the ATMS laboratory.
	6.	Demonstrate the proper use of stationary tools used in ATMS.
	7.	Demonstrate the proper use of lifting, hoisting, and supporting equipment used in ATMS.
Unit 4: Measurement and Industry-Related Math Skills		
	1.	Identify types of measuring devices used in ATMS.

	2.	Apply math skills related to the ATMS industry.
	3.	Read and interpret technical plans for constructing a project.
Unit 5: Oxyfuel Cutting		
	1.	Assemble and handle oxyfuel cutting equipment.
	2.	Operate oxyfuel cutting equipment.
Unit 6: Shielded Metal Arc Welding (SMAW)		
	1.	Set up SMAW equipment.
	2.	Demonstrate procedures for SMAW.
Unit 7: Compact Engine Inspection, Service, and Repair		
	1.	Investigate the applications of small engines in ATMS.
	2.	Describe the operation of the four-cycle engine.
	3.	Describe the operation of the two-cycle engine.
	4.	Perform compact gasoline engine service.
	5.	Read and interpret operator's manual to determine daily maintenance on compact gasoline engines.
	6.	Describe the basic operation and service of electrical systems.
	7.	Select typical fasteners used in ATMS.
	8.	Disassemble, inspect, and reassemble a compact gasoline engine.
Unit 8: Equipment and Systems Maintenance		
	1.	Read and interpret an operator's manual to determine daily maintenance on equipment.
	2.	Perform daily maintenance on tractors and equipment.
	3.	Identify the different types of equipment used in agricultural operations and describe their operation and key maintenance procedures.

Source: *Miss. Code Ann. §§ 37-1-3 and 37-31-103*

Appendix A: Agriculture, Food And Natural Resources (AFNR) Pathway Content Standards

	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8
AFNR								
ABS -AGRIBUSINESS SYSTEMS		X						
AS -ANIMAL SYSTEMS								
BS -BIOTECHNOLOGY								
CRP - CAREER READY PRACTICES	X	X	X	X	X	X	X	X
CS – AGRICULTURE, FOOD AND NATURAL RESOURCES CLUSTER SKILL	X	X	X	X	X	X	X	X
ES -ENVIRONMENTAL SERVICE SYSTEMS								
NRS -NATURAL RESOURCE SYSTEMS								
PS -PLANT SYSTEMS								
PST -POWER, STRUCTURAL, AND TECHNICAL SYSTEMS	X		X	X	X	X	X	X

ABS   AGRIBUSINESS SYSTEMS
AS   ANIMAL SYSTEMS
BS   BIOTECHNOLOGY
CRP   CAREER READY PRACTICES
CS   AGRICULTURE FOOD AND NATURAL RESOURCES CLUSTER SKILL
ES   ENVIRONMENTAL SERVICE SYSTEMS
FPP   FOOD PRODUCTS AND PROCESSING SYSTEMS
NRS   NATURAL RESOURCE SYSTEMS
PS   PLANT SYSTEMS
PST   POWER, STRUCTURAL, AND TECHNICAL SYSTEMS

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Agribusiness Systems Career Pathway Content Standards

The Agribusiness Systems (ABS) Career Pathway encompasses the study of agribusinesses and their management including, but not limited to, record keeping, budget management (cash and credit), and business planning, and sales and marketing. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the planning, development, application and management of agribusiness systems in AFNR settings.

Within each pathway, the standards are organized as follows:
- *Common Career Technical Core (CCTC) Standards* – These are the standards for Agribusiness Systems (AG-ABS) from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.
- *Performance Indicators* – These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a program of study in this area.

ABS.01. CCTC Standard: Apply management planning principles in AFNR businesses.
> **ABS.01.01. Performance Indicator:** Apply micro- and macroeconomic principles to plan and manage inputs and outputs in an AFNR business.
> **ABS.01.02. Performance Indicator:** Read, interpret, evaluate and write statements of purpose to guide business goals, objectives and resource allocation.
> **ABS.01.03. Performance Indicator:** Devise and apply management skills to organize and run an AFNR business in an efficient, legal and ethical manner.
> **ABS.01.04. Performance Indicator:** Evaluate, develop and implement procedures used to recruit, train and retain productive human resources for AFNR businesses.

ABS.02. CCTC Standard: Use record keeping to accomplish AFNR business objectives, manage budgets and comply with laws and regulations.
> **ABS.02.01. Performance Indicator:** Apply fundamental accounting principles, systems, tools and applicable laws and regulations to record, track and audit AFNR business transactions (e.g., accounts, debits, credits, assets, liabilities, equity, etc.).
> **ABS.02.02. Performance Indicator:** Assemble, interpret and analyze financial information and reports to monitor AFNR business performance and support decision-making (e.g., income statements, balance sheets, cash-flow analysis, inventory reports, break-even analysis, return on investment, taxes, etc.).

ABS.03. CCTC Standard: Manage cash budgets, credit budgets and credit for an AFNR business using generally accepted accounting principles.
> **ABS.03.01. Performance Indicator:** Develop, assess and manage cash budgets to achieve AFNR business goals.

ABS.03.02. Performance Indicator: Analyze credit needs and manage credit budgets to achieve AFNR business goals.

ABS.04. CCTC Standard: Develop a business plan for an AFNR business.
    ABS.04.01. Performance Indicator: Analyze characteristics and planning requirements associated with developing business plans for different types of AFNR businesses.
    ABS.04.02. Performance Indicator: Develop production and operational plans for an AFNR business.
    ABS.04.03. Performance Indicator: Identify and apply strategies to manage or mitigate risk.

ABS.05. CCTC Standard: Use sales and marketing principles to accomplish AFNR business objectives.
    ABS.05.01. Performance Indicator: Analyze the role of markets, trade, competition and price in relation to an AFNR business sales and marketing plans.
    ABS.05.02. Performance Indicator: Assess and apply sales principles and skills to accomplish AFNR business objectives.
    ABS.05.03. Performance Indicator: Assess marketing principles and develop marketing plans to accomplish AFNR business objectives.

Animal Systems Career Pathway Content Standards

The Animal Systems (AS) Career Pathway encompasses the study of animal systems, including content areas such as life processes, health, nutrition, genetics, and management and processing, as applied to small animals, aquaculture, exotic animals, livestock, dairy, horses and/or poultry. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the development, application and management of animal systems in AFNR settings.

Within each pathway, the standards are organized as follows:
- *Common Career Technical Core (CCTC) Standards* – These are the standards for Animal Systems (AG-AS) from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.
- *Performance Indicators* – These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a program of study in this area.

AS.01. CCTC Standard: Analyze historic and current trends impacting the animal systems industry.
    AS.01.01. Performance Indicator: Evaluate the development and implications of animal origin, domestication and distribution on production practices and the environment.
    AS.01.02. Performance Indicator: Assess and select animal production methods for use in animal systems based upon their effectiveness and impacts.

AS.01.03. Performance Indicator: Analyze and apply laws and sustainable practices to animal agriculture from a global perspective.

AS.02. CCTC Standard: Utilize best-practice protocols based upon animal behaviors for animal husbandry and welfare.

AS.02.01. Performance Indicator: Demonstrate management techniques that ensure animal welfare.

AS.02.02. Performance Indicator: Analyze procedures to ensure that animal products are safe for consumption (e.g., use in food system, etc.).

AS.03. CCTC Standard: Design and provide proper animal nutrition to achieve desired outcomes for performance, development, reproduction and/or economic production.

AS.03.01. Performance Indicator: Analyze the nutritional needs of animals.

AS.03.02 Performance Indicator: Analyze feed rations and assess if they meet the nutritional needs of animals.

AS.03.03 Performance Indicator: Utilize industry tools to make animal nutrition decisions.

AS.04. CCTC Standard: Apply principles of animal reproduction to achieve desired outcomes for performance, development and/or economic production.

AS.04.01. Performance Indicator: Evaluate animals for breeding readiness and soundness.

AS.04.02. Performance Indicator: Apply scientific principles to select and care for breeding animals.

AS.04.03 Performance Indicator: Apply scientific principles to breed animals.

AS.05. CCTC Standard: Evaluate environmental factors affecting animal performance and implement procedures for enhancing performance and animal health.

AS.05.01. Performance Indicator: Design animal housing, equipment and handling facilities for the major systems of animal production.

AS.05.02. Performance Indicator: Comply with government regulations and safety standards for facilities used in animal production.

AS.06. CCTC Standard: Classify, evaluate and select animals based on anatomical and physiological characteristics.

AS.06.01. Performance Indicator: Classify animals according to taxonomic classification systems and use (e.g. agricultural, companion, etc.).

AS.06.02. Performance Indicator: Apply principles of comparative anatomy and physiology to uses within various animal systems.

AS.06.03. Performance Indicator: Select and train animals for specific purposes and maximum performance based on anatomy and physiology.

AS.07. CCTC Standard: Apply principles of effective animal health care.

A**S.07.01. Performance Indicator:** Design programs to prevent animal diseases, parasites and other disorders and ensure animal welfare.

AS.07.02. Performance Indicator: Analyze biosecurity measures utilized to protect the welfare of animals on a local, state, national, and global level.

AS.08. CCTC Standard: Analyze environmental factors associated with animal production.
AS.08.01. Performance Indicator: Design and implement methods to reduce the effects of animal production on the environment.
AS.08.02. Performance Indicator: Evaluate the effects of environmental conditions on animals and create plans to ensure favorable environments for animals.

Common Career Technical Core Career Ready Practices Content Standards

The CCTC CRPs encompass fundamental skills and practices that all students should acquire to be career ready such as: responsibility, productivity, healthy choices, maintaining personal finances, communication, decision-making, creativity and innovation, critical-thinking, problem solving, integrity, ethical leadership, management, career planning, technology use and cultural/global competency. Students completing a program of study in any AFNR career pathway will demonstrate the knowledge, skills and behaviors that are important to career ready through experiences in a variety of settings (e.g., classroom, CTSO, work-based learning, community etc.).

DEFINITIONS: Within each pathway, the standards are organized as follows:
- *Common Career Technical Core (CCTC) Standards* – These are the standards for CRPs from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.
- *Performance Indicators* –These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a CTE program of study.

CRP.01. CCTC Standard: Act as a responsible and contributing citizen and employee.
CRP.01.01. Performance Indicator: Model personal responsibility in the workplace and community.
CRP.01.02 Performance Indicator: Evaluate and consider the near-term and long-term impacts of personal and professional decisions on employers and community before taking action.
CRP.01.03. Performance Indicator: Identify and act upon opportunities for professional and civic service at work and in the community.

CRP.02. CCTC Standard: Apply appropriate academic and technical skills.
CRP.02.01. Performance Indicator: Use strategic thinking to connect and apply academic learning, knowledge and skills to solve problems in the workplace and community.

CRP.02.02. Performance Indicator: Use strategic thinking to connect and apply technical concepts to solve problems in the workplace and community.

CRP.03. CCTC Standard: Attend to personal health and financial well-being.
    CRP.03.01. Performance Indicator: Design and implement a personal wellness plan.
    CRP.03.02. Performance Indicator: Design and implement a personal financial management plan.

CRP.04. CCTC Standard: Communicate clearly, effectively and with reason.
    CRP.04.01. Performance Indicator: Speak using strategies that ensure clarity, logic, purpose and professionalism in formal and informal settings.
    CRP.04.02. Performance Indicator: Produce clear, reasoned and coherent written and visual communication in formal and informal settings.
    CRP.04.03. Performance Indicator: Model active listening strategies when interacting with others in formal and informal settings.

CRP.05. CCTC Standard: Consider the environmental, social and economic impacts of decisions.
    CRP.05.01. Performance Indicator: Assess, identify and synthesize the information and resources needed to make decisions that positively impact the workplace and community.
    CRP.05.02. Performance Indicator: Make, defend and evaluate decisions at work and in the community using information about the potential environmental, social and economic impacts.

CRP.06. CCTC Standard: Demonstrate creativity and innovation.
    CRP.06.01. Performance Indicator: Synthesize information, knowledge and experience to generate original ideas and challenge assumptions in the workplace and community.
    CRP.06.02. Performance Indicator: Assess a variety of workplace and community situations to identify ways to add value and improve the efficiency of processes and procedures.
    CRP.06.03. Performance Indicator: Create and execute a plan of action to act upon new ideas and introduce innovations to workplace and community organizations.

CRP.07. CCTC Standard: Employ valid and reliable research strategies.
    CRP.07.01. Performance Indicator: Select and implement reliable research processes and methods to generate data for decision-making in the workplace and community.
    CRP.07.02. Performance Indicator: Evaluate the validity of sources and data used when considering the adoption of new technologies, practices and ideas in the workplace and community.

CRP.08. CCTC Standard: Utilize critical thinking to make sense of problems and persevere in solving them.
    CRP.08.01. Performance Indicator: Apply reason and logic to evaluate workplace and community situations from multiple perspectives.

CRP.08.02. Performance Indicator: Investigate, prioritize and select solutions to solve problems in the workplace and community.

CRP.08.03. Performance Indicator: Establish plans to solve workplace and community problems and execute them with resiliency.

CRP.09. CCTC Standard: Model integrity, ethical leadership and effective management.

CRP.09.01. Performance Indicator: Model characteristics of ethical and effective leaders in the workplace and community (e.g. integrity, self-awareness, self-regulation, etc.).

CRP.09.02. Performance Indicator: Implement personal management skills to function effectively and efficiently in the workplace (e.g., time management, planning, prioritizing, etc.).

CRP.09.03. Performance Indicator: Demonstrate behaviors that contribute to a positive morale and culture in the workplace and community (e.g., positively influencing others, effectively communicating, etc.).

CRP.10. CCTC Standard: Plan education and career path aligned to personal goals.

CRP.10.01. Performance Indicator: Identify career opportunities within a career cluster that match personal interests, talents, goals and preferences.

CRP.10.02. Performance Indicator: Examine career advancement requirements (e.g., education, certification, training, etc.) and create goals for continuous growth in a chosen career.

CRP.10.03. Performance Indicator: Develop relationships with and assimilate input and/or advice from experts (e.g., counselors, mentors, etc.) to plan career and personal goals in a chosen career area.

CRP.10.04. Performance Indicator: Identify, prepare, update and improve the tools and skills necessary to pursue a chosen career path.

CRP.11. CCTC Standard: Use technology to enhance productivity.

CRP.11.01. Performance Indicator: Research, select and use new technologies, tools and applications to maximize productivity in the workplace and community.

CRP.11.02. Performance Indicator: Evaluate personal and organizational risks of technology use and take actions to prevent or minimize risks in the workplace and community.

CRP.12. CCTC Standard: Work productively in teams while using cultural/global competence.

CRP.12.01. Performance Indicator: Contribute to team-oriented projects and builds consensus to accomplish results using cultural global competence in the workplace and community.

CRP.12.02. Performance Indicator: Create and implement strategies to engage team members to work toward team and organizational goals in a variety of workplace and community situations (e.g., meetings, presentations, etc.).

Agriculture, Food, and Natural Resources Cluster Skill Content Standards

The AFNR Cluster Skills (CS) encompasses the study of fundamental knowledge and skills related to all AFNR professions. Students completing a program of study in any AFNR career pathway will demonstrate fundamental knowledge of the nature, scope and relationships of AFNR systems and the skills necessary for analysis of current and historical issues and trends; application of technologies; safety, health and environmental practices; stewardship of natural resources; and exploration of career opportunities.

Within each pathway, the standards are organized as follows:
- *Common Career Technical Core (CCTC) Standards* – These are the standards for Agriculture, Food and Natural Resources Career Cluster® (AG) from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.
- *Performance Indicators* –These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a program of study in this area.

CS.01. CCTC Standard: Analyze how issues, trends, technologies and public policies impact systems in the Agriculture, Food & Natural Resources Career Cluster.
> **CS.01.01. Performance Indicator:** Research, examine and discuss issues and trends that impact AFNR systems on local, state, national and global levels.
> **CS.01.02. Performance Indicator:** Examine technologies and analyze their impact on AFNR systems.
> **CS.01.03. Performance Indicator:** Identify public policies and examine their impact on AFNR systems.

CS.02. CCTC Standard: 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.
> **CS.02.01. Performance Indicator:** Research and use geographic and economic data to solve problems in AFNR systems.
> **CS.02.02. Performance Indicator:** Examine the components of the AFNR systems and assess their impact on the local, state, national and global society and economy.

CS.03. CCTC Standard: Examine and summarize the importance of health, safety and environmental management systems in AFNR workplaces.
> **CS.03.01. Performance Indicator:** Identify and explain the implications of required regulations to maintain and improve safety, health and environmental management systems.
> **CS.03.02. Performance Indicator:** Develop and implement a plan to maintain and improve health, safety and environmental compliance and performance.

CS.03.03. Performance Indicator: Apply health and safety practices to AFNR workplaces.
CS.03.04. Performance Indicator: Use appropriate protective equipment and demonstrate safe and proper use of AFNR tools and equipment.

CS.04. CCTC Standard: Demonstrate stewardship of natural resources in AFNR activities.
CS.04.01. Performance Indicator: Identify and implement practices to steward natural resources in different AFNR systems.
CS.04.02. Performance Indicator: Assess and explain the natural resource related trends, technologies and policies that impact AFNR systems.

CS.05. CCTC Standard: Describe career opportunities and means to achieve those opportunities in each of the Agriculture, Food & Natural Resources career pathways.
CS.05.01. Performance Indicator: Evaluate and implement the steps and requirements to pursue a career opportunity in each of the AFNR career pathways (e.g., goals, degrees, certifications, resumes, cover letter, portfolios, interviews, etc.).

CS.06. CCTC Standard: Analyze the interaction among AFNR systems in the production, processing and management of food, fiber and fuel and the sustainable use of natural resources.
CS.06.01. Performance Indicator: Examine and explain foundational cycles and systems of AFNR.
CS.06.02. Performance Indicator: Analyze and explain the connection and relationships between different AFNR systems on a national and global level.

Biotechnology Systems Career Pathway Content Standards

The Biotechnology Systems (BS) Career Pathway encompasses the study of using data and scientific techniques to solve problems concerning living organisms with an emphasis on applications to agriculture, food and natural resource systems. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the development, application and management of biotechnology in the context of AFNR.

Within each pathway, the standards are organized as follows:

- *National Council for Agricultural Education (NCAE) Standard** – These are the standards set forth by the National Council for Agricultural Education for Biotechnology Systems. They define what students should know and be able to do after completing instruction in a program of study focused on applying biotechnology to AFNR systems.
- *Performance Indicators* – These statements distill each performance element into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related performance element at the conclusion of a program of study in this area.

BS.01. NCAE Standard: Assess factors that have influenced the evolution of biotechnology in agriculture (e.g., historical events, societal trends, ethical and legal implications, etc.).

>**BS.01.01**. **Performance Indicator**: Investigate and explain the relationship between past, current and emerging applications of biotechnology in agriculture (e.g., major innovators, historical developments, potential applications of biotechnology, etc.).

>**BS.01.02. Performance Indicator:** Evaluate the scope and implications of regulatory agencies on applications of biotechnology in agriculture and protection of public interests (e.g., health, safety, environmental issues, etc.).

>**BS.01.03. Performance Indicator:** Analyze the relationship and implications of bioethics, laws and public perceptions on applications of biotechnology in agriculture (e.g., ethical, legal, social, cultural issues).

BS.02. NCAE Standard: Demonstrate proficiency by safely applying appropriate laboratory skills to complete tasks in a biotechnology research and development environment (e.g., standard operating procedures, record keeping, aseptic technique, equipment maintenance, etc.).

>**BS.02.01**. **Performance Indicator**: Read, document, evaluate and secure accurate laboratory records of experimental protocols, observations and results.

>**BS.02.02. Performance Indicator:** Implement standard operating procedures for the proper maintenance, use and sterilization of equipment in a laboratory.

>**BS.02.03. Performance Indicator:** Apply standard operating procedures for the safe handling of biological and chemical materials in a laboratory.

>**BS.02.04. Performance Indicator:** Safely manage and dispose of biological materials, chemicals and wastes according to standard operating procedures.

>**BS.02.05. Performance Indicator:** Examine and perform scientific procedures using microbes, DNA, RNA and proteins in a laboratory.

BS.03. NCAE Standard: Demonstrate the application of biotechnology to solve problems in Agriculture, Food and Natural Resources (AFNR) systems (e.g., bioengineering, food processing, waste management, horticulture, forestry, livestock, crops, etc.).

>**BS.03.01. Performance Indicator:** Apply biotechnology principles, techniques and processes to create transgenic species through genetic engineering.

>**BS.03.02. Performance Indicator:** Apply biotechnology principles, techniques and processes to enhance the production of food through the use of microorganisms and enzymes.

>**BS.03.03. Performance Indicator:** Apply biotechnology principles, techniques and processes to protect the environment and maximize use of natural resources (e.g., biomass, bioprospecting, industrial biotechnology, etc.).

>**BS.03.04. Performance Indicator:** Apply biotechnology principles, techniques and processes to enhance plant and animal care and production (e.g., selective breeding, pharmaceuticals, biodiversity, etc.).

>**BS.03.05. Performance Indicator:** Apply biotechnology principles, techniques and processes to produce biofuels (e.g., fermentation, transesterification, methanogenesis, etc.).

BS.03.06. Performance Indicator: Apply biotechnology principles, techniques and processes to improve waste management (e.g., genetically modified organisms, bioremediation, etc.).

Environmental Service Systems Career Pathway Content Standards

The Environmental Service Systems (ESS) Career Pathway encompasses the study of systems, instruments and technology used to monitor and minimize the impact of human activity on environmental systems. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the development, application and management of environmental service systems in AFNR settings.

Within each pathway, the standards are organized as follows:

- *Common Career Technical Core (CCTC) Standards* – These are the standards for Environmental Service Systems (AG-ESS) from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.
- *Performance Indicators* – These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a program of study in this area.

ESS.01. CCTC Standard: Use analytical procedures and instruments to manage environmental service systems.

> **ESS.01.01. Performance Indicator:** Analyze and interpret laboratory and field samples in environmental service systems.
>
> **ESS.01.02. Performance Indicator:** Properly utilize scientific instruments in environmental monitoring situations (e.g., laboratory equipment, environmental monitoring instruments, etc.).

ESS.02. CCTC Standard: Evaluate the impact of public policies and regulations on environmental service system operations.

> **ESS.02.01. Performance Indicator:** Interpret and evaluate the impact of laws, agencies, policies and practices affecting environmental service systems.
>
> **ESS.02.02. Performance Indicator:** Compare and contrast the impact of current trends on regulation of environmental service systems (e.g., climate change, population growth, international trade, etc.).
>
> **ESS.02.03. Performance Indicator:** Examine and summarize the impact of public perceptions and social movements on the regulation of environmental service systems.

ESS.03. CCTC Standard: Develop proposed solutions to environmental issues, problems and applications using scientific principles of meteorology, soil science, hydrology, microbiology, chemistry and ecology.

ESS.03.01. Performance Indicator: Apply meteorology principles to environmental service systems.

ESS.03.02. Performance Indicator: Apply soil science and hydrology principles to environmental service systems.

ESS.03.03. Performance Indicator: Apply chemistry principles to environmental service systems.

ESS.03.04. Performance Indicator: Apply microbiology principles to environmental service systems.

ESS.03.05. Performance Indicator: Apply ecology principles to environmental service systems.

ESS.04. CCTC Standard: Demonstrate the operation of environmental service systems (e.g., pollution control, water treatment, wastewater treatment, solid waste management and energy conservation).

ESS.04.01. Performance Indicator: Use pollution control measures to maintain a safe facility and environment.

ESS.04.02. Performance Indicator: Manage safe disposal of all categories of solid waste in environmental service systems.

ESS.04.03. Performance Indicator: Apply techniques to ensure a safe supply of drinking water and adequate treatment of wastewater according to applicable rules and regulations.

ESS.04.04. Performance Indicator: Compare and contrast the impact of conventional and alternative energy sources on the environment and operation of environmental service systems.

ESS.05. CCTC Standard: Use tools, equipment, machinery and technology common to tasks in environmental service systems.

ESS.05.01. Performance Indicator: Use technological and mathematical tools to map land, facilities and infrastructure for environmental service systems.

ESS.05.02. Performance Indicator: Perform assessments of environmental conditions using equipment, machinery and technology.

Food Products and Processing Systems Career Pathway Content Standards

The Food Products and Processing Systems (FPP) Career Pathway encompasses the study of food safety and sanitation; nutrition, biology, microbiology, chemistry and human behavior in local and global food systems; food selection and processing for storage, distribution and consumption; and the historical and current development of the food industry. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the development, application and management of food products and processing systems in AFNR settings.

Within each pathway, the standards are organized as follows:
- *Common Career Technical Core (CCTC) Standards* – These are the standards for Food Products and Processing Systems (AG-FPP) from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These

statements define what students should know and be able to do after completing instruction in a program of study for this pathway.

- *Performance Indicators* – These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a program of study in this area.

FPP.01. CCTC Standard: Develop and implement procedures to ensure safety, sanitation and quality in food product and processing facilities.
> **FPP.01.01. Performance Indicator:** Analyze and manage operational and safety procedures in food products and processing facilities.
> **FPP.01.02. Performance Indicator:** Apply food safety and sanitation procedures in the handling and processing of food products to ensure food quality.
> **FPP.01.03. Performance Indicator:** Apply food safety procedures when storing food products to ensure food quality.

FPP.02. CCTC Standard: Apply principles of nutrition, biology, microbiology, chemistry and human behavior to the development of food products.
> **FPP.02.01. Performance Indicator:** Apply principles of nutrition and biology to develop food products that provide a safe, wholesome and nutritious food supply for local and global food systems.
> **FPP.02.02. Performance Indicator:** Apply principles of microbiology and chemistry to develop food products to provide a safe, wholesome and nutritious food supply for local and global food systems.
> **FPP.02.03. Performance Indicator:** Apply principles of human behavior to develop food products to provide a safe, wholesome and nutritious food supply for local and global food systems.

FPP.03. CCTC Standard: Select and process food products for storage, distribution and consumption.
> **FPP.03.01. Performance Indicator:** Implement selection, evaluation and inspection techniques to ensure safe and quality food products.
> **FPP.03.02. Performance Indicator:** Design and apply techniques of food processing, preservation, packaging and presentation for distribution and consumption of food products.
> **FPP.03.03. Performance Indicator:** Create food distribution plans and procedures to ensure safe delivery of food products.

FPP.04. CCTC Standard: Explain the scope of the food industry and the historical and current developments of food product and processing.
> **FPP.04.01. Performance Indicator:** Examine the scope of the food industry by evaluating local and global policies, trends and customs for food production.
> **FPP.04.02. Performance Indicator:** Evaluate the significance and implications of changes and trends in the food products and processing industry in the local and global food systems.

FPP.04.03. Performance Indicator: Identify and explain the purpose of industry organizations, groups and regulatory agencies that influence the local and global food systems.

Natural Resource Systems Career Pathway Content Standards

The Natural Resource Systems (NRS) Career Pathway encompasses the study of the management, protection, enhancement and improvement of soil, water, wildlife, forests and air as natural resources. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the development, application and management of natural resource systems in AFNR settings.

Within each pathway, the standards are organized as follows:
- *Common Career Technical Core (CCTC) Standards* – These are the standards for Natural Resource Systems (AG-NRS) from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.
- *Performance Indicators* – These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a program of study in this area.

NRS.01. CCTC Standard: Plan and conduct natural resource management activities that apply logical, reasoned and scientifically based solutions to natural resource issues and goals.

    NRS.01.01. Performance Indicator: Apply methods of classification to examine natural resource availability and ecosystem function in a particular region.

    NRS.01.02. Performance Indicator: Classify different types of natural resources in order to enable protection, conservation, enhancement and management in a particular geographical region.

    NRS.01.03. Performance Indicator: Apply ecological concepts and principles to atmospheric natural resource systems.

    NRS.01.04. Performance Indicator: Apply ecological concepts and principles to aquatic natural resource systems.

    NRS.01.05. Performance Indicator: Apply ecological concepts and principles to terrestrial natural resource systems.

    NRS.01.06. Performance Indicator: Apply ecological concepts and principles to living organisms in natural resource systems.

NRS.02. CCTC Standard: Analyze the interrelationships between natural resources and humans.

    NRS.02.01. Performance Indicator: Examine and interpret the purpose, enforcement, impact and effectiveness of laws and agencies related to natural resource management, protection, enhancement and improvement (e.g., water regulations, game laws, historic preservation laws, environmental policy, etc.).

NRS.02.02. Performance Indicator: Assess the impact of human activities on the availability of natural resources.

NRS.02.03. Performance Indicator: Analyze how modern perceptions of natural resource management, protection, enhancement and improvement change and develop over time.

NRS.02.04. Performance Indicator: Examine and explain how economics affects the use of natural resources.

NRS.02.05. Performance Indicator: Communicate information to the public regarding topics related to the management, protection, enhancement, and improvement of natural resources.

NRS.03. CCTC Standard: Develop plans to ensure sustainable production and processing of natural resources.

NRS.03.01. Performance Indicator: Sustainably produce, harvest, process and use natural resource products (e.g., forest products, wildlife, minerals, fossil fuels, shale oil, alternative energy, recreation, aquatic species, etc.).

NRS.03.02. Performance Indicator: Demonstrate cartographic skills, tools and technologies to aid in developing, implementing and evaluating natural resource management plans.

NRS.04. CCTC Standard: Demonstrate responsible management procedures and techniques to protect, maintain, enhance, and improve natural resources.

NRS.04.01. Performance Indicator: Demonstrate natural resource protection, maintenance, enhancement and improvement techniques.

NRS.04.02. Performance Indicator: Diagnose plant and wildlife diseases and follow protocols to prevent their spread.

NRS.04.03. Performance Indicator: Prevent or manage introduction of ecologically harmful species in a particular region.

NRS.04.04. Performance Indicator: Manage fires in natural resource systems.

Plant Science Systems Career Pathway Content Standards

The Plant Systems (PS) Career Pathway encompasses the study of plant life cycles, classifications, functions, structures, reproduction, media and nutrients, as wells as growth and cultural practices through the study of crops, turf grass, trees, shrubs and/or ornamental plants. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the development, application and management of plant systems in AFNR settings.

Within each pathway, the standards are organized as follows:
- *Common Career Technical Core (CCTC) Standards* – These are the standards for Plant Systems (AG-PS) from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.

- *Performance Indicators* – These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a program of study in this area.

PS.01. CCTC Standard: Develop and implement a crop management plan for a given production goal that accounts for environmental factors.

  PS.01.01. Performance Indicator: Determine the influence of environmental factors on plant growth.
  PS.01.02. Performance Indicator: Prepare and manage growing media for use in plant systems.
  PS.01.03. Performance Indicator: Develop and implement a fertilization plan for specific plants or crops.

PS.02. CCTC Standard: Apply principles of classification, plant anatomy, and plant physiology to plant production and management.

  PS.02.01. Performance Indicator: Classify plants according to taxonomic systems.
  PS.02.02. Performance Indicator: Apply knowledge of plant anatomy and the functions of plant structures to activities associated with plant systems.
  PS.02.03. Performance Indicator: Apply knowledge of plant physiology and energy conversion to plant systems.

PS.03. CCTC Standard: Propagate, culture and harvest plants and plant products based on current industry standards.

  PS.03.01. Performance Indicator: Demonstrate plant propagation techniques in plant system activities.
  PS.03.02. Performance Indicator: Develop and implement a management plan for plant production.
  PS.03.03. Performance Indicator: Develop and implement a plan for integrated pest management for plant production.
  PS.03.04. Performance Indicator: Apply principles and practices of sustainable agriculture to plant production.
  PS.03.05. Performance Indicator: Harvest, handle and store crops according to current industry standards.

PS.04. CCTC Standard: Apply principles of design in plant systems to enhance an environment (e.g. floral, forest landscape, and farm).

  PS.04.01. Performance Indicator: Evaluating, identifying and preparing plants to enhance an environment.
  PS.04.02. Performance Indicator: Create designs using plants.

Power, Structural and Technical Systems Career Pathway Content Standards

The Power, Structural and Technical Systems (PST) Career Pathway encompasses the study of agricultural equipment, power systems, alternative fuel sources and precision technology, as well as woodworking, metalworking, welding and project planning for agricultural structures. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the development, application and management of power, structural and technical systems in AFNR settings.

Within each pathway, the standards are organized as follows:
- *Common Career Technical Core (CCTC) Standards* – These are the standards for Power, Structural and Technical Systems (AG-PST) from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.
- *Performance Indicators* – These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a program of study in this area.

PST.01. CCTC Standard: Apply physical science principles and engineering applications to solve problems and improve performance in AFNR power, structural and technical systems.
>> **PST.01.01. Performance Indicator:** Apply physical science and engineering principles to assess and select energy sources for AFNR power, structural and technical systems.
>> **PST.01.02. Performance Indicator:** Apply physical science and engineering principles to design, implement and improve safe and efficient mechanical systems in AFNR situations.
>> **PST.01.03. Performance Indicator:** Apply physical science principles to metal fabrication using a variety of welding and cutting processes (e.g., SMAW, GMAW, GTAW, fuel-oxygen and plasma arc torch, etc.).

PST.02. CCTC Standard: Operate and maintain AFNR mechanical equipment and power systems.
>> **PST.02.01. Performance Indicator:** Perform preventative maintenance and scheduled service to maintain equipment, machinery and power units used in AFNR settings.
>> **PST.02.02. Performance Indicator:** Operate machinery and equipment while observing all safety precautions in AFNR settings.

PST.03. CCTC Standard: Service and repair AFNR mechanical equipment and power systems.
>> **PST.03.01. Performance Indicator:** Troubleshoot, service and repair components of internal combustion engines using manufacturers' guidelines.
>> **PST.03.02. Performance Indicator:** Service electrical systems and components of mechanical equipment and power systems using a variety of troubleshooting and/or diagnostic methods.

PST.03.03. Performance Indicator: Utilize manufacturers' guidelines to diagnose and troubleshoot malfunctions in machinery, equipment and power source systems (e.g., hydraulic, pneumatic, transmission, steering, suspension, etc.).

PST.04. CCTC Standard: Plan, build and maintain AFNR structures.
  PST.04.01. Performance Indicator: Create sketches and plans for AFNR structures.
  PST.04.02. Performance Indicator: Determine structural requirements, specifications and estimate costs for AFNR structures
  PST.04.03. Performance Indicator: Follow architectural and mechanical plans to construct, maintain and/or repair AFNR structures (e.g., material selection, site preparation and/or layout, plumbing, concrete/masonry, etc.).

  PST.04.04. Performance Indicator: Apply electrical wiring principles in AFNR structures.

PST.05. CCTC Standard: Use control, monitoring, geospatial and other technologies in AFNR power, structural and technical systems.
  PST.05.01. Performance Indicator: Apply computer and other technologies (e.g., robotics, CNC, UAS, etc.) to solve problems and increase the efficiency of AFNR systems.
  PST.05.02. Performance Indicator: Prepare and/or use electrical drawings to design, install and troubleshoot electronic control systems in AFNR settings.
  PST.05.03. Performance Indicator: Apply geospatial technologies to solve problems and increase the efficiency of AFNR systems.

Appendix B: 21st Century Skills[1]

21st Century Crosswalk for ATMS (Core)									
	Units	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Standards									
CS1		X	X						X
CS2		X	X						
CS3		X	X						
CS4		X	X						
CS5		X	X						
CS6		X	X	X	X	X	X	X	X
CS7		X	X	X	X	X	X	X	X
CS8		X	X						
CS9		X	X	X	X	X	X	X	X
CS10		X	X						
CS11		X	X	X	X	X	X	X	X
CS12		X	X	X	X	X	X	X	X
CS13		X	X	X	X	X	X	X	X
CS14		X	X	X	X	X	X	X	X
CS15		X	X	X	X	X	X	X	X
CS16		X	x	X	X	X	X	X	X

x

CSS1-21st Century Themes

CS1   Global Awareness
1. Using 21st century skills to understand and address global issues
2. Learning from and working collaboratively with individuals representing diverse cultures, religions, and lifestyles in a spirit of mutual respect and open dialogue in personal, work, and community contexts
3. Understanding other nations and cultures, including the use of non-English languages

CS2   Financial, Economic, Business, and Entrepreneurial Literacy
1. Knowing how to make appropriate personal economic choices
2. Understanding the role of the economy in society
3. Using entrepreneurial skills to enhance workplace productivity and career options

CS3   Civic Literacy
1. Participating effectively in civic life through knowing how to stay informed and understanding governmental processes
2. Exercising the rights and obligations of citizenship at local, state, national, and global levels
3. Understanding the local and global implications of civic decisions

CS4   Health Literacy
1. Obtaining, interpreting, and understanding basic health information and services and using such information and services in ways that enhance health
2. Understanding preventive physical and mental health measures, including proper diet, nutrition, exercise, risk avoidance, and stress reduction
3. Using available information to make appropriate health-related decisions

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[1] *21st century skills.* (n.d.). Washington, DC: Partnership for 21st Century Skills.

    4. Establishing and monitoring personal and family health goals
    5. Understanding national and international public health and safety issues

CS5 Environmental Literacy
1. Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water, and ecosystems.
2. Demonstrate knowledge and understanding of society's impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.).
3. Investigate and analyze environmental issues, and make accurate conclusions about effective solutions.
4. Take individual and collective action toward addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues).

CSS2-Learning and Innovation Skills

CS6 Creativity and Innovation
1. Think Creatively
2. Work Creatively with Others
3. Implement Innovations

CS7 Critical Thinking and Problem Solving
1. Reason Effectively
2. Use Systems Thinking
3. Make Judgments and Decisions
4. Solve Problems

CS8 Communication and Collaboration
1. Communicate Clearly
2. Collaborate with Others

CSS3-Information, Media and Technology Skills

CS9 Information Literacy
1. Access and Evaluate Information
2. Use and Manage Information

CS10 Media Literacy
1. Analyze Media
2. Create Media Products

CS11 ICT Literacy
1. Apply Technology Effectively

CSS4-Life and Career Skills

CS12 Flexibility and Adaptability
1. Adapt to change
2. Be Flexible

CS13 Initiative and Self-Direction
1. Manage Goals and Time
2. Work Independently

3. Be Self-directed Learners
CS14 Social and Cross-Cultural Skills
1. Interact Effectively with others
2. Work Effectively in Diverse Teams
CS15 Productivity and Accountability
1. Manage Projects
2. Produce Results
CS16 Leadership and Responsibility
1. Guide and Lead Others
2. Be Responsible to Others

Appendix C: International Society for Technology in Education Standards (ISTE)

	Units	1	2	3	4	5	6	7	8
Standards									
T1		X	X	X	X	X	X	X	X
T2		X	X						X
T3		X	X	X					X
T4		X	X						X
T5			X			X			X
T6		X	X	X		X			X
T7		X	X	X	X	X	X	X	X

T1 Empowered Learner
T2 Digital Citizen
T3 Knowledge Constructor
T4 Innovative Designer
T5 Computational Thinker
T6 Creative Communicator
T7 Global Collaborator

T1 Empowered Learner
Students leverage technology to take an active role in choosing, achieving and demonstrating competency in their learning goals, informed by the learning sciences. Students:
  a. Articulate and set personal learning goals, develop strategies leveraging technology to achieve them and reflect on the learning process itself to improve learning outcomes.
  b. Build networks and customize their learning environments in ways that support the learning process.
  c. Use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
  d. Understand the fundamental concepts of technology operations, demonstrate the ability to choose, use and troubleshoot current technologies and are able to transfer their knowledge to explore emerging technologies.

T2 Digital Citizen
Students recognize the rights, responsibilities and opportunities of living, learning and working in an interconnected digital world, and they act and model in ways that are safe, legal and ethical. Students:
  a. Cultivate and manage their digital identity and reputation and are aware of the permanence of their actions in the digital world.
  b. Engage in positive, safe, legal and ethical behavior when using technology, including social interactions online or when using networked devices.

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    c. Demonstrate an understanding of and respect for the rights and obligations of using and sharing intellectual property.

    d. Manage their personal data to maintain digital privacy and security and are aware of data-collection technology used to track their navigation online.

T3   Knowledge Constructor

Students critically curate a variety of resources using digital tools to construct knowledge, produce creative artifacts and make meaningful learning experiences for themselves and others. Students:

    a. Plan and employ effective research strategies to locate information and other resources for their intellectual or creative pursuits.

    b. Evaluate the accuracy, perspective, credibility and relevance of information, media, data or other resources.

    c. Curate information from digital resources using a variety of tools and methods to create collections of artifacts that demonstrate meaningful connections or conclusions.

    d. Build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions.

T4   Innovative Designer

Students use a variety of technologies within a design process to identify and solve problems by creating new, useful or imaginative solutions. Students:

    a. Know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts or solving authentic problems.

    b. Select and use digital tools to plan and manage a design process that considers design constraints and calculated risks.

    c. Develop, test and refine prototypes as part of a cyclical design process.

    d. Exhibit a tolerance for ambiguity, perseverance and the capacity to work with open-ended problems.

T5   Computational Thinker

Students develop and employ strategies for understanding and solving problems in ways that leverage the power of technological methods to develop and test solutions. Students:

    a. Formulate problem definitions suited for technology-assisted methods such as data analysis, abstract models and algorithmic thinking in exploring and finding solutions.

    b. Collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making.

    c. Break problems into component parts, extract key information, and develop descriptive models to understand complex systems or facilitate problem-solving.

    d. Understand how automation works and use algorithmic thinking to develop a sequence of steps to create and test automated solutions.

T6   Creative Communicator

Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats and digital media appropriate to their goals. Students:

a.   Choose the appropriate platforms and tools for meeting the desired objectives of their creation or communication.
b.   Create original works or responsibly repurpose or remix digital resources into new creations.
c.   Communicate complex ideas clearly and effectively by creating or using a variety of digital objects such as visualizations, models or simulations.
d.   Publish or present content that customizes the message and medium for their intended audiences.

T7   Global Collaborator
Students use digital tools to broaden their perspectives and enrich their learning by collaborating with others and working effectively in teams locally and globally. Students:
a.   Use digital tools to connect with learners from a variety of backgrounds and cultures, engaging with them in ways that broaden mutual understanding and learning.
b.   Use collaborative technologies to work with others, including peers, experts or community members, to examine issues and problems from multiple viewpoints.
c.   Contribute constructively to project teams, assuming various roles and responsibilities to work effectively toward a common goal.
d.   Explore local and global issues and use collaborative technologies to work with others to investigate solutions.

Appendix D: College- and Career-Ready Standards – English Language Arts

	Units	1	2	3	4	5	6	7	8
Standards									
RL.9.1									
RL.9.2									
RL.9.3									
RL.9.4									
RL.9.5									
RL.9.6									
RL.9.7									
RL.9.8									
RL.9.9									
RL.9.10									
RL.9.10									
RI.9.3									
RI.9.5									
RI.9.6									
RI.9.7									
RI.9.8									
RI.9.9									
W.9.1									
W.9.2		X	X	X	X	X	X	X	X
W.9.3			X						
W.9.4		X							
W.9.5									
W.9.6									
W.9.7				X					
W.9.8									X
W.9.9									
W.9.10			X						
SL.9.1		X	X	X	X	X	X	X	X
SL.9.2									
SL.9.3									
SL.9.4									
SL.9.5									
SL.9.6									
L.9.1									
L.9.2									
L.9.3									
L.9.4		X	X	X	X	X	X	X	X
L.9.5									
L.9.6									
RL.10.10									
RH.9-10.1									
RH.9-10.2									
RH.9-10.3									
RH.9-10.4									
RH.9-10.5									
RH.9-10.6									
RH.9-10.7									
RH.9-10.8									

RH.9-10.9								
RH.9-10.10								
RST.9-10.1		X	X	X	X	X	X	X	X
RST.9-10.2		X	X	X	X	X	X	X	X
RST.9-10.3		X	X	X	X	X	X	X	X
RST.9-10.4		X	X	X	X	X	X	X	X
RST.9-10.5		X	X	X	X	X	X	X	X
RST.9-10.6		X	X	X	X	X	X	X	X
RST.9-10.7									
RST.9-10.8									
RST.9-10.9									
RST.9-10.10									
WHST.9-10.1									
WHST.9-10.2									
WHST.9-10.3									
WHST.9-10.4									
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RH.11-12.8		X	X	X	X	X	X	X	X
RH.11-12.9									
RH.11-12.10									
RST.11-12.1									
RST.11-12.2									
RST.11-12.3				X	X	X	X	X	X
RST.11-12.4				X	X	X	X	X	X
RST.11-12.5				X	X	X	X	X	X
RST.11-12.6				X	X	X	X	X	X
RST.11-12.7				X	X	X	X	X	X
RST.11-12.8				X	X	X	X	X	X
RST.11-12.9				X	X	X	X	X	X
RST.11-12.10									
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WHST.11-12.2									
WHST.11-12.6									
WHST.11-12.8									

College and Career Ready English I
Reading Literature Key Ideas and Details

RL.9.1 Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.

RL.9.2 Determine a theme or central idea of a text and analyze in detail its development over the course of the text, including how it emerges and is shaped and refined by specific details; provide an objective summary of the text.

RL.9.3 Analyze how complex characters (e.g., those with multiple or conflicting motivations) develop over the course of a text, interact with other characters, and advance the plot or develop the theme.

Craft and Structure

RL.9.4 Determine the meaning of words and phrases as they are used in the text, including figurative and connotative meanings; analyze the cumulative impact of specific word choices on meaning and tone (e.g., how the language evokes a sense of time and place; how it sets a formal or informal tone).

RL.9.5 Analyze how an author's choices concerning how to structure a text, order events within it (e.g., parallel plots), and manipulate time (e.g., pacing, flashbacks) create such effects as mystery, tension, or surprise.

RL.9.6 Analyze a particular point of view or cultural experience reflected in a work of literature from outside the United States, drawing on a wide reading of world literature.

Integration of Knowledge and Ideas

RL.9.7 Analyze the representation of a subject or a key scene in two different artistic mediums, including what is emphasized or absent in each treatment (e.g., Auden's "Musée des Beaux Arts" and Breughel's Landscape with the Fall of Icarus).

RL.9.8 Not applicable to literature.

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RL.9.9 Analyze how an author draws on and transforms source material in a specific work (e.g., how Shakespeare treats a theme or topic from Ovid or the Bible or how a later author draws on a play by Shakespeare).

Range of Reading and Level of Text Complexity

RL.9.10 By the end of grade 9, read and comprehend literature, including stories, dramas, and poems, in the grades 9-10 text complexity band proficiently, with scaffolding as needed at the high end of the range.

College and Career Ready English I
Reading Informational Text Key Ideas and Details

RI.9.3 Analyze how the author unfolds an analysis or series of ideas or events, including the order in which the points are made, how they are introduced and developed, and the connections that are drawn between them.

Craft and Structure

RI.9.5 Analyze in detail how an author's ideas or claims are developed and refined by particular sentences, paragraphs, or larger portions of a text (e.g., a section or chapter).

RI.9.6 Determine an author's point of view or purpose in a text and analyze how an author uses rhetoric to advance that point of view or purpose.

Integration of Knowledge and Ideas

RI.9.7 Analyze various accounts of a subject told in different mediums (e.g., a person's life story in both print and multimedia), determining which details are emphasized in each account.

RI.9.8 Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is valid and the evidence is relevant and sufficient; identify false statements and fallacious reasoning.

RI.9.9 Analyze seminal U.S. documents of historical and literary significance (e.g., Washington's Farewell Address, the Gettysburg Address, Roosevelt's Four Freedoms speech, King's "Letter from Birmingham Jail"), including how they address related themes and concepts.

College and Career Ready English I
<u>Writing Text Types and Purposes</u>

W.9.1 Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

W.9.1a Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among claim(s), counterclaims, reasons, and evidence.

W.9.1b Develop claim(s) and counterclaims fairly, supplying evidence for each while pointing out the strengths and limitations of both in a manner that anticipates the audience's knowledge level and concerns.

W.9.1c 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.

W.9.1d Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

W.9.1e Provide a concluding statement or section that follows from and supports the argument presented.

W.9.2 Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

W.9.2a Introduce a topic; organize complex 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.

W.9.2b 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.

W.9.2c Use appropriate and varied transitions to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.

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W.9.2d Use precise language and domain-specific vocabulary to manage the complexity of the topic.

W.9.2e Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

W.9.2f 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).

W.9.3 Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.

W.9.3a Engage and orient the reader by setting out a problem, situation, or observation, establishing one or multiple point(s) of view, and introducing a narrator and/or characters; create a smooth progression of experiences or events.

W.9.3b Use narrative techniques, such as dialogue, pacing, description, reflection, and multiple plot lines, to develop experiences, events, and/or characters.

W.9.3c Use a variety of techniques to sequence events so that they build on one another to create a coherent whole.

W.9.3d Use precise words and phrases, telling details, and sensory language to convey a vivid picture of the experiences, events, setting, and/or characters.

W.9.3e Provide a conclusion that follows from and reflects on what is experienced, observed, or resolved over the course of the narrative.

<u>Production and Distribution of Writing</u>

W.9.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1–3 above.)

W.9.5 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. (Editing for conventions should demonstrate command of Language standards 1–3 up to and including grades 9–10.)

W.9.6 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.

Research to Build and Present Knowledge

W.9.7 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.

College and Career Ready English I

W.9.8 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.

W.9.9 Draw evidence from literary or informational texts to support analysis, reflection, and research.

W.9.9a Apply grades 9–10 Reading standards to literature (e.g., "Analyze how an author draws on and transforms source material in a specific work [e.g., how Shakespeare treats a theme or topic from Ovid or the Bible or how a later author draws on a play by Shakespeare]").

W.9.9b Apply grades 9–10 Reading standards to literary nonfiction (e.g., "Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is valid and the evidence is relevant and sufficient; identify false statements and fallacious reasoning").

Range of Writing

W.9.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audience.

College and Career Ready English I

SL.9.1 Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9– 10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.

SL.9.1a Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.

SL.9.1b Work with peers to set rules for collegial discussions and decision making (e.g., informal consensus, taking votes on key issues, presentation of alternate views), clear goals and deadlines, and individual roles as needed.

SL.9.1c Propel conversations by posing and responding to questions that relate the current discussion to broader themes or larger ideas; actively incorporate others into the discussion; and clarify, verify, or challenge ideas and conclusions.

SL.9.1d Respond thoughtfully to diverse perspectives, summarize points of agreement and disagreement, and, when warranted, qualify or justify their own views and understanding and make new connections in light of the evidence and reasoning presented.

SL.9.2 Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source.

SL.9.3 Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, identifying any fallacious reasoning or exaggerated or distorted evidence.

Presentation of Knowledge and Ideas

SL.9.4 Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.

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SL.9.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

SL.9.6 Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate. (See grades 9–10 Language standards 1 and 3 for specific expectations.)

College and Career Ready English I
Language
Conventions of Standard English
L.9.1 Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.
L.9.1a Use parallel structure.*
L.9.1b Use various types of phrases (noun, verb, adjectival, adverbial, participial, prepositional, absolute) and clauses (independent, dependent; noun, relative, adverbial) to convey specific meanings and add variety and interest to writing or presentations.
L.9.2 Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.
L.9.2a Use a semicolon (and perhaps a conjunctive adverb) to link two or more closely related independent clauses.
L.9.2b Use a colon to introduce a list or quotation.
L.9.2c Spell correctly

Knowledge of Language
L.9.3 Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend more fully when reading or listening
L.9.3a Write and edit work so that it conforms to the guidelines in a style manual (e.g., MLA Handbook, Turabian's Manual for Writers) appropriate for the discipline and writing type.

Vocabulary Acquisition and Use
L.9.4 Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 9–10 reading and content, choosing flexibly from a range of strategies.
L.9.4a Use context (e.g., the overall meaning of a sentence, paragraph, or text; a word's position or function in a sentence) as a clue to the meaning of a word or phrase.
L.9.4b Identify and correctly use patterns of word changes that indicate different meanings or parts of speech (e.g., analyze, analysis, analytical; advocate, advocacy).

College and Career Ready English I
L.9.4c Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning, its part of speech, or its etymology.
L.9.4d Verify the preliminary determination of the meaning of a word or phrase (e.g., by checking the inferred meaning in context or in a dictionary).
L.9.5 Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.
L.9.5a Interpret figures of speech (e.g., euphemism, oxymoron) in context and analyze their role in the text.
L.9.5b Analyze nuances in the meaning of words with similar denotations.
L.9.6 Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

College and Career Ready English II
Range of Reading and Level of Text Complexity
RL.10.10 By the end of grade 10, read and comprehend literature, including stories, dramas, and poems, at the high end of the grades 9-10 text complexity band independently and proficiently.Grades 9-10: Literacy in History/SS
Reading in History/Social Studies Key Ideas and Details
RH.9-10.1 Cite specific textual evidence to support analysis of primary and secondary sources, attending to such features as the date and origin of the information.

RH.9-10.2 Determine the central ideas or information of a primary or secondary source; provide an accurate summary of how key events or ideas develop over the course of the text.

RH.9-10.3 Analyze in detail a series of events described in a text; determine whether earlier events caused later ones or simply preceded them.

Craft and Structure

RH.9-10.4 Determine the meaning of words and phrases as they are used in a text, including vocabulary describing political, social, or economic aspects of history/social science.

RH.9-10.5 Analyze how a text uses structure to emphasize key points or advance an explanation or analysis.

RH.9-10.6 Compare the point of view of two or more authors for how they treat the same or similar topics, including which details they include and emphasize in their respective accounts.

Integration of Knowledge and Ideas

RH.9-10.7 Integrate quantitative or technical analysis (e.g., charts, research data) with qualitative analysis in print or digital text.

RH.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claims.

RH.9-10.9 Compare and contrast treatments of the same topic in several primary and secondary sources.

Range of Reading and Level of Text Complexity

RH.9-10.10 By the end of grade 10, read and comprehend history/social studies texts in the grades 9–10 text complexity band independently and proficiently.

Grades 9-10: Literacy in Science and Technical Subjects
Reading in Science and Technical Subjects Key Ideas and Details

RST.9-10.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

RST.9-10.2 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.

RST.9-10.3 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.

Craft and Structure

RST.9-10.4 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 9–10 texts and topics.

RST.9-10.5 Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).

RST.9-10.6 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.

Integration of Knowledge and Ideas

RST.9-10.7 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.

RST.9-10.8 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.

RST.9-10.9 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

Range of Reading and Level of Text Complexity

RST.9-10.10 By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently.

Grades 9-10: Writing in History/SS, Science, and Technical Subjects
Writing Text Types and Purposes

WHST.9-10.1 Write arguments focused on discipline-specific content.

WHST.9-10.1a 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.

WHST.9-10.1b 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.

WHST.9-10.1c 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.

WHST.9-10.1d Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.1e Provide a concluding statement or section that follows from or supports the argument presented.

WHST.9-10.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

WHST.9-10.2a 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.

WHST.9-10.2b 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.

Grades 9-10

<u>Writing in History/SS, Science, and Technical Subjects</u>

WHST.9-10.2c Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.

WHST.9-10.2d 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.

WHST.9-10.2e Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.2f 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).

WHST.9-10.3 Not Applicable

<u>Production and Distribution of Writing</u>

WHST.9-10.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.9-10.5 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.

WHST.9-10.6 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.

<u>Research to Build and Present Knowledge</u>

WHST.9-10.7 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.

WHST.9-10.8 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.

WHST.9-10.9 Draw evidence from informational texts to support analysis, reflection, and research.

Grades 9-10

Writing in History/SS, Science, and Technical Subjects
Range of Writing
WHST.9-10.10 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.

English III
Reading Literature Key Ideas and Details
RL.11.1 Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.
RL.11.2 Determine two or more themes or central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to produce a complex account; provide an objective summary of the text.
RL.11.3 Analyze the impact of the author's choices regarding how to develop and relate elements of a story or drama (e.g., where a story is set, how the action is ordered, how the characters are introduced and developed).

Craft and Structure
RL.11.4 Determine the meaning of words and phrases as they are used in the text, including figurative and connotative meanings; analyze the impact of specific word choices on meaning and tone, including words with multiple meanings or language that is particularly fresh, engaging, or beautiful. (Include Shakespeare as well as other authors.)
RL.11.5 Analyze how an author's choices concerning how to structure specific parts of a text (e.g., the choice of where to begin or end a story, the choice to provide a comedic or tragic resolution) contribute to its overall structure and meaning as well as its aesthetic impact.
RL.11.6 Analyze a case in which grasping a point of view requires distinguishing what is directly stated in a text from what is really meant (e.g., satire, sarcasm, irony, or understatement).

Integration of Knowledge and Ideas
RL.11.7 Analyze multiple interpretations of a story, drama, or poem (e.g., recorded or live production of a play or recorded novel or poetry), evaluating how each version interprets the source text. (Include at least one play by Shakespeare and one play by an American dramatist.)
RL.11.8 Not applicable to literature.
RL.11.9 Demonstrate knowledge of eighteenth-, nineteenth- and early-twentieth century foundational works of American literature, including how two or more texts from the same period treat similar themes or topics.

Range of Reading and Level of Text Complexity
RL.11.10 By the end of grade 11, read and comprehend literature, including stories, dramas, and poems, in the grades 11-CCR text complexity band proficiently, with scaffolding as needed at the high end of the range.

English III
Reading Informational Text Key Ideas and Details
Rl.11.3 Analyze a complex set of ideas or sequence of events and explain how specific individuals, ideas, or events interact and develop over the course of the text.

Craft and Structure
Rl.11.4 Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze how an author uses and refines the meaning of a key term or terms over the course of a text (e.g., how Madison defines faction in Federalist No. 10).
Rl.11.5 Analyze and evaluate the effectiveness of the structure an author uses in his or her exposition or argument, including whether the structure makes points clear, convincing, and engaging.
Rl.11.6 Determine an author's point of view or purpose in a text in which the rhetoric is particularly effective, analyzing how style and content contribute to the power, persuasiveness or beauty of the text.

<u>Integration of Knowledge and Ideas</u>

Rl.11.7 Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem.

Rl.11.8 Delineate and evaluate the reasoning in seminal U.S. texts, including the application of constitutional principles and use of legal reasoning (e.g., in U.S. Supreme Court majority opinions and dissents) and the premises, purposes, and arguments in works of public advocacy (e.g., The Federalist, presidential addresses).

Rl.11.9 Analyze seventeenth-, eighteenth-, and nineteenth-century foundational U.S. documents of historical and literary significance (including Them Declaration of Independence, the Preamble to the Constitution, the Bill of Rights, and Lincoln's Second Inaugural Address) for their themes, purposes, and rhetorical features.

<u>Range of Reading and Level of Text Complexity</u>

Rl.11.10 By the end of grade 11, read and comprehend literary nonfiction in the grades 11-CCR text complexity band proficiently, with scaffolding as needed at the high end of the range.

English III
<u>Writing</u>

W.11.1 Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

W.11.1a 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 claim(s), counterclaims, reasons, and evidence.

W.11.1b Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant evidence for each while pointing out the strengths and limitations of both in a manner that anticipates the audience's knowledge level, concerns, values, and possible biases.

W.11.1c 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.

W.11.1d Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

W.11.1e Provide a concluding statement or section that follows from and supports the argument presented.

W.11.2 Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

W.11.2a Introduce a topic; 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.

English III

W.11.2b 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.

W.11.2c Use appropriate and varied transitions and syntax to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.

W.11.2d Use precise language, domain-specific vocabulary, and techniques such as metaphor, simile, and analogy to manage the complexity of the topic.

W.11.2e Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

W.11.2f 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).

W.11.3 Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.

W.11.3a Engage and orient the reader by setting out a problem, situation, or observation and its significance, establishing one or multiple point(s) of view, and introducing a narrator and/or characters; create a smooth progression of experiences or events.

W.11.3b Use narrative techniques, such as dialogue, pacing, description, reflection, and multiple plot lines, to develop experiences, events, and/or characters.

W.11.3c Use a variety of techniques to sequence events so that they build on one another to create a coherent whole and build toward a particular tone and outcome (e.g., a sense of mystery, suspense, growth, or resolution).

W.11.3d Use precise words and phrases, telling details, and sensory language to convey a vivid picture of the experiences, events, setting, and/or characters.

W.11.3e Provide a conclusion that follows from and reflects on what is experienced, observed, or resolved over the course of the narrative.

Production and Distribution of Writing

W.11.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1–3 above.)

English III

W.11.5 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. (Editing for conventions should demonstrate command of Language standards 1–3 up to and including grades 11–12.)

W.11.6 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

W.11.7 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.

W.11.8 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 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.

W.11.9 Draw evidence from literary or informational texts to support analysis, reflection, and research.

W.11.9a Apply grades 11–12 Reading standards to literature (e.g., "Demonstrate knowledge of eighteenth-, nineteenth- and early-twentieth-century foundational works of American literature, including how two or more texts from the same period treat similar themes or topics").

W.11.9b Apply grades 11–12 Reading standards to literary nonfiction (e.g., "Delineate and evaluate the reasoning in seminal U.S. texts, including the application of constitutional principles and use of legal reasoning [e.g., in U.S. Supreme Court Case majority opinions and dissents] and the premises, purposes, and arguments in works of public advocacy [e.g., The Federalist, presidential addresses]").

Range of Writing

W.11.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

English III
Speaking and Listening
Comprehension and Collaboration

SL.11.1 Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.

SL11.1a Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.

SL.11.1b Work with peers to promote civil, democratic discussions and decision making, set clear goals and deadlines, and establish individual roles as needed.

SL.11.1c Propel conversations by posing and responding to questions that probe reasoning and evidence; ensure a hearing for a full range of positions on a topic or issue; clarify, verify, or challenge ideas and conclusions; and promote divergent and creative perspectives.

SL.11.1d Respond thoughtfully to diverse perspectives; synthesize comments, claims, and evidence made on all sides of an issue; resolve contradictions when possible; and determine what additional information or research is required to deepen the investigation or complete the task.

SL.11.2 Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.

SL.11.3 Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, assessing the stance, premises, links among ideas, word choice, points of emphasis, and tone used.

Presentation of Knowledge and Ideas

SL.11.4 Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.

English III

SL11.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

SL.11.6 Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate. (See grades 11–12 Language standards 1 and 3 for specific expectations.)

English III
Language
Conventions of Standard English

L.11.1a Apply the understanding that usage is a matter of convention, can change over time, and is sometimes contested.

L.11.1b Resolve issues of complex or contested usage, consulting references (e.g., Merriam-Webster's Dictionary of English Usage, Garner's Modern American Usage) as needed.

L.11.2a Observe hyphenation conventions.

L.11.3a Vary syntax for effect, consulting references (e.g., Tufte's Artful Sentences) for guidance as needed; apply an understanding of syntax to the study of complex texts when reading.

Vocabulary Acquisition and Use

L.11.4 Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 11–12 reading and content, choosing flexibly from a range of strategies.

L.11.4b Identify and correctly use patterns of word changes that indicate different meanings or parts of speech (e.g., conceive, conception, conceivable).

English IV
Range of Reading and Level of Text Complexity

RL.12.10 By the end of grade 12, read and comprehend literature, including stories, dramas, and poems, at the high end of the grades 11–CCR text complexity band independently and proficiently.

Grades 11-12: Literacy in History/SS
Reading in History/Social Studies Key Ideas and Details

RH.11-12.1 Cite specific textual evidence to support analysis of primary and secondary sources, connecting insights gained from specific details to an understanding of the text as a whole.

RH.11-12.2 Determine the central ideas or information of a primary or secondary source; provide an accurate summary that makes clear the relationships among the key details and ideas.

RH.11-12.3 Evaluate various explanations for actions or events and determine which explanation best accords with textual evidence, acknowledging where the text leaves matters uncertain. Craft and Structure

RH.11-12.4 Determine the meaning of words and phrases as they are used in a text, including analyzing how an author uses and refines the meaning of a key term over the course of a text (e.g., how Madison defines faction in Federalist No. 10).
RH.11-12.5 Analyze in detail how a complex primary source is structured, including how key sentences, paragraphs, and larger portions of the text contribute to the whole.
RH.11-12.6 Evaluate authors' differing points of view on the same historical event or issue by assessing the authors' claims, reasoning, and evidence. Integration of Knowledge and Ideas
Rh.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, as well as in words) in order to address a question or solve a problem.
RH.11-12.8 Evaluate an author's premises, claims, and evidence by corroborating or challenging them with other information.
RH.11-12.9 Integrate information from diverse sources, both primary and secondary, into a coherent understanding of an idea or event, noting discrepancies among sources. Range of Reading and Level of Text Complexity
RH.11-12.10 By the end of grade 12, read and comprehend history/social studies texts in the grades 11–CCR text complexity band independently and proficiently.

Grades 11-12: Literacy in Science and Technical Subjects
Reading in Science and Technical Subjects Key Ideas and Details
RST. 11-12.1 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.
RST.11-12.2 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.
RST.11-12.3 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
RST.11-12.4 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 11–12 texts and topics.
RST.11-12.5 Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
RST.11-12.6 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.
RST.11-12.7 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.
RST.11-12.8 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.
RST.11-12.9 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.

Range of Reading and Level of Text Complexity
RST.11-12.10 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.
Grades 11-12: Writing I History/SS, Science and Technical Subjects
Writing
Text Types and Purposes
WHST.11-12.1a 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.
WHST.11-12.1b 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.

WHST.11-12.1c 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.

WHST.11-12.2a 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.

Grades 11-12: Writing I History/SS, Science and Technical Subjects

WHST.11-12.2d 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.

Production and Distribution of Writing

WHST.11-12.6 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.

WHST.11-12.8 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.

Appendix E: College- and Career-Ready Standards – Mathematics

Standards	Units	1	2	3	4	5	6	7	8
N-Q.1			X		X		X	X	X
N-Q.2			X		X		X	X	X
N-Q.3			X		X		X	X	X
8.EE.8									
A-SSE.1									
A-SSE.2									
A-SSE.3									
A-SSE.4									
A-CED.1									
A-CED.2									
A-CED.3									
A-CED.4									
A-REI.2									
A-REI.3									
A-REI.4									
A-REI.5									
A-REI.6									
A-REI.7									
A-REI.8									
A-REI.9									
A-REI.10									
A-REI.11									
A-REI.12									
8.F.1									
8.F.2									
8.F.3									
8.F.4									
8.F.5									
F-IF.1									
F-IF.2									
F-IF.3									
F-IF.4									
F-IF.5									
F-IF.6									
F-IF.7									
F-IF.8									
F-IF.9									
F-BF.1									
F-BF.2									
F-BF.3									
F-BF.4									
F-BF.5									
F-LE.1								X	
F-LE.2								X	
F-LE.3								X	
F-LE.4								X	
F-LE.5								X	
8.G.6									
8.G.7									
8.G.8									
G-CO.1									
G-CO.2									
G-CO.3									
G-CO.4									
G-CO.5									
G-CO.6									
G-CO.7									
G-CO.8									

G-CO.9									
G-CO.10									
G-CO.11									
G-CO.12									
G-CO.13									
8.SP.1									
8.SP.2									
8.SP.3									
8.SP.4									
S-ID.1									
S-ID.2									
S-ID.3									
S-ID.4									
S-ID.5									
S-ID.6									
S-ID.7									
S-ID.8									
S-ID.9									
N-RN.1									
N-RN.2									
N-RN.3									
A-APR.									
A-APR.2									
A-APR.3									
A-APR.4									
A-APR.5									
A-APR.6									
A-APR.7									
G-SRT.1									
G-SRT.2									
G-SRT.3									
G-SRT.4									
G-SRT.5									
G-SRT.6									
G-SRT.7									
G-SRT.8									
G-SRT.9									
G-SRT.10									
G-SRT.11									
G-C.1									
G-C.2									
G-C.3									
G-C.4									
G-C.5									
G-GPE.1									
G-GPE.2									
G-GPE.3									
G-GPE.4									
G-GPE.5									
G-GPE.6									
G-GPE.7									
G-GMD.1									
G-GMD.2									
G-GMD.3									
G-GMD.4									
G-MG.1									X
G-MG.2									X
G-MG.3									X
N-CN.1									
N-CN.2									
N-CN.3									
N-CN.4									
N-CN.5									
N-CN.6									
N-CN.7									
N-CN.8									

N-CN.9									
F-TF.1									
F-TF.2									
F-TF.3									
F-TF.4									
F-TF.5									
F-TF.6									
F-TF.7									
F-TF.8									
F-TF.9									
S-IC.1									
S-IC.2									
S-IC.3									
S-IC.4									
S-IC.5									
S-IC.6									
S-CP.1									
S-CP.2									
S-CP.3									
S-CP.4									
S-CP.5									
S-CP.6									
S-CP.7									
S-CP.8									
S-CP.9									
N-VM.1									
N-VM.2									
N-VM.3									
N-VM.4									
N-VM.5									
N-VM.6									
N-VM.7									
N-VM.8									
N-VM.9									
N-VM.10									
N-VM.11									
N-VM.12									
S-MD.1									
S-MD.2									
S-MD.3									
S-MD.4									
S-MD.5									
S-MD.6									
S-MD.7									

Mathematics Standards

Number and Quantity
Reason quantitatively and use unites to solve problems

N-Q.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.*

N-Q.2 Define appropriate quantities for the purpose of descriptive modeling.*

N-Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.*

Algebra
Analyze and solve linear equations and pairs of simultaneous linear equations

8.EE.8 Analyze and solve pairs of simultaneous linear equations.

a. Understand that solutions to a system of two linear equations in two variables correspond to points of intersection of their graphs, because points of intersection satisfy both equations simultaneously.

b. Solve systems of two linear equations in two variables algebraically, and estimate solutions by graphing the equations. Solve simple cases by inspection. For example, $3x + 2y = 5$ and $3x + 2y = 6$ have no solution because $3x + 2y$ cannot simultaneously be 5 and 6.

c. Solve real-world and mathematical problems leading to two linear equations in two variables. For example, given coordinates for two pairs of points, determine whether the line through the first pair of points intersects the line through the second pair.

Interpret the structure of expressions

A-SSE.1 Interpret expressions that represent a quantity in terms of its context.*
a. Interpret parts of an expression, such as terms, factors, and coefficients.
b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret P(1+r)n as the product of P and a factor not depending on P.
A-SSE.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.*
c. Use the properties of exponents to transform expressions for exponential functions. For example the expression 1.15t can be rewritten as [1.151/12] 12t ≈ 1.01212t to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.

Creating equations that describe numbers or relationships

A-CED.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*
A-CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*
A-CED.3 Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.*
A-CED.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R.*

Solve equations and inequalities in one variable

A-REI.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

Solve systems of equations

A-REI.5 Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.
A-REI.6 Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

Represent and solve equations and inequalities graphically

A-REI.10 Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).
A-REI.11 Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*
A-REI.12 Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Functions

Define, evaluate, and compare functions

8.F.1 Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output. 1
8.F.2 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a linear function represented by a table of values and a linear function represented by an algebraic expression, determine which function has the greater rate of change.
8.F.3 Interpret the equation y = mx + b as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. For example, the function A = s2 giving the area of a square as a

function of its side length is not linear because its graph contains the points (1,1), (2,4) and (3,9), which are not on a straight line.

Use functions to model relationships between quantities

8.F.4 Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x, y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.

8.F.5 Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.

Understand the concept of a function and use function notation

F-IF.1 Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).

F-IF.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

F-IF.3 Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by f(0) = f(1) = 1, f(n+1) = f(n) + f(n-1) for n ≥ 1.

Interpret functions that arise in applications in terms of the context

F-IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

F-IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*

F-IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.* Analyze functions using different representations Supporting

F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.* a. Graph linear and quadratic functions and show intercepts, maxima, and minima.

F-IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

Build a function that models a relationship between two quantities

F-BF.1 Write a function that describes a relationship between two quantities.* a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

F-BF.2 Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.*

Construct and compare linear, quadratic, and exponential models and solve problems

F-LE.1 Distinguish between situations that can be modeled with linear functions and with exponential functions.*
a. Prove that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals.
b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.
c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.

F-LE.2 Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).*

F-LE.3 Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.* Interpret expressions for functions in terms of the situation they model Supporting

F-LE.5 Interpret the parameters in a linear or exponential function in terms of a context.*

Geometry
Understand and apply the Pythagorean Theorem

8.G.6 Explain a proof of the Pythagorean Theorem and its converse.

8.G.7 Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.

8.G.8 Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.

Experiment with transformations in the plane

G-CO.1 Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.

G-CO.2 Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).

G-CO.3 Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.

G-CO.4 Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.

G-CO.5 Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.

Understand congruence in terms of rigid motions

G-CO.6 Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.

G-CO.7 Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.

G-CO.8 Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.

Prove geometric theorems

G-CO.9 Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.

G-CO.10 Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.

G-CO.11 Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.

Statistics and Probability
Investigate patterns of association in bivariate data

8.SP.1 Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association.

8.SP.2 Know that straight lines are widely used to model relationships between two quantitative variables. For scatter plots that suggest a linear association, informally fit a straight line, and informally assess the model fit by judging the closeness of the data points to the line.

8.SP.3 Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept. For example, in a linear model for a biology experiment, interpret a slope of 1.5 cm/hr as meaning that an additional hour of sunlight each day is associated with an additional 1.5 cm in mature plant height.

8.SP.4 Understand that patterns of association can also be seen in bivariate categorical data by displaying frequencies and relative frequencies in a two-way table. Construct and interpret a two-way table summarizing data on two categorical variables collected from the same subjects. Use relative frequencies calculated for rows or columns to describe possible association between the two variables. For example, collect data from students in your class on whether or not they have a curfew on school nights and whether or not they have assigned chores at home. Is there evidence that those who have a curfew also tend to have chores?

Summarize, represent, and interpret data on a single count or measurement variable

S-ID.1 Represent data with plots on the real number line (dot plots, histograms, and box plots).*

S-ID.2 Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.*

S-ID.3 Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).*

Summarize, represent, and interpret data on two categorical and quantitative variables

S-ID.5 Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.*

S-ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.*

a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

c. Fit a linear function for a scatter plot that suggests a linear association.

Interpret linear models

S-ID.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.*

S-ID.8 Compute (using technology) and interpret the correlation coefficient of a linear fit.*

S-ID.9 Distinguish between correlation and causation.*

Algebra I
Number and Quantity
Use properties of rational and irrational numbers

N-RN.3 Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.

Reason quantitatively and use units to solve problems

N-Q.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.*

N-Q.2 Define appropriate quantities for the purpose of descriptive modeling.*

N-Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.*

Algebra
Interpret the structure of expressions

A-SSE.1 Interpret expressions that represent a quantity in terms of its context.*
a. Interpret parts of an expression, such as terms, factors, and coefficients.
b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret P(1+r)n as the product of P and a factor not depending on P.
A-SSE.2 Use the structure of an expression to identify ways to rewrite it. For example, see x4 – y 4 as (x2) 2 – (y2) 2 thus recognizing it as a difference of squares that can be factored as (x2 – y 2) (x2 + y2).

Write expressions in equivalent forms to solve problems
A-SSE.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.*
a. Factor a quadratic expression to reveal the zeros of the function it defines.
b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.
c. Use the properties of exponents to transform expressions for exponential functions. For example the expression 1.15t can be rewritten as [1.151/12] 12t ≈ 1.01212t to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.

Algebra I
Perform arithmetic operations on polynomials
A-APR.1 Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.

Understand the relationship between zeros and factors of polynomials
A-APR.3 Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.

Create equations that describe numbers or relationships
A-CED.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*
A-CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*
A-CED.3 Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.*
A-CED.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R.*

Understand solving equations as a process of reasoning and explain the reasoning
A-REI.1 Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

Solve equations and inequalities in one variable
A-REI.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.
A-REI.4 Solve quadratic equations in one variable.
a. Use the method of completing the square to transform any quadratic equation in x into an equation of the form (x – p) 2 = q that has the same solutions. Derive the quadratic formula from this form.
b. Solve quadratic equations by inspection (e.g., for x 2 = 49), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as a ± bi for real numbers a and b.

Algebra I
Solve systems of equations

A-REI.5 Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.
A-REI.6 Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

Represent and solve equations and inequalities graphically
A-REI.10 Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).
A-REI.11 Explain why the x-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*
A-REI.12 Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Functions
Understand the concept of a function and use function notation
F-IF.1 Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then $f(x)$ denotes the output of f corresponding to the input x. The graph of f is the graph of the equation $y = f(x)$.
F-IF.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.
F-IF.3 Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by $f(0) = f(1) = 1$, $f(n+1) = f(n) + f(n-1)$ for $n \geq 1$

Interpret functions that arise in applications in terms of the context
F-IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*
F-IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*
F-IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.*

Algebra I
Analyze functions using different representations
F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*
a. Graph linear and quadratic functions and show intercepts, maxima, and minima.
b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.
F-IF.8 Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.
a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.
F-IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum. B

Build a function that models a relationship between two quantities

F-BF.1 Write a function that describes a relationship between two quantities.*
a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

Build new functions from existing functions
F-BF.3 Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them

Construct and compare linear, quadratic, and exponential models and solve problems
F-LE.1 Distinguish between situations that can be modeled with linear functions and with exponential functions.*
a. Prove that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals.
b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.
c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.
F-LE.2 Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).*
F-LE.3 Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.*

Algebra I
Interpret expressions for functions in terms of the situation they model
F-LE.5 Interpret the parameters in a linear or exponential function in terms of a context.*

Statistics and Probability *
Summarize, represent, and interpret data on a single count or measurement variable
S-ID.1 Represent data with plots on the real number line (dot plots, histograms, and box plots).*
S-ID.2 Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.*
S-ID.3 Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).*

Summarize, represent, and interpret data on two categorical and quantitative variables
S-ID.5 Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.*
S-ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.*
a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.
b. Informally assess the fit of a function by plotting and analyzing residuals.
c. Fit a linear function for a scatter plot that suggests a linear association.

Interpret linear models
S-ID.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.*
S-ID.8 Compute (using technology) and interpret the correlation coefficient of a linear fit.*
S-ID.9 Distinguish between correlation and causation.*

Geometry Course
Geometry
Experiment with transformations in the plane

G-CO.1 Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.

G-CO.2 Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).

G-CO.3 Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.

G-CO.4 Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.

G-CO.5 Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.

Understand congruence in terms of rigid motions

G-CO.6 Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.

G-CO.7 Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.

G-CO.8 Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.

Prove geometric theorems

G-CO.9 Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.

G-CO.10 Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.

G-CO.11 Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.

Geometry Course
Make geometric constructions

G-CO.12 Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.

G-CO.13 Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.

Understand similarity in terms of similarity transformations

G-SRT.1 Verify experimentally the properties of dilations given by a center and a scale factor:
a. A dilation takes a line not passing through the center of the dilation to a parallel line, and leaves a line passing through the center unchanged.
b. The dilation of a line segment is longer or shorter in the ratio given by the scale factor.

G-SRT.2 Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.

G-SRT.3 Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.

Prove theorems involving similarity

G-SRT.4 Prove theorems about triangles. Theorems include: a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity.
G-SRT.5 Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.

Define trigonometric ratios and solve problems involving right triangles

G-SRT.6 Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.
G-SRT.7 Explain and use the relationship between the sine and cosine of complementary angles.
G-SRT.8 Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.*

Understand and apply theorems about circles

G-C.1 Prove that all circles are similar
G-C.2 Identify and describe relationships among inscribed angles, radii, and chords. Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.
G-C.3 Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.

Find arc lengths and areas of sectors of circles

G-C.5 Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector.

Translate between the geometric description and the equation for a conic section A

G-GPE.1 Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.

Use coordinates to prove simple geometric theorems algebraically

G-GPE.4 Use coordinates to prove simple geometric theorems algebraically. For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle; prove or disprove that the point $(1, \sqrt{3})$ lies on the circle centered at the origin and containing the point $(0, 2)$.
G-GPE.5 Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point).
G-GPE.6 Find the point on a directed line segment between two given points that partitions the segment in a given ratio.
G-GPE.7 Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.*

Explain volume formulas and use them to solve problems

G-GMD.1 Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri's principle, and informal limit arguments.
G-GMD.3 Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.*

Visualize relationships between two-dimensional and three-dimensional objects

G-GMD.4 Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.

Apply geometric concepts in modeling situations

G-MG.1 Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).*
G-MG.2 Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).*

G-MG.3 Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).*

Algebra II
Number and Quantity
Extend the properties of exponents to rational exponents

N-RN.1 Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. For example, we define 51/3 to be the cube root of 5 because we want [51/3] 3 = 5(1/3) 3 to hold, so [51/3] 3 must equal 5.

N-RN.2 Rewrite expressions involving radicals and rational exponents using the properties of exponents.

Reason quantitatively and use units to solve problems

N-Q.2 Define appropriate quantities for the purpose of descriptive modeling.*

Perform arithmetic operations with complex numbers

N-CN.1 Know there is a complex number i such that i 2 = −1, and every complex number has the form a + bi with a and b real.

N-CN.2 Use the relation i 2 = –1 and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.

Use complex numbers in polynomial identities and equations

N-CN.7 Solve quadratic equations with real coefficients that have complex solutions.

Algebra
Interpret the structure of expressions

A-SSE.2 Use the structure of an expression to identify ways to rewrite it. For example, see x4 – y 4 as (x2) 2 – (y2) 2, thus recognizing it as a difference of squares that can be factored as (x2 – y 2) (x2 + y2).

Write expressions in equivalent forms to solve problems

A-SSE.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.* c. Use the properties of exponents to transform expressions for exponential functions. For example the expression 1.15t can be rewritten as [1.151/12] 12t ≈ 1.01212t to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.

Algebra II

A-SSE.4 Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems. For example, calculate mortgage payments.*

Understand the relationship between zeros and factors of polynomials

A-APR.2 Know and apply the Remainder Theorem: For a polynomial p(x) and a number a, the remainder on division by x – a is p(a), so p(a) = 0 if and only if (x – a) is a factor of p(x).

A-APR.3 Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.

Use polynomial identities to solve problems

A-APR.4 Prove polynomial identities and use them to describe numerical relationships. For example, the polynomial identity (x2 + y2) 2 = (x2 – y 2) 2 + (2xy) 2 can be used to generate Pythagorean triples.

Rewrite rational expressions

A-APR.6 Rewrite simple rational expressions in different forms; write a(x)/b(x) in the form q(x) + r(x)/b(x), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a computer algebra system.

Create equations that describe numbers or relationships

A-CED.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*

Understand solving equations as a process of reasoning and explain the reasoning

A-REI.1 Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

A-REI.2 Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

Solve equations and inequalities in one variable

A-REI.4 Solve quadratic equations in one variable. b. Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers a and b.

Algebra II
Solve systems of equations

A-REI.6 Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

A-REI.7 Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line $y = -3x$ and the circle $x^2 + y^2 = 3$.

Represent and solve equations and inequalities graphically

A-REI.11 Explain why the x-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*

Functions
Understand the concept of a function and use function notation

F-IF.3 Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by $f(0) = f(1) = 1$, $f(n+1) = f(n) + f(n-1)$ for $n \geq 1$.

Interpret functions that arise in applications in terms of the context

F-IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

F-IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.*

Analyze functions using different representations

F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*

c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.

e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

Algebra II

F-IF.8 Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

b. Use the properties of exponents to interpret expressions for exponential functions. For example, identify percent rate of change in functions such as y = (1.02)t , y = (0.97)t , y = (1.01)12t, y = (1.2)t/10, and classify them as representing exponential growth and decay.

F-IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

Build a function that models a relationship between two quantities

F-BF.1 Write a function that describes a relationship between two quantities.*

a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

b. Combine standard function types using arithmetic operations. For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.

F-BF.2 Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.*

Build new functions from existing functions

F-BF.3 Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

F-BF.4 Find inverse functions. a. Solve an equation of the form f(x) = c for a simple function f that has an inverse and write an expression for the inverse. For example, f(x) =2x 3 or f(x) = (x+1)/(x-1) for x ≠ 1.

Construct and compare linear, quadratic, and exponential models and solve problems

F-LE.2 Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).*

F-LE.4 For exponential models, express as a logarithm the solution to abct = d where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology.*

Interpret expressions for functions in terms of the situation they model

F-LE.5 Interpret the parameters in a linear or exponential function in terms of a context.*

Algebra II
Extend the domain of trigonometric functions using the unit circle

F-TF.1 Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.

F-TF.2 Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.

Model periodic phenomena with trigonometric functions

F-TF.5 Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.*

Prove and apply trigonometric identities

F-TF.8 Prove the Pythagorean identity $\sin(\Theta)^2 + \cos(\Theta)^2 = 1$ and use it to find $\sin(\Theta)$, $\cos(\Theta)$, or $\tan(\Theta)$, given $\sin(\Theta)$, $\cos(\Theta)$, or $\tan(\Theta)$ and the quadrant of the angle.

Geometry
Translate between the geometric description and the equation for a conic section

G-GPE.2 Derive the equation of a parabola given a focus and directrix.

Statistics and Probability
Summarize, represent, and interpret data on a single count or measurement variable

S-ID.4 Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.*

Summarize, represent, and interpret data on two categorical and quantitative variables

S-ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.*

a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

Algebra II
Understand and evaluate random processes underlying statistical experiments

S-IC.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population.*

S-IC.2 Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model?*

Make inferences and justify conclusions from sample surveys, experiments, and observational studies

S-IC.3 Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.*

S-IC.4 Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.*

S-IC.5 Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.*

S-IC.6 Evaluate reports based on data.*

Understand independence and conditional probability and use them to interpret data

S-CP.1 Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events ("or," "and," "not").*

S-CP.2 Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.*

S-CP.3 Understand the conditional probability of A given B as P(A and B)/P(B), and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.*

S-CP.4 Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities. For example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results.*

S-CP.5 Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.*

Use the rules of probability to compute probabilities of compound events in a uniform probability model

S-CP.6 Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A, and interpret the answer in terms of the model.*

S-CP.7 Apply the Addition Rule, P(A or B) = P(A) + P(B) – P(A and B), and interpret the answer in terms of the model.*

Integrated Mathematics
Number and Quantity

Reason quantitatively and use units to solve problems
        N-Q.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.*
        N-Q.2 Define appropriate quantities for the purpose of descriptive modeling.*
        N-Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.*

Algebra
Interpret the structure of expressions
        A-SSE.1 Interpret expressions that represent a quantity in terms of its context.*
        a. Interpret parts of an expression, such as terms, factors, and coefficients.
        b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret $P(1+r)n$ as the product of P and a factor not depending on P.
Write expressions in equivalent forms to solve problems
        A-SSE.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.*
        c. Use the properties of exponents to transform expressions for exponential functions. For example the expression $1.15t$ can be rewritten as $[1.151/12]\ 12t \approx 1.01212t$ to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.

Create equations that describe numbers or relationships
        A-CED.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*
        A-CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*
        A-CED.3 Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.*
        A-CED.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law $V = IR$ to highlight resistance R.*

Integrated Mathematics I
Solve equations and inequalities in one variable
        A-REI.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

Solve systems of equations
        A-REI.5 Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.
        A-REI.6 Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

Represent and solve equations and inequalities graphically
        A-REI.10 Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).
        A-REI.11 Explain why the x-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*
        A-REI.12 Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Functions
Understand the concept of a function and use function notation

F-IF.1 Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).

F-IF.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

F-IF.3 Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by f(0) = f(1) = 1, f(n+1) = f(n) + f(n-1) for n ≥ 1.

Interpret functions that arise in applications in terms of the context

F-IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

Integrated Mathematics I

F-IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*

F-IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.*

Analyze functions using different representations

F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*

a. Graph linear and quadratic functions and show intercepts, maxima, and minima.

F-IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

Build a function that models a relationship between two quantities

F-BF.1 Write a function that describes a relationship between two quantities.* a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

F-BF.2 Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.*

Construct and compare linear, quadratic, and exponential models and solve problems

F-LE.1 Distinguish between situations that can be modeled with linear functions and with exponential functions.*

a. Prove that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals.

b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.

c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.

F-LE.2 Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).*

F-LE.3 Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.*

Interpret expressions for functions in terms of the situation they model

F-LE.5 Interpret the parameters in a linear or exponential function in terms of a context.*

Integrated Mathematics I
Geometry
Experiment with transformations in the plane

G-CO.1 Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.

G-CO.2 Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).

G-CO.3 Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.

G-CO.4 Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.

G-CO.5 Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.

Understand congruence in terms of rigid motions

G-CO.6 Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.

G-CO.7 Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.

G-CO.8 Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.

Prove geometric theorems

G-CO.9 Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.

G-CO.10 Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.

G-CO.11 Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.

Integrated Mathematics I
Statistics and Probability
Summarize, represent, and interpret data on a single count or measurement variable

S-ID.1 Represent data with plots on the real number line (dot plots, histograms, and box plots).*

S-ID.2 Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.*

S-ID.3 Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).*

Summarize, represent, and interpret data on two categorical and quantitative variables

S-ID.5 Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.*

S-ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.*

a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

c. Fit a linear function for a scatter plot that suggests a linear association.

Interpret linear models

S-ID.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.*
S-ID.8 Compute (using technology) and interpret the correlation coefficient of a linear fit.*
S-ID.9 Distinguish between correlation and causation.*

Integrated Mathematics I
Number and Quantity
Extend the properties of exponents to rational exponents
N-RN.1 Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. For example, we define 51/3 to be the cube root of 5 because we want [51/3] 3 = 5(1/3) 3 to hold, so [51/3] 3 must equal 5.
N-RN.2 Rewrite expressions involving radicals and rational exponents using the properties of exponents.

Use properties of rational and irrational numbers
N-RN.3 Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.

Reason quantitatively and use units to solve problems
N-Q.2 Define appropriate quantities for the purpose of descriptive modeling.*

Perform arithmetic operations with complex numbers
N-CN.1 Know there is a complex number i such that $i^2 = -1$, and every complex number has the form a + bi with a and b real.
N-CN.2 Use the relation $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.

Use complex numbers in polynomial identities and equations
N-CN.7 Solve quadratic equations with real coefficients that have complex solutions.

Algebra
Interpret the structure of expressions
A-SSE.1 Interpret expressions that represent a quantity in terms of its context.* b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret P(1+r)n as the product of P and a factor not depending on P.

Integrated Mathematics II
A-SSE.2 Use the structure of an expression to identify ways to rewrite it. For example, see x4 – y 4 as (x2) 2 – (y2) 2, thus recognizing it as a difference of squares that can be factored as (x2 – y 2) (x2 + y2).

Write expressions in equivalent forms to solve problems
A-SSE.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.*
a. Factor a quadratic expression to reveal the zeros of the function it defines.
b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.

Perform arithmetic operations on polynomials
A-APR.1 Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.

Create equations that describe numbers or relationships
A-CED.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*

A-CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*

A-CED.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law $V = IR$ to highlight resistance R.*

Understand solving equations as a process of reasoning and explain the reasoning M

A-REI.1 Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

Solve equations and inequalities in one variable

A-REI.4 Solve quadratic equations in one variable.

a. Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x - p) 2 = q$ that has the same solutions. Derive the quadratic formula from this form.

b. Solve quadratic equations by inspection (e.g., for $x 2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers a and b.

Solve systems of equations

A-REI.7 Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line $y = -3x$ and the circle $x2 + y2 = 3$.

Functions

Interpret functions that arise in applications in terms of the context M

F-IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

F-IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*

F-IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.*

Analyze functions using different representations

F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*

a. Graph linear and quadratic functions and show intercepts, maxima, and minima.

b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.

e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

F-IF.8 Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.

b. Use the properties of exponents to interpret expressions for exponential functions. For example, identify percent rate of change in functions such as $y = (1.02)t$, $y = (0.97)t$, $y = (1.01)12t$, $y = (1.2)t/10$, and classify them as representing exponential growth and decay.

F-IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

Integrated Mathematics II
Build a function that models a relationship between two quantities

F-BF.1 Write a function that describes a relationship between two quantities.*
a. Determine an explicit expression, a recursive process, or steps for calculation from a context.
b. Combine standard function types using arithmetic operations. For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.

Build new functions from existing functions

F-BF.3 Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

Geometry
Understand similarity in terms of similarity transformations

G-SRT.1 Verify experimentally the properties of dilations given by a center and a scale factor:
a. A dilation takes a line not passing through the center of the dilation to a parallel line, and leaves a line passing through the center unchanged.
b. The dilation of a line segment is longer or shorter in the ratio given by the scale factor.
G-SRT.2 Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.
G-SRT.3 Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.

Prove theorems using similarity

G-SRT.4 Prove theorems about triangles. Theorems include: a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity.
G-SRT.5 Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.

Define trigonometric ratios and solve problems involving right triangles

G-SRT.6 Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.
G-SRT.7 Explain and use the relationship between the sine and cosine of complementary angles.

Integrated Mathematics II

G-SRT.8 Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.*

Explain volume formulas and use them to solve problems

G-GMD.1 Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri's principle, and informal limit arguments.
G-GMD.3 Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.*

Statistics and Probability*
Summarize, represent, and interpret data on two categorical and quantitative variables

S-ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.*
a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.
b. Informally assess the fit of a function by plotting and analyzing residuals.

Understand independence and conditional probability and use them to interpret data

S-CP.1 Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events ("or," "and," "not").*

S-CP.2 Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.*

S-CP.3 Understand the conditional probability of A given B as P(A and B)/P(B), and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.*

S-CP.4 Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities. For example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results.*

S-CP.5 Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.

Integrated Mathematics II
Use the rules of probability to compute probabilities of compound events in a uniform probability model

S-CP.6 Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A, and interpret the answer in terms of the model.*

S-CP.7 Apply the Addition Rule, P(A or B) = P(A) + P(B) – P(A and B), and interpret the answer in terms of the model.*

Integrated Mathematics III
Number and Quantity
Reason quantitatively and use units to solve problems

N-Q.2 Define appropriate quantities for the purpose of descriptive modeling.*

Algebra
Interpret the structure of expressions

A-SSE.2 Use the structure of an expression to identify ways to rewrite it. For example, see $x^4 - y^4$ as $(x^2)^2 - (y^2)^2$, thus recognizing it as a difference of squares that can be factored as $(x^2 - y^2)(x^2 + y^2)$.

Write expressions in equivalent forms to solve problems

A-SSE.4 Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems. For example, calculate mortgage payments.*

Understand the relationship between zeros and factors of polynomials

A-APR.2 Know and apply the Remainder Theorem: For a polynomial p(x) and a number a, the remainder on division by x – a is p(a), so p(a) = 0 if and only if (x – a) is a factor of p(x).

A-APR.3 Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.

Use polynomial identities to solve problems

A-APR.4 Prove polynomial identities and use them to describe numerical relationships. For example, the polynomial identity $(x^2 + y^2)^2 = (x^2 - y^2)^2 + (2xy)^2$ can be used to generate Pythagorean triples.

Rewrite rational expressions

A-APR.6 Rewrite simple rational expressions in different forms; write a(x)/b(x) in the form q(x) + r(x)/b(x), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a computer algebra system.

Integrated Mathematics III

Create equations that describe numbers or relationships

    A-CED.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*

    A-CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*

Understand solving equations as a process of reasoning and explain the reasoning

    A-REI.1 Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

    A-REI.2 Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

Represent and solve equations and inequalities graphically

    A-REI.11 Explain why the x-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*

Interpret functions that arise in applications in terms of the context

    F-IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

    F-IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.*

Analyze functions using different representations

    F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.* c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior. e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

    F-IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

Build new functions from existing functions

    F-BF.3 Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k\,f(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

    F-BF.4 Find inverse functions. a. Solve an equation of the form $f(x) = c$ for a simple function f that has an inverse and write an expression for the inverse. For example, $f(x) = 2x3$ or $f(x) = (x+1)/(x-1)$ for $x \neq 1$.

Construct and compare linear, quadratic, and exponential models and solve problems

    F-LE.4 For exponential models, express as a logarithm the solution to $abct = d$ where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology.*

Extend the domain of trigonometric functions using the unit circle

    F-TF.1 Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.

F-TF.2 Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.

Model periodic phenomena with trigonometric functions

F-TF.5 Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.*

Prove and apply trigonometric identities

F-TF.8 Prove the Pythagorean identity $\sin(\Theta)^2 + \cos(\Theta)^2 = 1$ and use it to find $\sin(\Theta)$, $\cos(\Theta)$, or $\tan(\Theta)$, given $\sin(\Theta)$, $\cos(\Theta)$, or $\tan(\Theta)$ and the quadrant of the angle.

Integrated Mathematics III
Geometry
Make geometric constructions

G-CO.12 Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.
G-CO.13 Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.

Understand and apply theorems about circles

G-C.1 Prove that all circles are similar.
G-C.2 Identify and describe relationships among inscribed angles, radii, and chords. Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.
G-C.3 Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.

Find arc lengths and areas of sectors of circles

G-C.5 Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector.

Translate between the geometric description and the equation for a conic section

G-GPE.1 Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.
G-GPE.2 Derive the equation of a parabola given a focus and directrix.

Use coordinates to prove simple geometric theorems algebraically

G-GPE.4 Use coordinates to prove simple geometric theorems algebraically. For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle; prove or disprove that the point $(1, \sqrt{3})$ lies on the circle centered at the origin and containing the point $(0, 2)$.
G-GPE.5 Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point).

Integrated Mathematics III

G-GPE.6 Find the point on a directed line segment between two given points that partitions the segment in a given ratio.
G-GPE.7 Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.*

Visualize relationships between two-dimensional and three-dimensional objects

G-GMD.4 Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.

Apply geometric concepts in modeling situations
G-MG.1 Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).*
G-MG.2 Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).*
G-MG.3 Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).*

Statistics and Probability*
Summarize, represent, and interpret data on a single count or measurement variable S
S-ID.4 Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.*

Summarize, represent, and interpret data on two categorical and quantitative variables
S-ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.*
a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.
b. Informally assess the fit of a function by plotting and analyzing residuals.

Understand and evaluate random processes underlying statistical experiments
S-IC.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population.

Integrated Mathematics III
S-IC.2 Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model?*

Make inferences and justify conclusions from sample surveys, experiments, and observational studies
S-IC.3 Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.*
S-IC.4 Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.*
S-IC.5 Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.*
S-IC.6 Evaluate reports based on data.*

Advanced Mathematics Plus
Number and Quantity
Perform arithmetic operations with complex numbers
N-CN.3 Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.

Represent complex numbers and their operations on the complex plane
N-CN.4 Represent complex numbers on the complex plane in rectangular and polar form (including real and imaginary numbers), and explain why the rectangular and polar forms of a given complex number represent the same number.
N-CN.5 Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation. For example, $(-1 + \sqrt{3} i)3 = 8$ because $(-1 + \sqrt{3} i)$ has modulus 2 and argument 120°.

N-CN.6 Calculate the distance between numbers in the complex plane as the modulus of the difference, and the midpoint of a segment as the average of the numbers at its endpoints.

Use complex numbers in polynomial identities and equations

N-CN.8 Extend polynomial identities to the complex numbers. For example, rewrite x2 + 4 as (x + 2i)(x – 2i).

N-CN.9 Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials

Represent and model with vector quantities

N-VM.1 Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., v, |v|, ||v||, v).

N-VM.2 Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.

N-VM.3 Solve problems involving velocity and other quantities that can be represented by vectors.

Advanced Mathematics Plus

Perform operations on vectors

N-VM.4 Add and subtract vectors.

a. Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes.

b. Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.

c. Understand vector subtraction v – w as v + (–w), where –w is the additive inverse of w, with the same magnitude as w and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise.

N-VM.5 Multiply a vector by a scalar.

a. Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as c(vx, vy) = (cvx, cvy).

b. Compute the magnitude of a scalar multiple cv using ||cv|| = |c|v. Compute the direction of cv knowing that when |c|v 0, the direction of cv is either along v (for c > 0) or against v (for c < 0).

Perform operations on matrices and use matrices in applications

N-VM.6 Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network.

N-VM.7 Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled.

N-VM.8 Add, subtract, and multiply matrices of appropriate dimensions.

N-VM.9 Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties.

N-VM.10 Understand that the zero and identity matrices play a role in matrix addition and multiplication similar to the role of 0 and 1 in the real numbers. The determinant of a square matrix is nonzero if and only if the matrix has a multiplicative inverse.

N-VM.11 Multiply a vector (regarded as a matrix with one column) by a matrix of suitable dimensions to produce another vector. Work with matrices as transformations of vectors.

N-VM.12 Work with 2×2 matrices as transformations of the plane, and interpret the absolute value of the determinant in terms of area.

Algebra
Use polynomial identities to solve problems

A-APR.5 Know and apply the Binomial Theorem for the expansion of (x + y) n in powers of x and y for a positive integer n, where x and y are any numbers, with coefficients determined for example by Pascal's Triangle.

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Rewrite rational expressions

A-APR.7 Understand that rational expressions form a system analogous to the rational numbers, closed under addition, subtraction, multiplication, and division by a nonzero rational expression; add, subtract, multiply, and divide rational expressions.

Solve systems of equations

A-REI.8 Represent a system of linear equations as a single matrix equation in a vector variable.

A-REI.9 Find the inverse of a matrix if it exists and use it to solve systems of linear equations (using technology for matrices of dimension 3×3 or greater).

Functions
Analyze functions using different representations

F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*

d. Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.

Build a function that models a relationship between two quantities

F-BF.1 Write a function that describes a relationship between two quantities. *

c. Compose functions. For example, if T(y) is the temperature in the atmosphere as a function of height, and h(t) is the height of a weather balloon as a function of time, then T(h(t)) is the temperature at the location of the weather balloon as a function of time.

Build new functions from existing functions

F-BF.4 Find inverse functions.

b. Verify by composition that one function is the inverse of another.

c. Read values of an inverse function from a graph or a table, given that the function has an inverse.

d. Produce an invertible function from a non-invertible function by restricting the domain.

F-BF.5 Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.

Advanced Mathematics Plus
Extend the domain of trigonometric functions using the unit circle

F-TF.3 Use special triangles to determine geometrically the values of sine, cosine, tangent for $\pi/3$, $\pi/4$ and $\pi/6$, and use the unit circle to express the values of sine, cosine, and tangent for $\pi-x$, $\pi+x$, and $2\pi-x$ in terms of their values for x, where x is any real number.

F-TF.4 Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions.

Model periodic phenomena with trigonometric functions

F-TF.6 Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed.

F-TF.7 Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology, and interpret them in terms of the context. *

Prove and apply trigonometric identities

F-TF.9 Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.

Geometry
Apply trigonometry to general triangles

G-SRT.9 Derive the formula A = ½ ab sin(C) for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side.

G-SRT.10 Prove the Laws of Sines and Cosines and use them to solve problems.

G-SRT.11 Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in right and non-right triangles (e.g., surveying problems, resultant forces).

Understand and apply theorems about circles

G-C.4 Construct a tangent line from a point outside a given circle to the circle.

Translate between the geometric description and the equation for a conic section
Advanced Mathematics Plus
G-GPE.3 Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant.

Explain volume formulas and use them to solve problems
G-GMD.2 Give an informal argument using Cavalieri's principle for the formulas for the volume of a sphere and other solid figures.

Statistics and Probability*
Use the rules of probability to compute probabilities of compound events in a uniform probability model
S-CP.8 Apply the general Multiplication Rule in a uniform probability model, $P(A \text{ and } B) = P(A)P(B|A) = P(B)P(A|B)$, and interpret the answer in terms of the model.*
S-CP.9 Use permutations and combinations to compute probabilities of compound events and solve problems.*

Calculate expected values and use them to solve problems
S-MD.1 Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space; graph the corresponding probability distribution using the same graphical displays as for data distributions.*
S-MD.2 Calculate the expected value of a random variable; interpret it as the mean of the probability distribution.*
S-MD.3 Develop a probability distribution for a random variable defined for a sample space in which theoretical probabilities can be calculated; find the expected value. For example, find the theoretical probability distribution for the number of correct answers obtained by guessing on all five questions of a multiple-choice test where each question has four choices, and find the expected grade under various grading schemes.*
S-MD.4 Develop a probability distribution for a random variable defined for a sample space in which probabilities are assigned empirically; find the expected value. For example, find a current data distribution on the number of TV sets per household in the United States, and calculate the expected number of sets per household. How many TV sets would you expect to find in 100 randomly selected households?*

Advanced Mathematics Plus
Use probability to evaluate outcomes of decisions
S-MD.5 Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values. *
a. Find the expected payoff for a game of chance. For example, find the expected winnings from a state lottery ticket or a game at a fast-food restaurant.
b. Evaluate and compare strategies on the basis of expected values. For example, compare a high-deductible versus a low-deductible automobile insurance policy using various, but reasonable, chances of having a minor or a major accident.*
S-MD.6 Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator).*
S-MD.7 Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).*