2019 Welding

Mississippi Department of Education

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The Research and Curriculum Unit (RCU), located in Starkville, MS, as part of Mississippi State University, was established to foster educational enhancements and innovations. In keeping with the land grant mission of Mississippi State University, the RCU is dedicated to improving the quality of life for Mississippians. The RCU enhances 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.

Table of Contents

Acknowledgments....4
Standards....5
Preface....7
Mississippi Teacher Professional Resources....8
Executive Summary....9
Course Outlines....10
Research Synopsis....14
Using This Document....17
Unit 1: Orientation....18
Unit 2: Fundamentals of Student Organizations....19
Unit 3: Employability Skills....20
Unit 4: Communication Skills....21
Unit 5: Basic Safety....22
Unit 6: Introduction to Construction Math....23
Unit 7: Hand and Power Tools....24
Unit 8: Introduction to Construction Drawings....25
Unit 9: Introduction to Materials Handling....26
Unit 10: Oxyfuel Cutting....27
Unit 11: SMAW Equipment and Set-up....28
Unit 12: SMAW Electrodes....29
Unit 13: SMAW Beads and Fillet Welds....30
Unit 14: Orientation and Welding Safety Review....31
Unit 15: Base Metal Preparation....32
Unit 16: Joint Fit-up and Alignment....33
Unit 17: Weld Quality....34
Unit 18: Plasma Arc Cutting....35
Unit 19: Air Carbon Arc Cutting and Gouging....36
Unit 20: SMAW Groove Welds with Backing....37
Unit 21: SMAW Open Root Groove Welds Plate....38
Unit 22: Gas Metal Arc Welding (GMAW) and Flux Core Arc Welding (FCAW)....39
Unit 23: Gas Tungsten Arc Welding (GTAW)....40
Student Competency Profile....41

~~Appendix A: Industry Standards.....45~~
~~Appendix B: 21st Century Skills.....48~~
~~Appendix C: College and Career Ready Standards.....51~~
~~Appendix D: College and Career Ready Standards.....71~~
~~Appendix E: International Society for Technology in Education Standards (ISTE).....106~~

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Standards

Standards are superscripted in each unit and are referenced in the appendices. Standards in the Welding Curriculum Framework and Supporting Materials are based on the following:

The NCCER developed and published a set of industry standards that are taught nationwide by contractors, associations, construction users, and secondary and postsecondary schools called the NCCER Learning Series. When developing this set of standards, the NCCER assembled a team of subject matter experts that represented construction companies and schools across the nation. Each committee met several times and combined experts' knowledge and experience to finalize the set of national industry standards.

As a part of the accreditation process, all Mississippi Construction Technology instructors will be required to successfully complete the Instructor Certification Training Program. This program ensures that instructors possess a deep knowledge of content of the standards.

This state-of-the-art curriculum is modeled after the eight Mississippi NCCER Accredited Training and Education Facilities (ATEF). In order to become an NCCER ATEF program, school districts must meet a set of guidelines including the following:

1. Use the approved curriculum.
2. All instructors must be NCCER certified.
3. All completed Form 200s and release forms on all student completions are to be forwarded to MCEF for proper approval. MCEF will in turn forward to NCCER for processing.
4. Follow NCCER guidelines on test security and performance profiles.
5. Have an active advisory committee with at least two commercial contractors involved.
6. Follow safety practices and Occupational Safety and Health Administration (OSHA) standards used in the class and lab areas.
7. Involve commercial contractors in class presentations or field trips.
8. All construction programs must be included in the accreditation process.
9. Show active involvement in student leadership development (e.g., SkillsUSA).
10. Provide demonstrated placement into construction-related occupations and timely reports to MCEF.

Districts will be required to complete a self-evaluation of all programs and host a site visit from industry to ensure proper lab, safety, and instructional procedures are in place.

College and Career-Ready Standards

The College and Career-Ready 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) because they provide a consistent, clear understanding of what students are expected to learn so that teachers and parents know what they need to do to help them. Reprinted from mde.k12.ms.us/MCCRS

International Society for Technology in Education Standards (ISTE)

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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. Retrieved from P21 Partnership for 21st Century Learning, P21 Framework Definitions. Published 2015. p21.org/storage/documents/P21_Framework_Definitions.pdf

Preface

Secondary career and technical education 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.

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 No Child Left Behind Act of 2001).

Mississippi Teacher Professional Resources

The following are resources for Mississippi teachers.

Curriculum, Assessment, Professional Learning, and other program resources can be found at The Research and Curriculum Unit'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, please call 662.325.2510.

Executive Summary

Pathway Description

Welding is an instructional program that prepares students for employment or continued education in the occupations of the welding field. The curriculum framework for this program was developed in partnership with the Mississippi Construction Education Foundation (MCEF). MCEF is the accredited sponsor for the National Center for Construction Education and Research (NCCER).

Industry Certification

NCCER Learning Series

Assessment

The latest assessment blueprint for the curriculum can be found at rcu.msstate.edu/Curriculum/CurriculumDownload.aspx.

Grade Level and Class Size Recommendations

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

Student Prerequisites

In order for students to be able to experience success in the 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

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 any of training sessions provided, please contact the Research and Curriculum Unit at 662.325.2510.

Course Outlines

Option 1 – Four One Carnegie Unit Courses

This curriculum consists of four one-credit courses, which should be completed in the following sequence:

1. **Orientation and Cutting – Course Code: 993302**
2. **Shielded Metal Arc Welding (SMAW) – Course Code: 993303**
3. **Advanced Welding I – Course Code: 993304**
4. **Advanced Welding II – Course Code: 993306**

Course Description: Orientation and Cutting – Course Code: 993302
This course focuses on the NCCER Learning Series Core. 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 Oxyfuel Cutting fundamentals.

Course Description: Shielded Metal Arc Welding (SMAW) – Course Code: 993303
This course introduces students to Shielded Metal Arc Welding (SMAW). Students will focus on proper equipment setup, safety measures, and proper welding techniques. This one-Carnegie-unit course should only be taken after students successfully complete Orientation and Cutting.

Course Description: Advanced Welding I – Course Code: 993304
This course focuses on specialized welding symbols used in blueprints and drawings. Additionally, students will learn about Plasma Arc Cutting (PAC), Carbon Arc Cutting (CAC), and advanced techniques used in SMAW. This one-Carnegie-unit course should only be taken after students successfully complete Shielded Metal Arc Welding (SMAW).

Course Description: Advanced Welding II – Course Code: 993306
This course will offer students the opportunity to examine Gas Metal Arc Welding (GMAW) and Flux-Cored Arc Welding (FCAW). Additionally, students will learn about Gas Tungsten Arc Welding (GTAW). Students will learn safety measures, setup procedures, and welding techniques for each type of welding. This one-Carnegie-unit course should only be taken after students successfully complete Advanced Welding I.

Orientation and Cutting – Course Code: 993302

Unit	Unit Name	Hours
1	Orientation	3
2	Fundamentals of Student Organizations	4.5
3	Employability Skills	7.5
4	Communication Skills	7.5
5	Basic Safety	15
6	Introduction to Construction Math	15

7	Hand and Power Tools	22.5
8	Introduction to Construction Drawing	15
9	Introduction to Materials Handling	7.5
10	Oxyfuel Cutting	22.5
Total		120

Shielded Metal Arc Welding [SMAW] – Course Code: 993303

Unit	Unit Name	Hours
11	SMAW Equipment and Set-Up	7.5
12	SMAW Electrodes	7.5
13	SMAW Beads and Fillet Welds	100
Total		115

Advanced Welding I – Course Code: 993304

Unit	Unit Name	Hours
14	Orientation and Welding Safety Review	15
15	Base Metal Preparation	15
16	Joint Fit-Up and Alignment	7.5
17	Weld Quality	15
18	Plasma Arc Cutting	7.5
19	Air Carbon Arc Cutting and Gouging	15
20	SMAW Groove Welds with Backing	60
Total		135

Advanced Welding II – Course Code: 993306

Unit	Unit Name	Hours
21	SMAW Open Root Groove Welds Plate	60
22	Gas Metal Arc Welding (GMAW) and Flux Core Arc Welding	30
23	Gas Tungsten Arc Welding (GTAW)	30
Total		120

Option 2 – Two-Two Carnegie Unit Courses

This curriculum consists of two two-credit courses, which should be completed in the following sequence:

1. **Introduction to Welding – Course Code: 993300**

2. **Advanced Welding – Course Code: 993301**

Course Description: Introduction to Welding – Course Code: 993300
This course focuses on the NCCER Learning Series Core and SMAW. 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 Oxyfuel Cutting fundamentals. Students will cover proper equipment setup, safety measures, and correct welding techniques.

Course Description: Advanced Welding – Course Code: 993301
This course focuses on specialized PAC, CAC, and advanced techniques used in SMAW. Additionally, this course will offer students the opportunity to examine GMAW and FCAW. Additionally, students will learn about GTAW. Students will learn safety measures, setup procedures, and welding techniques for each type of welding. This two-Carnegie-unit course should only be taken after students successfully complete Introduction to Welding.

Introduction to Welding – Course Code: 993300

Unit	Unit Name	Hours
1	Orientation	3
2	Fundamentals of Student Organizations	4.5
3	Employability Skills	7.5
4	Communication Skills	7.5
5	Basic Safety	15
6	Introduction to Construction Math	15
7	Hand and Power Tools	22.5
8	Introduction to Construction Drawing	15
9	Introduction to Materials Handling	7.5
10	Oxyfuel Cutting	22.5
11	SMAW Equipment and Set-Up	7.5
12	SMAW Electrodes	7.5
13	SMAW Beads and Fillet Welds	100
Total		235

Advanced Welding – Course Code: 993301

Unit	Unit Name	Hours
14	Orientation and Welding Safety Review	15
15	Base Metal Preparation	15
16	Joint Fit-Up and Alignment	7.5
17	Weld Quality	15
18	Plasma Arc Cutting	7.5
19	Air Carbon Arc Cutting and Gouging	15
20	SMAW Groove Welds with Backing	60
21	SMAW Open Root Groove Welds Plate	60
22	Gas Metal Arc Welding (GMAW) and Flux Core Arc Welding	30
23	Gas Tungsten Arc Welding (GTAW)	30
Total		255

Research Synopsis

Introduction

The Welding curriculum is designed to prepare the students for entry-level employment in the field of welding and fabrication. Students in Welding I complete study in occupational orientation and safety, basic math, introduction to blueprints (welding symbols), hand and power tools, Oxy/Fuel operations, and Shielded Metal Arc Welding (SMAW). Students in Welding II complete study in occupational orientation and safety, advanced Shielded Metal Arc Welding (SMAW), semi-automatic arc welding [Gas Metal Arc Welding and Flux Cored Arc Welding (GMAW/FCAW)], Gas Tungsten Arc Welding (GTAW), Carbon Arc Cutting Principles and Practices (CAC-A), Plasma Arc Cutting (PAC), and employability skills.

Needs of the Future Workforce

Data for this synopsis were compiled from the Mississippi Department of Employment Security (2018). Employment opportunities for each of the occupations listed below are:

Table 1.1: Current and Projected Occupation Report

	Employment		**Projected Growth 2014-2024**			**Average Wage 2017**	
Occupation	**Current (2014)**	**Projected (2024)**	**Number**	**Percent**	**Total Projected Avg. Annual Job Openings**	**Hourly**	**Annual**
Welders, Cutters, Solderers, and Brazers	6,640	7,160	520	7.8%	240	$20.96	$43,600
Structural Iron and Steel Workers	680	680	0	0.0%	10	$21.22	$44,140
Structural Metal Fabricators and Fitters	1,360	1,460	100	7.4%	30	$18.20	$37,850
Boilermakers	510	540	30	5.9%	15	$28.25	$58,760
Plumbers, Pipefitter, and Steamfitters	4,150	4,420	270	6.5%	80	$21.47	$44,650
Sheet Metal Workers	1,820	1910	90	4.9%	50	$18.03	$37,510

Source: Mississippi Department of Employment Security; www.mdes.ms.gov (accessed June, 2018).

Perkins IV Requirements

The Welding curriculum meets Perkins IV requirements of high-skill, high-wage, and/or high-demand occupations by introducing students to and preparing students for occupations. 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 Welding curriculum is integrated with academic Common Core Standards. Lastly, the Welding curriculum focuses on ongoing and meaningful professional development for teachers as well as relationships with industry.

Summary of Standards

The standards to be included in the Welding curriculum are the Mississippi College and Career Readiness Standards for Mathematics and Science, 21st Century Skills, and the National Educational Technology Standards (NETS) for students. Combining these standards to create this document will result in highly skilled, well-rounded students who are prepared to enter a secondary academic or career and technical program of study. They will also be prepared to academically compete nationally as the Common Core Standards are designed to prepare students for success in community colleges, Institutions of Higher Learning, and careers.

Transition to Postsecondary Education

The latest articulation information for Secondary to Postsecondary can be found at the Mississippi Community College Board (MCCB) website: mccb.edu

Best Practices

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 Welding teacher's goal should be to include teaching strategies that incorporate current technology. It is suggested that each classroom house a classroom set of desktop student computers 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, such as the Welding LMS Content Management System that introduces students to education in an online environment and places the responsibility of learning on the student.

Differentiated Instruction

Students learn in a variety of ways. Some are visual learners, needing only to read information and study it to succeed. Others are auditory learners, thriving best when information is read aloud to them. Still others are tactile learners, needing to participate actively in their learning experiences. Add the student's background, emotional health, and circumstances, and a very unique learner emerges. Many activities are graded by rubrics that allow students to choose the type of product they will produce. By providing various teaching and assessment strategies, students with various learning styles can succeed.

Career and Technical Education Student Organizations

Teachers should investigate opportunities to sponsor a student organization. There are several here in Mississippi that will foster the types of learning expected from the Welding curriculum. SkillsUSA is the student's organization for Welding. SkillsUSA provides students with growth

opportunities and competitive events. It also opens the doors to the world of manufacturing, welding and construction as well as offering scholarships opportunities.

Cooperative Learning

Cooperative learning can help students understand topics when independent learning cannot. Therefore, you will see several opportunities in the Welding 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 Welding curriculum provides opportunities for students to work together and help each other to complete complex tasks.

Conclusion

The Welding Curriculum is one of Mississippi's most comprehensive trade and industrial curriculums. Students that complete these programs are well equipped for a variety of endeavors. Instructors are urged to encourage Welding students to pursue educational opportunities at community colleges and universities in Mississippi.

Using This Document

Suggested Time on Task

This section indicates 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.

Unit 1: Orientation

Competencies and Suggested Objectives
1. Describe local program and center expectations, policies, and procedures. DOK 1, EMP a. Describe local program and career center policies and procedures, including dress code, attendance, academic requirements, discipline, shop/lab rules and regulations, and transportation regulations. b. Give a brief overview of the course. Explain to students what the Construction/Manufacturing Pathway is, why it is important, and how it will be delivered. c. Compare and contrast local program and school policies to expectations of employers. d. Preview course objectives, program policy, and the industry standards.
2. Work-based Learning opportunities related to program areas. DOK 1 a. Define Work-based Learning. b. Explore the opportunities available through the program areas, including: • CPE • Job Shadowing • Apprenticeship programs • On-the-Job Training

Unit 2: Fundamentals of Student Organizations

Competencies and Suggested Objectives
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.
1. Discuss the history, mission, and purpose of student organizations, including SkillsUSA. DOK 1 a. Trace the history of the program area student organization. b. Identify the mission, purpose, and/or goals of the program area student organization.
2. Explore the advantages of membership in a student organization. DOK 1 a. Discuss the membership process for the program area student organization. b. Explain the activities related to the local chapter and the state and national organization.
3. Discuss the organization's brand resources. DOK 1 a. Identify the motto, creed, and/or pledge and discuss their meanings. b. Recognize related brand resources such as: • Emblem • Colors • Official Attire • Logos • Graphic Standards
4. Describe the importance of effective communication skills. DOK 1 a. Demonstrate verbal and nonverbal communication skills. b. Apply appropriate speaking and listening skills to class and work related situations.
5. Apply leadership skills to class and work related situations and 21st Century Skills. DOK 1 a. Define leadership. b. Discuss the attributes of a leader. c. Identify the roles a leader can assume.
6. Utilize teambuilding skills in class and work related situations. DOK 1 a. Define teambuilding. b. Discuss the attributes of a team. c. Identify the roles included in a team.
7. Discuss the various competitions offered through the program area student organization. DOK 1 a. Describe each of the competitions and the skills needed to accomplish the tasks. b. Perform the tasks needed to complete an assigned requirement for a competition.

Unit 3: Employability Skills

Competencies and Suggested Objectives
1. Describe employment opportunities in the construction industry. DOK 1, EMP a. Describe employment opportunities, including potential earnings, employee benefits, job availability, working conditions, educational requirements, required technology skills, and continuing education/training. b. Discuss the guidelines for developing a proper résumé. c. Demonstrate completing job applications.
2. Examine the Mississippi Department of Employment Security (MDES) website and its applications relating to employment opportunities. DOK 1, EMP a. Perform various searches through the MDES website such as: • Number of jobs available for a specific area of expertise • Hourly wage • Percent of jobs in the county • Percent of jobs in the state
3. Demonstrate appropriate interview skills. DOK 1, EMP a. Identify interview skills such as speaking, dress, professionalism, punctuality. b. Simulate a job interview.
4. Describe basic employee responsibilities and appropriate work ethics. DOK 1, EMP a. Compare and contrast employment responsibilities and expectations to local school and program policies and expectations. b. Define effective relationship skills and workplace issues including, but not limited to, sexual harassment, stress, and substance abuse.

Unit 4: Communication Skills

Competencies and Suggested Objectives
1. Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations. DOK 2, COM a. Follow basic written and verbal instructions. b. Effectively communicate in on-the-job situations using verbal, written, or electronic communication.
2. Discuss the importance of good listening skills in on-the-job situations. DOK 2, COM a. Apply the tips for developing good listening skills.

Unit 5: Basic Safety

Competencies and Suggested Objectives
1. Describe, define, and illustrate general safety rules for working in a shop/lab and how they relate to the manufacturing industry. DOK 2, BSM a. Describe how to avoid on-site accidents. b. Explain the relationship between housekeeping and safety. c. Explain the importance of following all safety rules and company safety policies according to OSHA standards. d. Explain the importance of reporting all on-the-job injuries, accidents, and near misses. e. Explain the need for evacuation policies and the importance of following them. f. Explain causes of accidents and the impact of accident costs. g. Compare and contrast shop/lab safety rules to industry safety rules.
2. Identify and apply safety around welding operations. DOK 1, BSM a. Use proper safety practices when welding or working around welding operations. b. Use proper safety practices when welding in or near trenches and excavations. c. Explain the term "proximity work."
3. Display appropriate safety precautions to take around common jobsite hazards. DOK 1, BSM a. Explain the safety requirements for working in confined areas. b. Explain the different barriers and barricades and how they are used.
4. Demonstrate the appropriate use and care of personal protective equipment (PPE). DOK 1, BSM a. Identify commonly used PPE items. b. Understand proper use of PPE. c. Demonstrate appropriate care for PPE.
5. Explain fall protection, ladder, stair, and scaffold procedures and requirements. DOK 1, BSM a. Explain the use of proper fall protection. b. Inspect and safely work with various ladders, stairs, and scaffolds.
6. Explain the safety data sheet (SDS). DOK 1, BSM a. Explain the function of the SDS. b. Interpret the requirements of the SDS. c. Discuss hazardous material exposures.
7. Display appropriate safety procedures related to fires. DOK 1, BSM a. Explain the process by which fires start. b. Explain fire prevention of various flammable liquids. c. Explain the classes of fire and the types of extinguishers. d. Illustrate the proper steps to follow when using a fire extinguisher. e. Demonstrate the proper techniques for putting out a fire.
8. Explain safety in and around electrical situations. DOK 1, BSM a. Explain injuries that can result when electrical contact occurs. b. Explain safety around electrical hazards. c. Explain action to take when an electrical shock occurs.
Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a 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 6: Introduction to Construction Math

Competencies and Suggested Objectives
1. Apply the four basic math skills using whole numbers, fractions, decimals, and percentages, both with and without a calculator. DOK 2, ICM a. Define basic geometric shapes used in the manufacturing industry. b. Add, subtract, multiply, and divide whole numbers, decimals, and fractions with and without a calculator. c. Convert whole numbers to fractions, and convert fractions to whole numbers. d. Convert decimals to percentages, and convert percentages to decimals. e. Convert fractions to decimals. f. Convert fractions to percentages. g. Demonstrate reading a standard and metric ruler and tape measure. h. Recognize and use metric units of length, weight, volume, and temperature.

Unit 7: Hand and Power Tools

Competencies and Suggested Objectives
1. Demonstrate the use and maintenance of hand and power tools. DOK 2, IHT, IPT a. Identify, visually inspect, and discuss the safe use of common hand and power tools. b. Discuss rules of safety. c. Select and demonstrate the use of tools. d. Explain the procedures for maintenance.
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

Unit 8: Introduction to Construction Drawings

Competencies and Suggested Objectives
1. Read, analyze, and understand basic components of a blueprint. DOK 3, BLU a. Recognize and identify terms, components, and symbols commonly used on blueprints. b. Relate information on drawings to actual locations on the print. c. Recognize different types of drawing. d. Interpret and use drawing dimensions.
2. Interpret welding symbols from a blueprint. DOK3, WWS, WDD
3. Examine a welding detail drawing. DOK3, WWS, WDD
4. Interpret basic elements of a welding detail drawing. DOK3, WWS, WDD
5. Demonstrate how to sketch or draw basic welding drawings. DOK3, WWS, WDD

Unit 9: Introduction to Materials Handling

Competencies and Suggested Objectives
1. Safely handle and store materials. DOK 2, IMH a. Define a load. b. Establish a pre-task plan prior to moving a load. c. Use proper materials-handling techniques. d. Choose appropriate materials-handling equipment for the task. e. Recognize hazards and follow safety procedures required for materials handling.

Unit 10: Oxyfuel Cutting

Competencies and Suggested Objectives
1. Identify and describe the basic equipment, setup, and safety rules for proper use of equipment, and prepare base metal for oxyfuel cutting. DOK 2, WOC, WSS a. Identify and explain the use of oxyfuel cutting equipment. b. Demonstrate how to use an oxyfuel torch. c. Perform oxyfuel cutting • Straight line and square shapes • Piercing and slot cutting • Bevels • Washing • Gouging d. Set up and operate a motorized, portable oxyfuel gas cutting machine.
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

Unit 11: SMAW Equipment and Set-up

Competencies and Suggested Objectives
1. Demonstrate SMAW-related safety practices and recognize how electrical characteristics apply to SMAW. DOK 3, SWS
2. Identify and describe SMAW equipment to include welding cable, connectors, and common tools used to clean various welds. DOK 2, SWS
3. Explain and demonstrate how to set up and start SMAW equipment. DOK 2, SWS
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

Unit 12: SMAW Electrodes

Competencies and Suggested Objectives
1. Explain the SMAW electrode classification system and how to select the proper electrode for the task. DOK 2, SES a. Recognize the AWS filler metal specification system and various electrode characteristics. b. Describe the characteristics of the four main electrode groups.
2. Explain how to select electrodes and describe their proper care and handling. DOK 2, SES a. Select he proper electrodes for any given welding task. b. Demonstrate the proper handling and storage of electrodes.
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

Unit 13: SMAW Beads and Fillet Welds

Competencies and Suggested Objectives
1. Explain how to prepare for SMAW welding and how to strike an arc. DOK 3, SBF a. Identify safety practices related to SMAW. b. Prepare the area and equipment for welding. c. Demonstrate how to strike an arc and respond to arc blow.
2. Explain how to successfully complete various types of beads and welds. DOK 3, SBF a. Demonstrate how to properly restart and terminate a weld pass. b. Perform the proper technique required to produce stringer beads.
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

Unit 14: Orientation and Welding Safety Review

Competencies and Suggested Scenarios
1. Describe local program and vocational or career and technical center policies and procedures. DOK 1, COM, EMP a. Describe local program and vocational or career and technical center policies and procedures.
2. Describe employment opportunities and responsibilities of the welder. DOK 2, EMP a. Describe employer expectations in the workplace.
3. Explore leadership skills and personal development opportunities. DOK 2, COM, EMP a. Demonstrate team-building and leadership skills. b. Demonstrate appropriate work ethics through practice.
4. Describe general safety rules for working in a welding shop/lab and industry. DOK 1, BSM, WSS a. Discuss safety issues and prevention associated with the installation and welding shop or lab area. b. Demonstrate fire safety and prevention techniques in the workplace.
Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a 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 15: Base Metal Preparation

Competencies and Suggested Objectives
1. Identify safety practices related to preparing various types of base metals and demonstrate basic cleaning procedures. DOK 1, BMP
2. Identify and describe basic weld joint design and types of welds. DOK 2, BMP a. Identify and describe the loads that are routinely placed on weld joints. b. Describe a welding procedure specification (WPS) and the information it provides.
3. Prepare joints for welding. DOK 3, BMP a. Mechanically prepare joints for welding. b. Thermally prepare joints for welding.
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

Unit 16: Joint Fit-up and Alignment

Competencies and Suggested Objectives
1. Identify fit-up gauges and measuring devices to check joint fit-up. DOK 2, JFA a. Discuss the use of Straightedges. b. Discuss the use of Squares. c. Discuss the use of Levels. d. Discuss the use of Hi-Lo Gauges.
2. Demonstrate the use of fit-up gauges and measuring devices to check joint fit-up. DOK 2, JFA a. Demonstrate the proper use of Straightedges. b. Demonstrate the proper use of Squares. c. Demonstrate the proper use of Levels. d. Demonstrate the proper use of Hi-Lo Gauges.
3. Discuss the various fit-up tools. DOK 2, JFA a. Describe the use of Hydraulic Jacks in joint fit-up. b. Describe the use of Chain Hoists in joint fit-up. c. Describe the use of Come-Alongs in joint fit-up.
4. Demonstrate the proper way to fit-up joints using the various fit-up tools. DOK 2, JFA

Unit 17: Weld Quality

Competencies and Suggested Objectives
1. Explore regulations and job code specifications for welding, base metal cleaning, joint designs and their purpose. DOK 2, BMP, WQT, JFA, WSS a. Discuss codes governing welding, the causes of weld imperfections, welder qualification tests, and the importance of quality of skill. b. Select and use a nondestructive examination practice and a destructive test method to test a student-made weld. c. Explain joint fit-up.
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

Unit 18: Plasma Arc Cutting

Competencies and Suggested Objectives
1. Explain the Plasma Arc Cutting (PAC) process. DOK 2, WSS, PAC a. Discuss safety procedures and protective devices used in PAC. b. Discuss transferred and non-transferred arc processes.
2. Identify PAC equipment and accessories. DOK 2, WSS, PAC a. Identify the PAC equipment power source control unit. b. Identify the various PAC equipment torches and nozzles. c. Demonstrate proper setup of PAC equipment for safe operation.
3. Set up and perform various types of cuts using PAC equipment. DOK 2, PAC
4. Properly store equipment and clean the work area after use. DOK 1, PAC

Unit 19: Air Carbon Arc Cutting and Gouging

Competencies and Suggested Objectives
1. Explain the Air Carbon Arc Cutting (CAC-A) process. DOK 2, WSS, CAC a. Discuss safety procedures and protective devices used in CAC-A. b. Describe cutting, gouging, washing, and beveling.
2. Identify the various CAC-A electrodes. DOK 2, WSS, CAC a. Identify plain, copper-coated for direct current and copper-coated for alternating current. b. Identify various electrode styles such as round, round-jointed, and special shapes. c. Demonstrate proper setup of CAC-A equipment for safe operation.
3. Perform washing and gouging activities using CAC-A equipment. DOK 3, CAC
4. Properly store equipment and clean the work area after use. DOK 3, CAC

Unit 20: SMAW Groove Welds with Backing

Competencies and Suggested Objectives
1. Review safety hazards, protective devices used, and basic operation of SMAW equipment. DOK 1, WSS, SWS
2. Discuss the various groove welds with backing. DOK 3, GWB, OGW a. Discuss proper Square groove welds. b. Discuss proper Bevel groove welds. c. Discuss proper V-groove welds. d. Discuss proper U-groove welds. e. Discuss proper J-groove welds. f. Discuss proper Flare V-groove welds. g. Discuss proper Flare V-groove welds.
3. Discuss and demonstrate proper SMAW equipment setup for making V-groove welds with backing. DOK 3, SWS
4. Prepare materials to perform SMAW V-groove welds with backing. DOK 3, GWB, OGW
5. Setup and perform SMAW V-groove welds with backing in the 1G, 2G, 3G and 4G positions. DOK 3, GWB, OGW
6. Properly store equipment and clean the work area after use. DOK 3, SWS
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

Unit 21: SMAW Open Root Groove Welds Plate

Competencies and Suggested Objectives
1. Review safety hazards, protective devices used, and basic operation of SMAW equipment. DOK 1, WSS, SWS
2. Discuss the various open V-groove welds. DOK 3, GWB, OGW a. Discuss proper Square groove welds. b. Discuss proper Bevel groove welds. c. Discuss proper V-groove welds. d. Discuss proper U-groove welds. e. Discuss proper J-groove welds. f. Discuss proper Flare V-groove welds. g. Discuss proper Flare bevel groove welds.
3. Discuss and demonstrate proper SMAW equipment setup for making V-groove welds. DOK 3, SWS
4. Prepare materials to perform SMAW V-groove welds. DOK 3, GWB, OGW
5. Setup and perform SMAW V-groove welds in the 1G, 2G, 3G and 4G positions. DOK 3, GWB, OGW
6. Properly store equipment and clean the work area after use. DOK 3, SWS
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

Unit 22: Gas Metal Arc Welding (GMAW) and Flux Core Arc Welding (FCAW)

Competencies and Suggested Scenarios
1. Explain the GMAW and FCAW welding processes. DOK 3, CFE, CFP, WSS a. Explain the characteristics of welding current and power sources. b. Explain the use of GMAW and FCAW shielding gases and filler metals. c. Discuss the safety precautions to observe when operating GMAW and FCAW equipment.
2. Explain the use of GMAW and FCAW equipment parts and modes. DOK 3, CFE, CFP, WSS a. Discuss Spray Transfer mode. b. Discuss Globular mode. c. Discuss Short-circuiting mode. d. Discuss Pulse mode.
3. Demonstrate proper setup of GMAW and FCAW equipment. DOK 3, CFE, CFP, WSS
4. Set up and perform GMAW-S (short-circuit) multiple-pass fillet welds on carbon steel plate coupons in multiple positions, using solid or composite wire and shielding gas. DOK 3, CFE, CFP, WSS
5. Set up and perform GMAW-S (short-circuit) multiple-pass V-groove welds on carbon steel plate coupons in multiple positions (with or without backing), using solid or composite wire and shielding gas. DOK 3, CFE, CFP, WSS
6. Set up and perform FCAW multiple-pass fillet welds on carbon steel plate coupons in multiple positions, using flux-cored wire and, if required, shielding gas. DOK 3, CFE, CFP, WSS
7. Set up and perform FCAW multiple-pass V-groove welds on carbon steel plate coupons in multiple positions (with or without backing) using flux-cored wire and, if required, shielding gas. DOK 3, CFE, CFP, WSS
8. Properly store equipment and clean the work area after use. DOK 3, CFE, CFP, WSS

Unit 23: Gas Tungsten Arc Welding (GTAW)

Competencies and Suggested Scenarios
1. Explain the GTAW welding process including safety procedures. DOK 3, WSS, GTE, GTP
2. Identify the various parts and function of GTAW equipment. DOK 3, WSS, GTE, GTP a. Identify and describe the function of the various GTAW torches. b. Identify and describe the function of the gas nozzles used in GTAW. c. Identify and describe the function of tungsten electrodes used in GTAW. d. Identify and describe the function of the shielding gas used in GTAW.
3. Identify the various types and appropriate uses of GTAW filler metals. DOK 3, WSS, GTE, GTP a. Discuss Carbon Steel and Low-Alloy Steel. b. Discuss Stainless Steel, Aluminum and Aluminum alloy. c. Discuss Copper, Copper alloy, Nickel and Nickel alloy. d. Discuss Magnesium alloy, Titanium and Titanium alloy. e. Discuss Stainless Steel flux-cored electrodes and rods.
4. Demonstrate the proper setup of GTAW Equipment. DOK 3, WSS, GTE, GTP
5. Setup and perform multiple-pass GTAW fillet welds on carbon steel plate coupons in 1F, 2F, 3F and 4F positions using carbon steel filler metal. DOK 3, WSS, GTE, GTP
6. Properly store equipment and clean the work area after use. DOK 3, WSS, GTE, GTP

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: Orientation		
	1.	Describe local program and center expectations, policies, and procedures.
	2.	Work-based Learning opportunities related to program areas.
Unit 2: Fundamentals of Student Organizations		
	1.	Discuss the history, mission, and purpose of student organizations, including SkillsUSA.
	2.	Explore the advantages of membership in a student organization.
	3.	Discuss the organization's brand resources.
	4.	Describe the importance of effective communication skills.
	5.	Apply leadership skills to class and work related situations and 21st Century Skills.
	6.	Utilize teambuilding skills in class and work related situations.
	7.	Discuss the various competitions offered through the program area student organization.
Unit 3: Employability Skills		
	1.	Describe employment opportunities in the construction industry.
	2.	Examine the Mississippi Department of Employment Security (MDES) website and its applications relating to employment opportunities.
	3.	Demonstrate appropriate interview skills.
	4.	Describe basic employee responsibilities and appropriate work ethics.
Unit 4: Communication Skills		
	1.	Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations.
	2.	Discuss the importance of good listening skills in on-the-job situations.
Unit 5: Basic Safety		
	1.	Describe, define, and illustrate general safety rules for working in a shop/lab and how they relate to the manufacturing industry.
	2.	Identify and apply safety around welding operations.
	3.	Display appropriate safety precautions to take around common jobsite hazards.

	4.	Demonstrate the appropriate use and care of personal protective equipment (PPE).
	5.	Explain fall protection, ladder, stair, and scaffold procedures and requirements.
	6.	Explain the safety data sheet (SDS).
	7.	Display appropriate safety procedures related to fires.
	8.	Explain safety in and around electrical situations.
Unit 6: Introduction to Construction Math		
	1.	Apply the four basic math skills using whole numbers, fractions, decimals, and percentages, both with and without a calculator.
Unit 7: Hand and Power Tools		
	1.	Demonstrate the use and maintenance of hand and power tools.
Unit 8: Introduction to Construction Drawings		
	1.	Read, analyze, and understand basic components of a blueprint.
	2.	Interpret welding symbols from a blueprint.
	3.	Examine a welding detail drawing.
	4.	Interpret basic elements of a welding detail drawing.
	5.	Demonstrate how to sketch or draw basic welding drawings.
Unit 9: Introduction to Materials Handling		
	1.	Safely handle and store materials.
Unit 10: Oxyfuel Cutting		
	1.	Identify and describe the basic equipment, setup, and safety rules for proper use of equipment, and prepare base metal for oxyfuel cutting.
Unit 11: SMAW Equipment and Set-up		
	1.	Demonstrate SMAW-related safety practices and recognize how electrical characteristics apply to SMAW.
	2.	Identify and describe SMAW equipment to include welding cable, connectors, and common tools used to clean various welds.
	3.	Explain and demonstrate how to set up and start SMAW equipment.
Unit 12: SMAW Electrodes		
	1.	Explain the SMAW electrode classification system and how to select the proper electrode for the task.
	2.	Explain how to select electrodes and describe their proper care and handling.
Unit 13: SMAW Beads and Fillet Welds		
	1.	Explain how to prepare for SMAW welding and how to strike an arc.
	2.	Explain how to successfully complete various types of beads and welds.
Unit 14: Orientation and Welding Safety Review		
	1.	Describe local program and vocational or career and technical center policies and procedures.

	2.	~~Describe employment opportunities and responsibilities of the welder.~~
	3.	~~Explore leadership skills and personal development opportunities.~~
	4.	~~Describe general safety rules for working in a welding shop/lab and industry.~~
~~Unit 15: Base Metal Preparation~~		
	1.	~~Identify safety practices related to preparing various types of base metals and demonstrate basic cleaning procedures.~~
	2.	~~Identify and describe basic weld joint design and types of welds.~~
	3.	~~Prepare joints for welding.~~
~~Unit 16: Joint Fit-up and Alignment~~		
	1.	~~Identify fit-up gauges and measuring devices to check joint fit-up.~~
	2.	~~Demonstrate the use of fit-up gauges and measuring devices to check joint fit-up.~~
	3.	~~Discuss the various fit-up tools.~~
	4.	~~Demonstrate the proper way to fit-up joints using the various fit-up tools.~~
~~Unit 17: Weld Quality~~		
	1.	~~Explore regulations and job code specifications for welding, base metal cleaning, joint designs and their purpose.~~
~~Unit 18: Plasma Arc Cutting~~		
	1.	~~Explain the Plasma Arc Cutting (PAC) process.~~
	2.	~~Identify PAC equipment and accessories.~~
	3.	~~Set up and perform various types of cuts using PAC equipment.~~
	4.	~~Properly store equipment and clean the work area after use.~~
~~Unit 19: Air Carbon Arc Cutting and Gouging~~		
	1.	~~Explain the Air Carbon Arc Cutting (CAC-A) process.~~
	2.	~~Identify the various CAC-A electrodes.~~
	3.	~~Perform washing and gouging activities using CAC-A equipment.~~
	4.	~~Properly store equipment and clean the work area after use.~~
~~Unit 20~~: ~~SMAW Groove Welds with Backing~~		
	1.	~~Review safety hazards, protective devices used, and basic operation of SMAW equipment.~~
	2.	~~Discuss the various groove welds with backing.~~
	3.	~~Discuss and demonstrate proper SMAW equipment setup for making V-groove welds with backing.~~
	4.	~~Prepare materials to perform SMAW V-groove welds with backing.~~
	5.	~~Setup and perform SMAW V-groove welds with backing in the 1G, 2G, 3G and 4G positions.~~
	6.	~~Properly store equipment and clean the work area after use.~~
~~Unit 21: SMAW Open Root Groove Welds Plate~~		

	1.	~~Review safety hazards, protective devices used, and basic operation of SMAW equipment.~~
	2.	~~Discuss the various open V-groove welds.~~
	3.	~~Discuss and demonstrate proper SMAW equipment setup for making V-groove welds.~~
	4.	~~Prepare materials to perform SMAW V-groove welds.~~
	5.	~~Setup and perform SMAW V-groove welds in the 1G, 2G, 3G and 4G positions.~~
	6.	~~Properly store equipment and clean the work area after use.~~
~~Unit 22: Gas Metal Arc Welding (GMAW) and Flux Core Arc Welding (FCAW)~~		
	1.	~~Explain the GMAW and FCAW welding processes.~~
	2.	~~Explain the use of GMAW and FCAW equipment parts and modes.~~
	3.	~~Demonstrate proper setup of GMAW and FCAW equipment.~~
	4.	~~Set up and perform GMAW-S (short-circuit) multiple-pass fillet welds on carbon steel plate coupons in multiple positions, using solid or composite wire and shielding gas.~~
	5.	~~Set up and perform GMAW-S (short-circuit) multiple-pass V-groove welds on carbon steel plate coupons in multiple positions (with or without backing), using solid or composite wire and shielding gas.~~
	6.	~~Set up and perform FCAW multiple-pass fillet welds on carbon steel plate coupons in multiple positions, using flux-cored wire and, if required, shielding gas.~~
	7.	~~Set up and perform FCAW multiple-pass V-groove welds on carbon steel plate coupons in multiple positions (with or without backing) using flux-cored wire and, if required, shielding gas.~~
	8.	~~Properly store equipment and clean the work area after use.~~
~~Unit 23: Gas Tungsten Arc Welding (GTAW)~~		
	1.	~~Explain the GTAW welding process including safety procedures.~~
	2.	~~Identify the various parts and function of GTAW equipment.~~
	3.	~~Identify the various types and appropriate uses of GTAW filler metals.~~
	4.	~~Demonstrate the proper setup of GTAW Equipment.~~
	5.	~~Setup and perform multiple-pass GTAW fillet welds on carbon steel plate coupons in 1F, 2F, 3F and 4F positions using carbon steel filler metal.~~
	6.	~~Properly store equipment and clean the work area after use.~~

Appendix A: Industry Standards

NCCER Learning Series Standards for the Construction Core Technology Program[1] (taken from the National Center for Construction Education and Research)

Crosswalk for Welding												
	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10	Unit 11	Unit 12
Core												
BSM					X							
ICM						X						
IHT							X					
IPT							X					
BLU								X				
COM				X								
EMP			X									
IMH									X			
Welding												
WSS												
WOC										X		
PAC												
CAC												
BMP												
WQT												
SWS											X	
SES												X
SBF												
JFA												
GWB												
OGW												
WWS								X				
WDD								X				
PPM												
HTM												
CFE												
CFP												
CTE												
CTP												

[1] *NCCER learning series.* Retrieved October 12, 2011, from http://www.nccer.org/

Crosswalk for Welding											
	Units 13	Unit 14	Unit 15	Unit 16	Unit 17	Unit 18	Unit 19	Unit 20	Unit 21	Unit 22	Unit 23
Core											
BSM											
ICM											
IHT											
IPT											
BLU											
COM											
EMP											
IMH											
Welding											
WSS		X									
WOC											
PAC						X					
CAC							X				
BMP			X								
WQT					X						
SWS											
SES											
SBF	X										
JFA				X							
GWB								X			
OGW									X		
WWS											
WDD											
PPM											
HTM											
GFE										X	
GFP										X	
GTE											X
GTP											X

NCCER Core

BSM – BASIC SAFETY (00101-15)
ICM – INTRODUCTION TO CONSTRUCTION MATH (00102-15)
IHT – INTRODUCTION TO HAND TOOLS (00103-15)
IPT – INTRODUCTION TO POWER TOOLS (00104-15)
BLU – INTRODUCTION TO CONSTRUCTION DRAWINGS (00105-15)
COM – BASIC COMMUNICATION SKILLS (00107-15)
EMP – BASIC EMPLOYABILITY SKILLS (00108-15)
IMH – INTRODUCTION TO MATERIALS HANDLING (00109-15)

NCCER WELDING (CWD)

LEVEL ONE

WSS – Welding Safety
WOC – Oxy-Fuel Cutting
PAC – Plasma Arc Cutting
CAC – Air Carbon Arc Cutting and Gouging

BMP – Base Metal Prep
WQT – Weld Quality
SWS – SMAW – Equipment and Setup
SES – Shielded Metal Arc Electrodes
SBF – SMAW – Beads and Fillet Welds
JFA – Joint Fit-up and Alignment
GWB – SMAW – Groove Welds with Backing
OGW – SMAW – Open V-Groove Welds

LEVEL TWO

WWS – Welding Symbols
WDD – Reading Welding Detail Drawings
PPM – Physical Characteristics and Mechanical Properties of Metals
HTM – Preheating and Post-weld Heat Treatment of Metal
GFE – GMAW AND FCAW: Equipment and Filler Metals
GFP – GMAW AND FCAW: Plate
GTE – GTAW: Equipment and Filler Metals
GTP – GTAW – Plate

Appendix B: 21st Century Skills[2]

21st Century Crosswalk for Welding											
	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
21st Century Standards											
CS1		X	X	X	X		X	X	X	X	
CS2		X	X	X	X		X	X	X	X	X
CS3		X	X		X		X	X	X	X	X
CS4		X	X	X	X		X	X	X	X	X
CS5											X
CS6		X	X	X	X		X	X	X	X	
CS7		X	X	X	X		X	X	X	X	X
CS8		X	X	X	X		X	X	X	X	X
CS9		X	X	X	X		X	X	X	X	X
CS10		X									X
CS11		X									
CS12		X	X	X	X	X	X	X	X	X	
CS13		X	X	X	X	X	X	X	X	X	X
CS14		X	X	X	X	X	X	X	X	X	X
CS15		X	X	X	X	X	X	X	X	X	X
CS16		X	X	X	X	X	X	X	X	X	X
		Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17	Unit 18	Unit 19	Unit 20
CS1		X	X	X	X		X	X	X	X	
CS2		X	X	X	X		X	X	X	X	X
CS3		X	X		X		X	X	X	X	X
CS4		X	X	X	X		X	X	X	X	X
CS5											X
CS6		X	X	X	X		X	X	X	X	
CS7		X	X	X	X		X	X	X	X	X
CS8		X	X	X	X		X	X	X	X	X
CS9		X	X	X	X		X	X	X	X	X
CS10		X									X
CS11		X									
CS12		X	X	X	X	X	X	X	X	X	
CS13		X	X	X	X	X	X	X	X	X	X
CS14		X	X	X	X	X	X	X	X	X	X
CS15		X	X	X	X	X	X	X	X	X	X
CS16		X	X	X	X	X	X	X	X	X	X
		Unit 21	Unit 22	Unit 23							
CS1		X	X								
CS2		X	X	X							
CS3		X	X	X							
CS4		X	X	X							
CS5				X							
CS6		X	X								
CS7		X	X	X							
CS8		X	X	X							
CS9		X	X	X							
CS10				X							
CS11											
CS12		X	X								
CS13		X	X	X							
CS14		X	X	X							
CS15		X	X	X							
CS16		X	X	X							

[2] *21st century skills.* (n.d.). Washington, DC: Partnership for 21st Century Skills.

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
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: College and Career Ready Standards

English Standards											
	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
RL.9.1		X	X	X	X	X	X	X	X	X	X
RL.9.2											
RL.9.3											
RL.9.4		X	X	X	X	X	X	X	X	X	X
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		X	X	X	X	X	X	X	X	X	X
RI.9.6											
RI.9.7											
RI.9.8											
RI.9.9											
W.9.1											
W.9.2											
W.9.3											
W.9.4		X	X	X	X	X	X	X	X	X	X
W.9.5		X	X	X	X	X	X	X	X	X	X
W.9.6		X	X	X	X	X	X	X	X	X	X
W.9.7											
W.9.8		X	X	X	X	X	X	X	X	X	X
W.9.9											
W.9.10											
SL.9.1											
SL.9.2											
SL.9.3											
SL.9.4		X	X	X	X	X	X	X	X	X	X
SL.9.5		X	X	X	X	X	X	X	X	X	X
SL.9.6		X	X	X	X	X	X	X	X	X	X
L.9.1		X	X	X	X	X	X	X	X	X	X
L.9.2		X	X	X	X	X	X	X	X	X	X
L.9.3		X	X	X	X	X	X	X	X	X	X
L.9.4		X	X	X	X	X	X	X	X	X	X
L.9.5											
L.9.6		X	X	X	X	X	X	X	X	X	X
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		X	X	X	X	X	X	X	X	X	X
RH.9-10.8											
RH.9-10.9											
RH.9-10.10		X	X	X	X	X	X	X	X	X	X
RST.9-10.1		X	X	X	X	X	X	X	X	X	X
RST.9-10.2		X	X	X	X	X	X	X	X	X	X
RST.9-10.3		X	X	X	X	X	X	X	X	X	X
RST.9-10.4		X	X	X	X	X	X	X	X	X	X

RST.9-10.5		X	X	X	X	X	X	X	X	X	X
RST.9-10.6		X	X	X	X	X	X	X	X	X	X
RST.9-10.7		X	X	X	X	X	X	X	X	X	X
RST.9-10.8		X	X	X	X	X	X	X	X	X	X
RST.9-10.9		X	X	X	X	X	X	X	X	X	X
RST.9-10.10											
WHST.9-10.1											
WHST.9-10.2		X	X	X	X	X	X	X	X	X	X
WHST.9-10.3											
WHST.9-10.4											
WHST.9-10.5		X	X	X	X	X	X	X	X	X	X
WHST.9-10.6		X	X	X	X	X	X	X	X	X	X
WHST.9-10.7		X	X	X	X	X	X	X	X	X	X
WHST.9-10.8		X	X	X	X	X	X	X	X	X	X
WHST.9-10.9											
WHST.9-10.10		X	X	X	X	X	X	X	X	X	X
RL.11.1											
RL.11.2											
RL.11.3											
RL.11.4											
RL.11.5											
RL.11.6											
RL.11.7											
RL.11.8											
RL.11.9											
RL.11.10											
RI.11.3											
RI.11.4											
RI.11.5											
RI.11.6											
RI.11.7											
RI.11.8											
RI.11.9											
RI.11.10											
W.11.1											
W.11.2											
W.11.3											
W.11.4											
W.11.5											
W.11.6											
W.11.7											
W.11.8											
W.11.9											
W.11.10											
SL.11.1		X	X	X	X	X	X	X	X	X	X
SL.11.2											
SL.11.3											
SL.11.4		X	X	X	X	X	X	X	X	X	X
SL.11.5											
SL.11.6											
L.11.1											
L.11.2											
L.11.3											
L.11.4											
RL.12.10											
RH.11-12.1											
RH.11-12.2											
RH.11-12.3											
RH.11-12.4											
RH.11-12.5		X	X	X	X	X	X	X	X	X	X
RH.11-12.6											
RH.11-12.7		X	X	X	X	X	X	X	X	X	X
RH.11-12.8											
RH.11-12.9		X	X	X	X	X	X	X	X	X	X
RH.11-12.10											

RST.11-12.1		X	X	X	X	X	X	X	X	X	X
RST.11-12.2		X	X	X	X	X	X	X	X	X	X
RST.11-12.3		X	X	X	X	X	X	X	X	X	X
RST.11-12.4		X	X	X	X	X	X	X	X	X	X
RST.11-12.5		X	X	X	X	X	X	X	X	X	X
RST.11-12.6		X	X	X	X	X	X	X	X	X	X
RST.11-12.7		X	X	X	X	X	X	X	X	X	X
RST.11-12.8		X	X	X	X	X	X	X	X	X	X
RST.11-12.9		X	X	X	X	X	X	X	X	X	X
RST.11-12.10		X	X	X	X	X	X	X	X	X	X
WHST.11-12.1		X	X	X	X	X	X	X	X	X	X
WHST.11-12.2		X	X	X	X	X	X	X	X	X	X
WHST.11-12.6		X	X	X	X	X	X	X	X	X	X
WHST.11-12.8		X	X	X	X	X	X	X	X	X	X

English Standards

	Units	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17	Unit 18	Unit 19	Unit 20
RL.9.1		X	X	X	X	X	X	X	X	X	X
RL.9.2											
RL.9.3											
RL.9.4		X	X	X	X	X	X	X	X	X	X
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		X	X	X	X	X	X	X	X	X	X
RI.9.6											
RI.9.7											
RI.9.8											
RI.9.9											
W.9.1											
W.9.2											
W.9.3											
W.9.4		X	X	X	X	X	X	X	X	X	X
W.9.5		X	X	X	X	X	X	X	X	X	X
W.9.6		X	X	X	X	X	X	X	X	X	X
W.9.7											
W.9.8		X	X	X	X	X	X	X	X	X	X
W.9.9											
W.9.10											
SL.9.1											
SL.9.2											
SL.9.3											
SL.9.4		X	X	X	X	X	X	X	X	X	X
SL.9.5		X	X	X	X	X	X	X	X	X	X
SL.9.6		X	X	X	X	X	X	X	X	X	X
L.9.1		X	X	X	X	X	X	X	X	X	X
L.9.2		X	X	X	X	X	X	X	X	X	X
L.9.3		X	X	X	X	X	X	X	X	X	X
L.9.4		X	X	X	X	X	X	X	X	X	X
L.9.5											
L.9.6		X	X	X	X	X	X	X	X	X	X
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		X	X	X	X	X	X	X	X	X	X
RH.9-10.8											
RH.9-10.9											
RH.9-10.10		X	X	X	X	X	X	X	X	X	X
RST.9-10.1		X	X	X	X	X	X	X	X	X	X
RST.9-10.2		X	X	X	X	X	X	X	X	X	X

RST.9-10.3		X	X	X	X	X	X	X	X	X	X
RST.9-10.4		X	X	X	X	X	X	X	X	X	X
RST.9-10.5		X	X	X	X	X	X	X	X	X	X
RST.9-10.6		X	X	X	X	X	X	X	X	X	X
RST.9-10.7		X	X	X	X	X	X	X	X	X	X
RST.9-10.8		X	X	X	X	X	X	X	X	X	X
RST.9-10.9		X	X	X	X	X	X	X	X	X	X
RST.9-10.10											
WHST.9-10.1											
WHST.9-10.2		X	X	X	X	X	X	X	X	X	X
WHST.9-10.3											
WHST.9-10.4											
WHST.9-10.5		X	X	X	X	X	X	X	X	X	X
WHST.9-10.6		X	X	X	X	X	X	X	X	X	X
WHST.9-10.7		X	X	X	X	X	X	X	X	X	X
WHST.9-10.8		X	X	X	X	X	X	X	X	X	X
WHST.9-10.9											
WHST.9-10.10		X	X	X	X	X	X	X	X	X	X
RL.11.1											
RL.11.2											
RL.11.3											
RL.11.4											
RL.11.5											
RL.11.6											
RL.11.7											
RL.11.8											
RL.11.9											
RL.11.10											
RI.11.3											
RI.11.4											
RI.11.5											
RI.11.6											
RI.11.7											
RI.11.8											
RI.11.9											
RI.11.10											
W.11.1											
W.11.2											
W.11.3											
W.11.4											
W.11.5											
W.11.6											
W.11.7											
W.11.8											
W.11.9											
W.11.10											
SL.11.1		X	X	X	X	X	X	X	X	X	X
SL.11.2											
SL.11.3											
SL.11.4		X	X	X	X	X	X	X	X	X	X
SL.11.5											
SL.11.6											
L.11.1											
L.11.2											
L.11.3											
L.11.4											
RL.12.10											
RH.11-12.1											
RH.11-12.2											
RH.11-12.3											
RH.11-12.4											
RH.11-12.5		X	X	X	X	X	X	X	X	X	X
RH.11-12.6											

RH.11-12.7		X	X	X	X	X	X	X	X	X	X
RH.11-12.8											
RH.11-12.9		X	X	X	X	X	X	X	X	X	X
RH.11-12.10											
RST.11-12.1		X	X	X	X	X	X	X	X	X	X
RST.11-12.2		X	X	X	X	X	X	X	X	X	X
RST.11-12.3		X	X	X	X	X	X	X	X	X	X
RST.11-12.4		X	X	X	X	X	X	X	X	X	X
RST.11-12.5		X	X	X	X	X	X	X	X	X	X
RST.11-12.6		X	X	X	X	X	X	X	X	X	X
RST.11-12.7		X	X	X	X	X	X	X	X	X	X
RST.11-12.8		X	X	X	X	X	X	X	X	X	X
RST.11-12.9		X	X	X	X	X	X	X	X	X	X
RST.11-12.10		X	X	X	X	X	X	X	X	X	X
WHST.11-12.1		X	X	X	X	X	X	X	X	X	X
WHST.11-12.2		X	X	X	X	X	X	X	X	X	X
WHST.11-12.6		X	X	X	X	X	X	X	X	X	X
WHST.11-12.8		X	X	X	X	X	X	X	X	X	X

~~English Standards~~

	~~Units~~	~~Unit 21~~	~~Unit 22~~	~~Unit 23~~							
~~RL.9.1~~		~~X~~	~~X~~	~~X~~							
~~RL.9.2~~											
~~RL.9.3~~											
~~RL.9.4~~		~~X~~	~~X~~	~~X~~							
~~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~~		~~X~~	~~X~~	~~X~~							
~~RI.9.6~~											
~~RI.9.7~~											
~~RI.9.8~~											
~~RI.9.9~~											
~~W.9.1~~											
~~W.9.2~~											
~~W.9.3~~											
~~W.9.4~~		~~X~~	~~X~~	~~X~~							
~~W.9.5~~		~~X~~	~~X~~	~~X~~							
~~W.9.6~~		~~X~~	~~X~~	~~X~~							
~~W.9.7~~											
~~W.9.8~~		~~X~~	~~X~~	~~X~~							
~~W.9.9~~											
~~W.9.10~~											
~~SL.9.1~~											
~~SL.9.2~~											
~~SL.9.3~~											
~~SL.9.4~~		~~X~~	~~X~~	~~X~~							
~~SL.9.5~~		~~X~~	~~X~~	~~X~~							
~~SL.9.6~~		~~X~~	~~X~~	~~X~~							
~~L.9.1~~		~~X~~	~~X~~	~~X~~							
~~L.9.2~~		~~X~~	~~X~~	~~X~~							
~~L.9.3~~		~~X~~	~~X~~	~~X~~							
~~L.9.4~~		~~X~~	~~X~~	~~X~~							
~~L.9.5~~											
~~L.9.6~~		~~X~~	~~X~~	~~X~~							
~~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~~		~~X~~	~~X~~	~~X~~							
~~RH.9-10.8~~											
~~RH.9-10.9~~											
~~RH.9-10.10~~		~~X~~	~~X~~	~~X~~							
~~RST.9-10.1~~		~~X~~	~~X~~	~~X~~							
~~RST.9-10.2~~		~~X~~	~~X~~	~~X~~							
~~RST.9-10.3~~		~~X~~	~~X~~	~~X~~							
~~RST.9-10.4~~		~~X~~	~~X~~	~~X~~							

RST.9-10.5		X	X	X							
RST.9-10.6		X	X	X							
RST.9-10.7		X	X	X							
RST.9-10.8		X	X	X							
RST.9-10.9		X	X	X							
RST.9-10.10											
WHST.9-10.1											
WHST.9-10.2		X	X	X							
WHST.9-10.3											
WHST.9-10.4											
WHST.9-10.5		X	X	X							
WHST.9-10.6		X	X	X							
WHST.9-10.7		X	X	X							
WHST.9-10.8		X	X	X							
WHST.9-10.9											
WHST.9-10.10		X	X	X							
RL.11.1											
RL.11.2											
RL.11.3											
RL.11.4											
RL.11.5											
RL.11.6											
RL.11.7											
RL.11.8											
RL.11.9											
RL.11.10											
RI.11.3											
RI.11.4											
RI.11.5											
RI.11.6											
RI.11.7											
RI.11.8											
RI.11.9											
RI.11.10											
W.11.1											
W.11.2											
W.11.3											
W.11.4											
W.11.5											
W.11.6											
W.11.7											
W.11.8											
W.11.9											
W.11.10											
SL.11.1		X	X	X							
SL.11.2											
SL.11.3											
SL.11.4		X	X	X							
SL.11.5											
SL.11.6											
L.11.1											
L.11.2											
L.11.3											
L.11.4											
RL.12.10											
RH.11-12.1											
RH.11-12.2											
RH.11-12.3											
RH.11-12.4											
RH.11-12.5		X	X	X							
RH.11-12.6											
RH.11-12.7		X	X	X							
RH.11-12.8											
RH.11-12.9		X	X	X							
RH.11-12.10											

RST.11-12.1		X	X	X							
RST.11-12.2		X	X	X							
RST.11-12.3		X	X	X							
RST.11-12.4		X	X	X							
RST.11-12.5		X	X	X							
RST.11-12.6		X	X	X							
RST.11-12.7		X	X	X							
RST.11-12.8		X	X	X							
RST.11-12.9		X	X	X							
RST.11-12.10		X	X	X							
WHST.11-12.1		X	X	X							
WHST.11-12.2		X	X	X							
WHST.11-12.6		X	X	X							
WHST.11-12.8		X	X	X							

Common Core 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.

Common Core English I

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.

Common Core 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.

Common Core English I

Writing Text Types and Purposes

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.

Common Core English I

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.

Production and Distribution of Writing

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.

Common Core 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.

Common Core 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.

Common Core English I

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.)

Common Core 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).

Common Core 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.

Common Core 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

Writing in History/SS, Science, and Technical Subjects

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

Production and Distribution of Writing

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.

Research to Build and Present Knowledge

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.

Integration of Knowledge and Ideas

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.

Range of Reading and Level of Text Complexity

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

Writing

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 D: College and Career Ready Standards

Mathematics Standards											
	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
N-Q.1											
N-Q.2											
N-Q.3		X	X	X	X	X	X	X	X	X	X
8.EE.8		X	X	X	X	X	X	X	X	X	X
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		X	X	X	X	X	X	X	X	X	X
A-REI.4		X	X	X	X	X	X	X	X	X	X
A-REI.5											
A-REI.6		X	X	X	X	X	X	X	X	X	X
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		X	X	X	X	X	X	X	X	X	X
F-BF.2		X	X	X	X	X	X	X	X	X	X
F-BF.3											
F-BF.4		X	X	X	X	X	X	X	X	X	X
F-BF.5											
F-LE.1		X	X	X	X	X	X	X	X	X	X
F-LE.2		X	X	X	X	X	X	X	X	X	X
F-LE.3											
F-LE.4											
F-LE.5											
8.G.6											
8.G.7											
8.G.8											
G-CO.1		X	X	X	X	X	X	X	X	X	X
G-CO.2		X	X	X	X	X	X	X	X	X	X

~~G-CO.3~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~G-CO.4~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~G-CO.5~~											
~~G-CO.6~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~G-CO.7~~											
~~G-CO.8~~											
~~G-CO.9~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~G-CO.10~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~G-CO.11~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~G-CO.12~~											
~~G-CO.13~~											
~~8.SP.1~~											
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~~S-ID.1~~											
~~S-ID.2~~											
~~S-ID.3~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~S-ID.4~~											
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~~G-SRT.9~~											
~~G-SRT.10~~											
~~G-SRT.11~~											
~~G-C.1~~											
~~G-C.2~~											
~~G-C.3~~											
~~G-C.4~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~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~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~G-GMD.4~~											
~~G-MG.1~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~

~~G-MG.2~~											
~~G-MG.3~~											
~~N-CN.1~~											
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~~N-CN.8~~											
~~N-CN.9~~											
~~F-TF.1~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~F-TF.2~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~F-TF.3~~											
~~F-TF.4~~											
~~F-TF.5~~											
~~F-TF.6~~											
~~F-TF.7~~											
~~F-TF.8~~											
~~F-TF.9~~											
~~S-IC.1~~											
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~~S-IC.6~~											
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~~N-VM.11~~											
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~~S-MD.1~~											
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~~S-MD.7~~											

Mathematics Standards

	Units	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17	Unit 18	Unit 19	Unit 20
N-Q.1											
N-Q.2											
N-Q.3		X	X	X	X	X	X	X	X	X	X
8.EE.8		X	X	X	X	X	X	X	X	X	X
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		X	X	X	X	X	X	X	X	X	X
A-REI.4		X	X	X	X	X	X	X	X	X	X
A-REI.5											
A-REI.6		X	X	X	X	X	X	X	X	X	X
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											
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F-IF.4											
F-IF.5											
F-IF.6											
F-IF.7											
F-IF.8											
F-IF.9											
F-BF.1		X	X	X	X	X	X	X	X	X	X
F-BF.2		X	X	X	X	X	X	X	X	X	X
F-BF.3											
F-BF.4		X	X	X	X	X	X	X	X	X	X
F-BF.5											
F-LE.1		X	X	X	X	X	X	X	X	X	X
F-LE.2		X	X	X	X	X	X	X	X	X	X
F-LE.3											
F-LE.4											
F-LE.5											
8.G.6											
8.G.7											
8.G.8											
G-CO.1		X	X	X	X	X	X	X	X	X	X
G-CO.2		X	X	X	X	X	X	X	X	X	X

~~G-CO.3~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~G-CO.4~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~G-CO.5~~											
~~G-CO.6~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~G-CO.7~~											
~~G-CO.8~~											
~~G-CO.9~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~G-CO.10~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~G-CO.11~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~G-CO.12~~											
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~~8.SP.1~~											
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~~S-ID.3~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
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~~G-C.4~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~G-C.5~~											
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~~G-GMD.1~~											
~~G-GMD.2~~											
~~G-GMD.3~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~G-GMD.4~~											
~~G-MG.1~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~

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~~F-TF.1~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~F-TF.2~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~F-TF.3~~											
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~~S-MD.7~~											

~~Mathematics Standards~~

	~~Units~~	~~Unit21~~	~~Unit 22~~	~~Unit 23~~						
~~N-Q.1~~										
~~N-Q.2~~										

~~N-Q.3~~		~~X~~	~~X~~	~~X~~							
~~8.EE.8~~		~~X~~	~~X~~	~~X~~							
~~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~~		~~X~~	~~X~~	~~X~~							
~~A-REI.4~~		~~X~~	~~X~~	~~X~~							
~~A-REI.5~~											
~~A-REI.6~~		~~X~~	~~X~~	~~X~~							
~~A-REI.7~~											
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~~F-IF.9~~											
~~F-BF.1~~		~~X~~	~~X~~	~~X~~							
~~F-BF.2~~		~~X~~	~~X~~	~~X~~							
~~F-BF.3~~											
~~F-BF.4~~		~~X~~	~~X~~	~~X~~							
~~F-BF.5~~											
~~F-LE.1~~		~~X~~	~~X~~	~~X~~							
~~F-LE.2~~		~~X~~	~~X~~	~~X~~							
~~F-LE.3~~											
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~~F-LE.5~~											
~~8.G.6~~											
~~8.G.7~~											
~~8.G.8~~											
~~G-CO.1~~		~~X~~	~~X~~	~~X~~							
~~G-CO.2~~		~~X~~	~~X~~	~~X~~							
~~G-CO.3~~		~~X~~	~~X~~	~~X~~							
~~G-CO.4~~		~~X~~	~~X~~	~~X~~							
~~G-CO.5~~											
~~G-CO.6~~		~~X~~	~~X~~	~~X~~							
~~G-CO.7~~											
~~G-CO.8~~											
~~G-CO.9~~		~~X~~	~~X~~	~~X~~							
~~G-CO.10~~		~~X~~	~~X~~	~~X~~							
~~G-CO.11~~		~~X~~	~~X~~	~~X~~							
~~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~~		~~X~~	~~X~~	~~X~~							
~~S-ID.4~~											
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~~A-APR.7~~											
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~~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~~		~~X~~	~~X~~	~~X~~							
~~G-C.5~~											
~~G-GPE.1~~											
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~~G-GPE.4~~											
~~G-GPE.5~~											
~~G-GPE.6~~											
~~G-GPE.7~~											
~~G-GMD.1~~											
~~G-GMD.2~~											
~~G-GMD.3~~		~~X~~	~~X~~	~~X~~							
~~G-GMD.4~~											
~~G-MG.1~~		~~X~~	~~X~~	~~X~~							
~~G-MG.2~~											
~~G-MG.3~~											
~~N-CN.1~~											
~~N-CN.2~~											
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~~N-CN.7~~											
~~N-CN.8~~											
~~N-CN.9~~											
~~F-TF.1~~		~~X~~	~~X~~	~~X~~							

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

~~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 ± 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 x2 + y2 = 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 ≥ 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 (Θ)2 + cos (Θ)2 = 1 and use it to find sin (Θ), cos (Θ), or tan (Θ), given sin (Θ), cos (Θ), or tan (Θ) 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 ≈ 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 ± 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, $f(x) = 2x^3$ 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 $ab^{ct} = d$ 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.

Advanced Mathematics Plus

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 $A = \frac{1}{2} ab \sin(C)$ 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 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).*

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

	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
ISTE Standards										
T1	X	X	X	X	X	X	X	X	X	X
T2	X	X	X	X	X	X	X	X	X	X
T3		X	X	X	X					
T4		X	X	X	X	X	X	X	X	X
T5			X							
T6		X	X	X			X	X	X	X
	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17	Unit 18	Unit 19	Unit 20
T1	X	X	X	X	X	X	X	X	X	X
T2	X	X	X	X	X	X	X	X	X	X
T3	X	X		X	X					
T4	X		X	X	X	X	X	X	X	X
T5										
T6	X	X		X			X	X	X	X
	Unit 21	Unit 22	Unit 23							
ISTE Standards										
T1	X	X	X							
T2	X	X	X							
T3		X	X							
T4		X	X							
T5			X							
T6		X	X							

T1 Creativity and Innovation
T2 Communication and Collaboration
T3 Research and Information Fluency
T4 Critical Thinking, Problem Solving, and Decision Making
T5 Digital Citizenship
T6 Technology Operations and Concepts

T1 Creativity and Innovation

Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students do the following:

a. Apply existing knowledge to generate new ideas, products, or processes.
b. Create original works as a means of personal or group expression.
c. Use models and simulations to explore complex systems and issues.
d. Identify trends and forecast possibilities.

T2 Communication and Collaboration

Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Students do the following:

a. Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.
b. Communicate information and ideas effectively to multiple audiences using a variety of media and formats.
c. Develop cultural understanding and global awareness by engaging with learners of other cultures.
d. Contribute to project teams to produce original works or solve problems.

T3 Research and Information Fluency

Students apply digital tools to gather, evaluate, and use information. Students do the following:

a. Plan strategies to guide inquiry.
b. Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.
c. Evaluate and select information sources and digital tools based on the appropriateness to specific tasks.
d. Process data and report results.

T4 Critical Thinking, Problem Solving, and Decision Making

Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources. Students do the following:

a. Identify and define authentic problems and significant questions for investigation.
b. Plan and manage activities to develop a solution or complete a project.
c. Collect and analyze data to identify solutions and/or make informed decisions.
d. Use multiple processes and diverse perspectives to explore alternative solutions.

T5 Digital Citizenship

Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior. Students do the following:

a. Advocate and practice safe, legal, and responsible use of information and technology.
b. Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity.
c. Demonstrate personal responsibility for lifelong learning.
d. Exhibit leadership for digital citizenship.

T6 Technology Operations and Concepts

Students demonstrate a sound understanding of technology concepts, systems, and operations. Students do the following:

a. Understand and use technology systems.
b. Select and use applications effectively and productively.
c. Troubleshoot systems and applications.
d. Transfer current knowledge to learning of new technologies.

2025 Welding

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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.

Table of Contents

Acknowledgments....4
Standards....6
Preface....7
Mississippi Teacher Professional Resources....8
Executive Summary....9
Course Outlines....11
Career Pathway Outlook....15
Professional Organizations....20
Using This Document....21
Unit 1: Build Your Future in Construction....22
Unit 2: Basic Safety....24
Unit 3: Introduction to Construction Math....26
Unit 4: Hand Tools....27
Unit 5: Power Tools....28
Unit 6: Introduction to Construction Drawings....29
Unit 7: Communication Skills....30
Unit 8: Employability Skills....31
Unit 9: Introduction to Materials Handling....32
Unit 10: Oxyfuel Cutting....33
Unit 11: Shielded Metal Arc Welding (SMAW) - Equipment and Setup....34
Unit 12: SMAW - Electrodes....35
Unit 13: SMAW - Beads and Fillet Welds....36
Unit 14: Orientation and Welding Safety Review....37
Unit 15: Base Metal Preparation....38
Unit 16: Joint Fit-up and Alignment....39
Unit 17: Weld Quality....40
Unit 18: Plasma Arc Cutting (PAC)....41
Unit 19: Air-Carbon Arc Cutting (A-CAC) and Gouging....42
Unit 20: SMAW - Groove Welds with Backing....43
Unit 21: SMAW - Open-Root Groove Welds-Plate....44
Unit 22: Gas Metal Arc Welding (GMAW) and Flux Core Arc Welding (FCAW)....45
Unit 23: Gas Tungsten Arc Welding (GTAW)....46

Student Competency Profile.....47
Appendix A: National Center for Construction Education and Research (NCCER) - National Craft Assessment and Certification Program – Core, Welding I, and Welding II Standards 51
Appendix B: American Welding Society (AWS) S.E.N.S.E. EG2.0 Guidelines.....53
Appendix C: College and Career Ready Standards – Mathematics (8th Grade, Algebra I, Geometry, and Algebra II) 54

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Standards

Standards and alignment crosswalks are referenced in the appendices. Depending on the curriculum, these crosswalks should identify alignment to the standards mentioned below, as well as possible related academic topics as required in the Subject Area Testing Program in Algebra I, Biology I, English II, and U.S. History from 1877, which could be integrated into the content of the units. Mississippi's CTE welding curriculum is aligned to the following standards:

National Center for Construction Education and Research (NCCER) Learning Series – Core, Welding I, and Welding 2 Standards
When developing this set of standards, the NCCER assembled a team of subject matter experts that represented construction companies and schools across the nation. Each committee met several times and combined experts' knowledge and experience to finalize the set of national industry standards.
nccer.org

American Welding Society (AWS) S.E.N.S.E. EG2.0 Guidelines
The American Welding Society (AWS), aws.org, sets industry standards for quality and welding qualifications. Their standards cover a variety of welding processes, materials, and applications. According to the NCCER website, these standards also correlate to the American Welding Society (AWS) S.E.N.S.E. (Schools Excelling through National Skills Education) program standards and guidelines for entry-level welders.
nccer.org/media/2023/03/aws_sense-nccer_welding-alignment.pdf

College- and Career-Readiness 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-Readiness Standards (MCCRS) to provide a consistent, clear understanding of what students are expected to learn and so teachers and parents know what they need to do to help them.
mdek12.org/oae/college-and-career-readiness-standards

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.
battelleforkids.org/networks/p21/frameworks-resources

Preface

Secondary 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 applied 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; Strengthening Career and Technical Education for the 21st Century Act, 2019 [Perkins V]; 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, contact the RCU at 662.325.2510 or helpdesk@rcu.msstate.edu.

Executive Summary

Pathway Description
Welding is a pathway in the Advanced Manufacturing career cluster. This instructional program prepares students for continued education or employment in welding occupations. The curriculum framework for this program was developed in partnership with Build Mississippi. Build Mississippi is the accredited sponsor for the National Center for Construction Education and Research (NCCER). This program begins with a welding industry introduction. It explores policies for local programs and student organizations such as SkillsUSA. Welding operations safe practices, skills in construction math, hand and power tool usage, and reading construction drawings are developed. The program also surveys employability skills, communication skills, materials handling, oxyfuel cutting, SMAW welding electrodes and welding equipment, and quality of welds.

College, Career, and Certifications
Year 1: NCCER Core Curriculum and Year 2: NCCER Welding Level 1

Grade Level and Class Size Recommendations
It is recommended that students enter this program as freshmen, sophomores, juniors, or seniors. Exceptions to this are a district-level decision based on class size, enrollment numbers, student maturity, and CTE delivery method. This is a hands-on, lab- or shop-based course. Therefore, a maximum of 15 students is recommended per class with only one class with the teacher at a time.

Student Prerequisites
For students to experience success in the program, the following student prerequisites are suggested:

1. C or higher in English (the previous year)
2. C or higher in high school-level math (last course taken or the instructor can specify the level of math instruction needed)
3. Instructor approval and Test of Adult Basic Education (TABE) reading score (eighth grade or higher)

or

1. TABE reading and math 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.

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/oel/apply-for-an-educator-license.

Professional Learning

If you have specific questions about the content of any training sessions provided, please contact the RCU at 662.325.2510 or helpdesk@rcu.msstate.edu.

Course Outlines

Option 1 – Four-1 Carnegie Unit Courses

This curriculum consists of four 1-credit courses, which should be completed in the following sequence:

1. **Orientation and Cutting – Course Code: 993302**
2. **Shielded Metal Arc Welding (SMAW) – Course Code: 993303**
3. **Advanced Welding I – Course Code: 993304**
4. **Advanced Welding II – Course Code: 993306**

Course Description: Orientation and Cutting – Course Code: 993302
This course focuses on the NCCER Learning Series Core. It addresses work-based learning opportunities, student organizations, and leadership skills. Students will demonstrate basic safety practices within the classroom shop area and within the industrial welding setting. They will apply construction math, use and maintain hand and power tools, read blueprints and interpret welding symbols all the while developing communication and employability skills. Students will follow safe materials handling procedures and perform multiple cutting techniques while operating oxyfuel torch equipment.

Course Description: Shielded Metal Arc Welding (SMAW) – Course Code: 993303
This course introduces students to Shielded Metal Arc Welding (SMAW). Students will understand and demonstrate safe welding practices. They will identify and properly configure equipment such as SMAW cables, connectors, and tools. Critical course topics include exploring the use of SMAW electrodes, studying the classification system, and then selecting and properly handling the electrodes for distinctive tasks. Technical mastery of skills that include preparing the work area, striking an arc, producing a variety of weld bead types, and completing fillet welds in multiple positions. This 1-Carnegie-unit course should only be taken after students have successfully completed "Orientation and Cutting."

Course Description: Advanced Welding I – Course Code: 993304
This course focuses on specialized welding symbols used in blueprints and drawings. Students will learn about Plasma Arc Cutting (PAC), Air Carbon Arc Cutting (A-CAC), and advanced techniques used in SMAW. It explores welding safety when preparing base metals, joint fit-up and alignment, weld quality, cutting processes, and SMAW groove welds with backing. Students prepare and fit up joints, interpret welding symbols concerning welding drawings, and perform non-destructive and destructive weld testing practices. This 1-Carnegie-unit course should only be taken after students have successfully completed "Shielded Metal Arc Welding (SMAW)."

Course Description: Advanced Welding II – Course Code: 993306
This course focuses on a variety of SMAW open-root groove welds, Gas Metal Arc Welding (GMAW), Flux Core Arc Welding (FCAW), and Gas Tungsten Arc Welding (GTAW). Students will demonstrate safe equipment handling as well as setup and cleanup procedures as they enhance their welding techniques. They will incorporate filler metals, multiple pass GTAW fillet and groove welds executed on carbon steel coupons in multiple positions. This course trains

students regarding welding processes producing quality bead and fillet welds, and V-groove welds on alloys and carbon steel. This 1-Carnegie-unit course should only be taken after students successfully complete "Advanced Welding I."

Orientation and Cutting – Course Code: 993302

Unit	Unit Title	Hours
1	Build Your Future in Construction	15
2	Basic Safety	15
3	Introduction to Construction Math	12
4	Hand Tools	8
5	Power Tools	8
6	Introduction to Construction Drawings	8
7	Communication Skills	8
8	Employability Skills	8
9	Introduction to Materials Handling	15
10	Oxyfuel Cutting	43
Total		**140**

Shielded Metal Arc Welding [SMAW] – Course Code: 993303

Unit	Unit Title	Hours
11	SMAW - Equipment and Setup	15
12	SMAW - Electrodes	15
13	SMAW - Beads and Fillet Welds	110
Total		**140**

Advanced Welding I – Course Code: 993304

Unit	Unit Title	Hours
14	Orientation and Welding Safety Review	10
15	Base Metal Preparation	15
16	Joint Fit-up and Alignment	8
17	Weld Quality	15
18	Plasma Arc Cutting	10
19	Air-Carbon Arc Cutting and Gouging	10
20	SMAW - Groove Welds with Backing	72
Total		**140**

Advanced Welding II – Course Code: 993306

Unit	Unit Title	Hours
21	SMAW - Open Root Groove Welds-Plate	60
22	Gas Metal Arc Welding (GMAW) and Flux Core Arc Welding (FCAW)	40
23	Gas Tungsten Arc Welding (GTAW)	40
Total		**140**

Option 2 – Two-2-Carnegie Unit Courses

This curriculum consists of two 2-credit courses, which should be completed in the following sequence:

1. **Introduction to Welding – Course Code: 993300**
2. **Advanced Welding – Course Code: 993301**

Course Description: Introduction to Welding – Course Code: 993300
This course focuses on the NCCER Learning Series Core. It addresses work-based learning opportunities, student organizations, and leadership skills. Students will demonstrate basic safety practices within the classroom shop area and within the industrial welding setting. They will apply construction math, use and maintain hand and power tools, read blueprints, and interpret welding symbols, all the while developing communication and employability skills. Students will follow safe materials handling procedures and perform multiple cutting techniques while operating oxyfuel torch equipment. This course also introduces students to Shielded Metal Arc Welding (SMAW). Students will understand and demonstrate safe welding practices. They will identify and properly configure equipment such as SMAW cables, connectors, and tools. Critical course topics include exploring the use of SMAW electrodes, studying the classification system, and then selecting and properly handling the electrodes for distinctive tasks. Technical mastery of skills is developed such as preparing the work area, striking an arc, producing a variety of weld bead types, and completing fillet welds in multiple positions.

Course Description: Advanced Welding – Course Code: 993301
This course focuses on specialized welding symbols used in blueprints and drawings. Students will learn about Plasma Arc Cutting (PAC), Air Carbon Arc Cutting (A-CAC), and advanced techniques used in SMAW. It explores welding safety when preparing base metals, joint fit-up and alignment, weld quality, cutting processes, and SMAW groove welds with backing. Students prepare and fit up joints, interpret welding symbols concerning welding drawings, and perform non-destructive and destructive weld testing practices. This course also focuses on a variety of SMAW open-root groove welds, Gas Metal Arc Welding (GMAW), Flux Core Arc Welding (FCAW), and Gas Tungsten Arc Welding (GTAW). Students will demonstrate safe equipment handling as well as setup and cleanup procedures as they enhance their welding techniques. They will incorporate filler metals, multiple pass GTAW fillet, and groove welds executed on carbon steel coupons in multiple positions. This course trains students regarding welding processes producing quality bead and fillet welds, and V-groove welds on alloys and carbon steel. This 2-Carnegie-unit course should only be taken after students successfully complete “Introduction to Welding.”

Introduction to Welding – Course Code: 993300

Unit	Unit Title	Hours
1	Build Your Future in Construction	15
2	Basic Safety	15
3	Introduction to Construction Math	12
4	Hand Tools	8
5	Power Tools	8

6	Introduction to Construction Drawings	8
7	Communication Skills	8
8	Employability Skills	8
9	Introduction to Materials Handling	15
10	Oxyfuel Cutting	43
11	SMAW - Equipment and Setup	15
12	SMAW - Electrodes	15
13	SMAW - Beads and Fillet Welds	110
Total		**280**

Advanced Welding – Course Code: 993301

Unit	Unit Name	Hours
14	Orientation and Welding Safety Review	10
15	Base Metal Preparation	15
16	Joint Fit-up and Alignment	8
17	Weld Quality	15
18	Plasma Arc Cutting	10
19	Air-Carbon Arc Cutting and Gouging	10
20	SMAW - Groove Welds with Backing	72
21	SMAW - Open Root Groove Welds-Plate	60
22	Gas Metal Arc Welding (GMAW) and Flux Core Arc Welding (FCAW)	40
23	Gas Tungsten Arc Welding (GTAW)	40
Total		**280**

Career Pathway Outlook

Overview

The Welding program prepares students for entry-level welding and fabrication employment. Students enrolled in this course will develop employability skills and understand the importance of occupational safety. They will hone their skills in basic math as they read blueprints, interpret welding symbols, operate hand and power tools, and examine weld quality. They will prepare proper mechanical and thermal joints of varying base metals and explain joint fit-up techniques when controlling weldment distortion. Students will study oxyfuel cutting operations, basic and advanced shielded metal arc welding (SMAW), semi-automatic arc welding involving gas metal arc welding (GMAW) and flux cored arc welding (FCAW), gas tungsten arc welding (GTAW), air-carbon arc cutting principles and practices (A-CAC), and plasma arc cutting (PAC). Students will also demonstrate multiple positions of groove and open-root groove welds. Emphasis is given to properly setting up, cleaning, and storing welding equipment when the work begins and ends each day. Detail oriented welders need to maintain steady hand-eye coordination, exhibit strength and stamina, and maintain a safe work environment awareness. A welding professional's work environment may include either indoor industrial manufacturing facilities, or they may work in all types of weather outdoors at construction sites, bridges, roads, railways, pipelines, and oil rigs. At times, they may work in a confined area designed to contain sparks and glare. They may work on a scaffold or platform high off the ground. A welder could choose underwater work environments, including lakes, rivers, offshore, or even deep sea. They could maintain, construct, or repair equipment on military bases or even cruise or passenger ships at shipyards.

Most careers related to welders, cutters, solderers, and brazers require at least a high school diploma, and some states and localities may require a license, although careers with the highest earning potential—welding inspector, welding engineer, welding research scientist, and postsecondary teachers, for example—require advanced degrees. Students can utilize their acquired welding–related skills and knowledge within educational pathways related to engineering, technology, vocational education, business management, agriculture, and military applications. They can accomplish this by attending some of the two-year and four-year welding–related postsecondary degree programs available within Mississippi and across the nation.

Needs of the Future Workforce

In relation to welding, construction laborers are on the list of the top twenty-fastest growing occupations nationally, and this career is projected to grow 4% through 2032, according to the U.S. Bureau of Labor and Statistics. The nation's aging infrastructure will require their expertise to help rebuild bridges, highways, and buildings. In 2022, welders, cutters, solderers, and brazers held about 431,800 jobs nationally. A categorized employment list for these professionals includes manufacturing, 65%, specialty trade contractors, 7%, repair and maintenance, 4%, and self-employed workers, 4%. Through 2032, 42,600 new openings for these careers are expected each year. These occupations in the Gulfport-Biloxi-Pascagoula, MS area have a higher share of employment than the national average, which accounts for nearly 15 out of every 1,000 jobs overall. The patterns of job growth shown in Table 1.1 relate to a range of welding occupations.

Table 1.1: Current and Projected Occupation Report

Description	Jobs, 2020	Projected Jobs, 2030	Change (Number)	Change (Percent)	Average Hourly Earnings, 2024
Agricultural Equipment Operators	440	500	60	13.6%	$14.62
Aircraft Mechanics and Service Technicians	1,130	1,180	50	4.4%	$32.97
Bicycle Repairers	30	40	10	33.3%	$13.89
Boilermakers	190	190	0	0%	$30.14
Construction Laborers	12,210	12,530	320	2.6%	$17.72
Control and Valve Installers and Repairers, Except Mechanical Door	480	500	20	4.2%	$27.61
Electric Motor, Power Tool, and Related Repairers	220	220	0	0%	$22.03
Electricians	5,780	6,280	500	8.7%	$27.39
Excavating and Loading Machine and Dragline Operators, Surface Mining	420	430	10	2.4%	$21.67
Farm Equipment Mechanics and Service Technicians	670	700	30	4.5%	$21.34
Farmers, Ranchers, and Other Agricultural Managers	6,580	7,160	580	8.8%	$25.53
Farming, Fishing, and Forestry Occupations	10,510	11,040	530	5%	$19.79
Farmworkers and Laborers, Crop, Nursery, and Greenhouse	3,230	3,380	150	4.6%	$17.30
First-Line Supervisors of Construction Trades and Extraction Workers	6,380	6,620	240	3.8%	$33.74
First-Line Supervisors of Mechanics, Installers, and Repairers	4,550	4,800	250	5.5%	$33.16
General and Operations Managers	19,310	20,980	1,670	8.6%	$48.63
Helpers--Installation, Maintenance, and Repair Workers	710	750	40	5.6%	$15.69

Helpers--Pipelayers, Plumbers, Pipefitters, and Steamfitters	350	390	40	11.4%	$16.30
Industrial Machinery Mechanics	5,110	5,450	340	6.7%	$27.69
Installation, Maintenance, and Repair Workers, All Other	1,140	1,200	60	5.3%	$26.34
Machinists	2,880	3,040	160	5.6%	$23.31
Maintenance and Repair Workers, General	13,760	15,160	1,400	10.2%	$19.52
Millwrights	540	570	30	5.6%	$25.78
Miscellaneous Assemblers and Fabricators	16,410	17,170	760	4.6%	$18.81
Mobile Heavy Equipment Mechanics, Except Engines	1,400	1,420	20	1.4%	$24.49
Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic	520	530	10	1.9%	$18.75
Operating Engineers and Other Construction Equipment Operators	3,430	3,590	160	4.7%	$21.78
Pipelayers	390	410	20	5.1%	$20.95
Plumbers, Pipefitters, and Steamfitters	3,050	3,300	250	8.2%	$25.61
Production Occupations	101,130	103,540	2,410	2.4%	$20.51
Rail Car Repairers	350	380	30	8.6%	$23.09
Riggers	430	470	40	9.3%	$29.64
Security and Fire Alarm Systems Installers	360	490	130	36.1%	$20.20
Service Unit Operators, Oil, Gas, and Mining	140	190	50	35.7%	$28.98
Sheet Metal Workers	1,510	1,570	60	4%	$23.02
Structural Iron and Steel Workers	640	650	10	1.6%	$22.00
Welders, Cutters, Solderers, and Brazers	6,370	6,830	460	7.2%	$24.61

Source: Mississippi Department of Employment Security; mdes.ms.gov (2024).

Perkins V Requirements and Academic Infusion

The welding curriculum meets Perkins V requirements of introducing students to and preparing them for high-skill, high-wage occupations in welding-related fields. It also offers students a program of study, including secondary, postsecondary, and institutions of higher learning courses, which will further prepare them for welding careers. Additionally, this curriculum is integrated with academic college- and career-readiness standards. Lastly, it focuses on ongoing and meaningful professional development for teachers as well as relationships with industry.

Transition to Postsecondary Education

The latest articulation information for secondary to postsecondary can be found at the Mississippi Community College Board website, mccb.edu.

Best Practices

Innovative Instructional Technologies

Classrooms should be equipped with tools that will teach today's digital learners through applicable and modern practices. The welding educator's goal should be to include teaching strategies that incorporate current technology. To make use of the latest online communication tools—wikis, blogs, podcasts, and social media platforms, for example—the classroom teacher is encouraged to use a learning management system that introduces students to education in an online environment and places more of the responsibility of learning on the student.

Differentiated Instruction

Students learn in a variety of ways, and numerous factors—students' background, emotional health, and circumstances, for example—create unique learners. By providing various teaching and assessment strategies, students with various learning preferences can have more opportunities to succeed.

CTE Student Organizations

Teachers should investigate opportunities to sponsor a student organization. There are several here in Mississippi that will foster the types of learning expected from the welding curriculum. SkillsUSA is an example of a student organization with several outlets for welding. Student organizations provide participants and members with growth opportunities and competitive events. They also open the doors to the world of welding careers and scholarship opportunities.

Cooperative Learning

Cooperative learning can help students understand topics when independent learning cannot. Therefore, you will see several opportunities in the welding 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 welding curriculum provides opportunities for students to work together and help each other complete complex tasks. There are many field experiences within the welding curriculum that will allow and encourage collaboration with professionals currently in the welding field.

Work-Based Learning

Work-based learning is an extension of understanding competencies taught in the welding classroom. This curriculum is designed in a way that necessitates active involvement by the students in the community around them and the global environment. These real-world connections and applications link all types of students to knowledge, skills, and professional dispositions. Work-based learning should encompass ongoing and increasingly more complex involvement with local companies and welding professionals. Thus, supervised collaboration and immersion into the welding around the students are keys to students' success, knowledge, and skills development.

Professional Organizations

American Institute of Steel Construction (AISC)
aisc.org

American Welding Society (AWS)
aws.org

Association for Iron & Steel Technology (AIST)
aist.org

Build Mississippi
buildmississippi.com

Fabricators & Manufacturers Association International (FMA)
fmanet.org

Industrial Fasteners Institute (IFI)
indfast.org

National Center for Construction Education and Research (NCCER)
nccer.org

National Steel Heating, Cooling Contractors of America (NSHCCA)
nshccaonline.com

Society of Manufacturing Engineers (SME)
sme.org

Using This Document

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.

Teacher Resources
All teachers should request to be added to the Canvas Resource Guide for their course. For questions or to be added to the guide, send a Help Desk ticket to the RCU by emailing helpdesk@rcu.msstate.edu.

Perkins V Quality Indicators and Enrichment Material
Some of the units may include an enrichment section at the end. This material will greatly enhance the learning experiences of students. If the welding program is using a national certification, work-based learning, or another measure of accountability that aligns with Perkins V as a quality indicator, this material could very well be assessed on that quality indicator. The teacher is responsible for ensuring all competencies for the selected quality indicator are covered throughout the year.

Unit 1: Build Your Future in Construction

Competencies and Suggested Objectives
1. Describe local program and center expectations, policies, and procedures. DOK1 a. Describe local program and career center policies and procedures, including dress code, attendance, academic requirements, discipline, shop/lab rules and regulations, and transportation regulations. b. Give a brief overview of the course and the welding industry. c. Explain the Advanced Manufacturing/Welding Pathway, why it is important, and how it will be delivered. d. Compare and contrast local program and school policies to expectations of employers. e. Preview course objectives, program policy, and the industry standards.
2. Investigate work-based learning opportunities related to program areas. DOK1 a. Define work-based learning. b. Identify ways to pursue a career in the welding industry. c. Explore the opportunities available through the program areas, including: • Job shadowing • Apprenticeship programs • On-the-job training
3. Discuss the history, mission, and purpose of student organizations, including SkillsUSA. DOK1 a. Trace the history of the program area student organization. b. Identify the mission, purpose, and/or goals of the program area student organization.
4. Explore the advantages of membership in a student organization. DOK1 a. Discuss the membership process for the program area student organization. b. Explain the activities related to the local chapter and the state and national organization.
5. Discuss the organization's brand resources. DOK2 a. Identify the motto, creed, and/or pledge and discuss their meanings. b. Recognize related brand resources such as: • Emblem • Colors • Official Attire • Logos • Graphic Standards
6. Apply leadership skills to class and work-related situations and 21st Century Skills. DOK2 a. Define leadership. b. Discuss the attributes of a leader. c. Identify the roles a leader can assume.
7. Utilize teambuilding skills in class and work-related situations. DOK2 a. Define teambuilding. b. Discuss the attributes of a team. c. Identify the roles included in a team.
8. Discuss the various competitions offered through the program area student organization. DOK2

a. Describe each of the competitions and the skills needed to accomplish the tasks. b. Perform the tasks needed to complete an assigned requirement for a competition.

Unit 2: Basic Safety

Competencies and Suggested Objectives
1. Describe, define, and illustrate general safety rules for working in a shop/lab and how they relate to welding and the manufacturing industry. DOK2 a. Describe how to avoid on-site accidents. b. Explain the relationship between housekeeping and safety. c. Explain the importance of following all safety rules and company safety policies according to Occupational Safety and Health Administration (OSHA) standards. d. Explain the importance of reporting all on-the-job injuries, accidents, and near misses. e. Explain the need for evacuation policies and the importance of following them. f. Explain causes of accidents and the impact of accident costs. g. Compare and contrast shop/lab safety rules to industry safety rules.
2. Identify and apply safety around welding operations. DOK2 a. Use proper safety practices when welding or working around welding operations. b. Use proper safety practices when welding in or near trenches and excavations. c. Explain the term "proximity work."
3. Display appropriate safety precautions to take around common job site hazards. DOK2 a. Explain the safety requirements for working in confined areas. b. Explain the different barriers and barricades and how they are used.
4. Demonstrate the appropriate use and care of personal protective equipment (PPE). DOK2 a. Identify commonly used PPE items. b. Understand proper use of PPE. c. Demonstrate appropriate care for PPE.
5. Explain fall protection, ladder, stair, and scaffold procedures and requirements. DOK2 a. Explain the use of proper fall protection. b. Inspect and safely work with various ladders, stairs, and scaffolds.
6. Explain the safety data sheet (SDS). DOK2 a. Explain the function of the SDS. b. Interpret the requirements of the SDS. c. Discuss hazardous material exposures.
7. Display appropriate safety procedures related to fires. DOK2 a. Explain the process by which fires start. b. Explain fire prevention of various flammable liquids. c. Explain the classes of fire and the types of extinguishers. d. Illustrate the proper steps to follow when using a fire extinguisher. e. Demonstrate the proper techniques for putting out a fire.
8. Explain safety in and around electrical situations. DOK2 a. Explain injuries that can result when electrical contact occurs. b. Explain safety around electrical hazards. c. Explain actions to take when an electrical shock occurs.

Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a 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.

Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

Unit 3: Introduction to Construction Math

Competencies and Suggested Objectives
1. Apply the four basic math skills using whole numbers, fractions, decimals, and percentages, both with and without a calculator. DOK3 a. Define basic angles and geometric shapes used in the manufacturing industry. • Explain angle types. • Explain geometric shapes and give an overview of their characteristics. • Discuss area and volume. b. Add, subtract, multiply, and divide whole numbers, decimals, and fractions with and without a calculator. c. Convert whole numbers to fractions and convert fractions to whole numbers. d. Convert decimals to percentages and convert percentages to decimals. e. Convert fractions to decimals. f. Convert fractions to percentages. g. Demonstrate reading a standard and metric ruler and tape measure. h. Recognize and use metric units of length, weight, volume, and temperature.

Unit 4: Hand Tools

Competencies and Suggested Objectives
1. Demonstrate the use and maintenance of hand tools. DOK2 a. Identify, visually inspect, and discuss the safe use of common hand tools used on job sites. b. Discuss rules of safety. c. Select and demonstrate the use of tools. d. Explain the procedures for maintenance.
2. Explore measurement and layout tools. DOK2

Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a 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.
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

Unit 5: Power Tools

Competencies and Suggested Objectives
1. Demonstrate the use and maintenance of power tools. DOK2 a. Identify, visually inspect, and discuss the safe use of common power tools including electric, pneumatic, and hydraulic. b. Discuss rules of safety. c. Select and demonstrate the use of tools. d. Explain the procedures for maintenance.

Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a 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.
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

Unit 6: Introduction to Construction Drawings

Competencies and Suggested Objectives
1. Read, analyze, and understand basic components of a blueprint. DOK3 a. Recognize and identify terms, components, and symbols commonly used on blueprints. b. Relate information on drawings to actual locations on the print. c. Recognize different types of drawings. d. Interpret and use drawing dimensions and scale types.
2. Interpret symbols from a blueprint. DOK3
3. Examine various detail drawings. DOK3

Enrichment
1. Interpret welding symbols from a blueprint.
2. Examine a welding detail drawing.
3. Interpret basic elements of a welding detail drawing.
4. Demonstrate how to sketch or draw basic welding drawings.

Note: Enrichment is highly recommended when covering the welding aspect of drawings.
Note: Welding symbols and welding detailed drawings will be incorporated into units throughout the year.

Unit 7: Communication Skills

Competencies and Suggested Objectives
1. Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations. DOK2 a. Follow basic written and verbal instructions. b. Effectively communicate in on-the-job situations using verbal, written, or electronic communication.
2. Discuss the importance of good listening skills in on-the-job situations. DOK2 a. Apply the tips for developing good listening and speaking skills.

Unit 8: Employability Skills

Competencies and Suggested Objectives
1. Describe employment opportunities in the welding and construction industry. DOK2 a. Describe employment opportunities, including potential earnings, employee benefits, job availability, working conditions, educational requirements, required technology skills, and continuing education/training. b. Discuss the guidelines for developing a proper résumé. c. Demonstrate completing job applications.
2. Examine the Mississippi Department of Employment Security (MDES) website and its applications relating to employment opportunities. DOK2 a. Perform various searches through the MDES website such as: • Number of jobs available for a specific area of expertise • Hourly wage • Percent of jobs in the county • Percent of jobs in the state
3. Demonstrate appropriate interview skills. DOK2 a. Identify interview skills such as speaking, dress, professionalism, punctuality. b. Simulate a job interview.
4. Describe basic employee responsibilities and appropriate work ethics. DOK2 a. Compare and contrast employment responsibilities and expectations to local school and program policies and expectations. b. Define effective relationship skills and workplace issues including, but not limited to, sexual harassment, stress, and substance abuse. c. Demonstrate critical thinking and effective leadership skills.

Unit 9: Introduction to Materials Handling

Competencies and Suggested Objectives
1. Safely handle and store materials. DOK2 a. Define a load. b. Establish a pre-task plan prior to moving a load. c. Use proper materials-handling techniques. d. Recognize hazards and follow safety procedures required for materials handling.
2. Choose appropriate materials-handling equipment for the task. DOK2 a. Motorized b. Non-Motorized

Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a 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.
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

Unit 10: Oxyfuel Cutting

Competencies and Suggested Objectives
1. Identify and describe the basic equipment, setup, and safety rules for proper use of equipment, and prepare base metal for oxyfuel cutting. DOK4 a. Identify and explain the use of oxyfuel-cutting equipment. b. Demonstrate how to use an oxyfuel torch. c. Perform and analyze oxyfuel cutting. • Straight line and square shapes • Piercing and slot cutting • Bevels • Washing • Gouging
2. Demonstrate the assembly and disassembly of oxyfuel equipment and associated consumables. DOK4 a. Set up and operate a manual handheld oxyfuel torch. b. Set up and operate a motorized, portable oxyfuel gas cutting machine.

Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a 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.
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

Unit 11: Shielded Metal Arc Welding (SMAW) - Equipment and Setup

Competencies and Suggested Objectives
1. Demonstrate shielded metal arc welding (SMAW)-related safety practices and recognize how electrical characteristics apply to SMAW. DOK3
2. Identify and describe SMAW equipment to include welding cable, connectors, and common tools used to clean various welds. DOK2
3. Explain and demonstrate how to set up and start SMAW equipment. DOK2

Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a 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.
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

Unit 12: SMAW - Electrodes

Competencies and Suggested Objectives
1. Explain the SMAW electrode classification system and how to select the proper electrode for the task. DOK2 a. Recognize the American Welding Society (AWS) filler metal specification system and various electrode characteristics. b. Describe the characteristics of the four main electrode groups.
2. Explain how to select electrodes and describe their proper care and handling. DOK2 a. Select the proper electrodes for any given welding task. b. Demonstrate the proper handling and storage of electrodes.

Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

Unit 13: SMAW - Beads and Fillet Welds

Competencies and Suggested Objectives
1. Demonstrate and explain how to prepare for SMAW welding and how to strike an arc. DOK3 a. Identify and describe safety practices related to SMAW. b. Arrange the area and equipment for welding. c. Master the skill of striking an arc. d. Investigate and draw conclusions on how to respond to arc blow.
2. Demonstrate and explain how to successfully complete various types of beads and fillet welds. DOK3 a. Master the skill of properly restarting and terminating a weld pass. b. Develop the proper techniques required to produce stringer and weave beads. c. Develop the proper techniques required to produce fillet welds in various positions.

Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a 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.
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.
Note: Welding symbols and welding detailed drawings will be incorporated into units throughout the year.

Unit 14: Orientation and Welding Safety Review

Competencies and Suggested Scenarios
1. Describe local program and career and technical center policies and procedures. DOK1 a. Describe local program and career and technical center policies and procedures.
2. Describe employment opportunities and responsibilities of the welder. DOK2 a. Describe employer expectations in the workplace.
3. Explore leadership skills and personal development opportunities. DOK2 a. Demonstrate team building and leadership skills. b. Demonstrate appropriate work ethics through practice.
4. Describe general safety rules for working in a welding shop/lab and an industrial setting. DOK1 a. Discuss safety issues and prevention associated with the installation and welding shop or lab area. b. Demonstrate fire safety and prevention techniques in the workplace.

Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a 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.
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

Unit 15: Base Metal Preparation

Competencies and Suggested Objectives
1. Identify safe practices related to preparation of various types of base metals. DOK1
2. Identify and describe basic weld joint design and types of welds. DOK2 a. Identify and describe the loads that are routinely placed on weld joints. b. Describe a welding procedure specification (WPS) and the information it provides.
3. Prepare joints for welding. DOK3 a. Mechanically prepare joints for welding. b. Thermally prepare joints for welding. c. Demonstrate basic properties of and cleaning procedures for types of carbon and stainless steel.

Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a 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.
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.
Note: Welding symbols and welding detailed drawings will be incorporated into units throughout the year.

Unit 16: Joint Fit-up and Alignment

Competencies and Suggested Objectives
1. Identify fit-up gauges and measuring devices to check joint fit-up. DOK2 a. Discuss the use of straightedges. b. Discuss the use of squares. c. Discuss the use of levels. d. Discuss the use of Hi-Lo gauges.
2. Demonstrate the use of fit-up gauges and measuring devices to check joint fit-up. DOK2 a. Demonstrate the proper use of straightedges. b. Demonstrate the proper use of squares. c. Demonstrate the proper use of levels. d. Demonstrate the proper use of Hi-Lo gauges.
3. Discuss the various fit-up tools. DOK2 a. Describe the use of hydraulic jacks in joint fit-up. b. Describe the use of chain hoists in joint fit-up. c. Describe the use of come-alongs in joint fit-up.
4. Demonstrate the proper way to fit-up joints using the various fit-up tools. DOK2 a. Explain techniques to control weldment distortion and thermal expansion. b. Explain the reasoning for various codes and specifications.

Note: Welding symbols and welding detailed drawings will be incorporated into units throughout the year.

Unit 17: Weld Quality

Competencies and Suggested Objectives
1. Explore regulations and job code specifications for welding, base metal cleaning, joint designs, and their purpose. DOK2 a. Discuss code agencies and the major codes governing welding, the causes of weld imperfections, welder qualification tests, and the importance of quality of skill. b. Select and use a nondestructive examination practice and a destructive test method to test a student-made weld. c. Explain joint fit-up.

Enrichment
1. Interpret welding symbols from a blueprint. 2. Examine a welding detail drawing. 3. Interpret basic elements of a welding detail drawing. 4. Demonstrate how to sketch or draw basic welding drawings.

Note: Enrichment is highly recommended when covering the welding aspect of drawings.
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.
Note: Welding symbols and welding detailed drawings will be incorporated into units throughout the year.

Unit 18: Plasma Arc Cutting (PAC)

Competencies and Suggested Objectives
1. Explain the plasma arc cutting (PAC) process. DOK2 a. Discuss safety procedures and protective devices used in PAC. b. Discuss transferred and non-transferred arc processes.
2. Identify PAC equipment and accessories. DOK2 a. Identify the PAC equipment power source control unit. b. Identify the various PAC equipment torches and nozzles. c. Demonstrate proper setup of PAC equipment for safe operation.
3. Set up and perform various types of cuts using PAC equipment. DOK3
4. Properly store equipment and clean the work area after use. DOK3

Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a 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.
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

Unit 19: Air-Carbon Arc Cutting (A-CAC) and Gouging

Competencies and Suggested Objectives
1. Explain the air carbon arc cutting (A-CAC) process. DOK2 a. Discuss safety procedures and protective devices used in A-CAC. b. Demonstrate proper setup of A-CAC equipment for safe operation. c. Describe cutting, gouging, washing, and beveling.
2. Identify the various A-CAC electrodes. DOK2 a. Identify plain, copper-coated for direct current and copper-coated for alternating current. b. Identify various electrode styles such as round, round-jointed, and special shapes.
3. Perform washing and gouging activities using A-CAC equipment. DOK3
4. Properly store equipment and clean the work area after use. DOK3

Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a 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.
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

Unit 20: SMAW - Groove Welds with Backing

Competencies and Suggested Objectives
1. Review safety hazards, protective devices used, and basic operation of SMAW equipment. DOK1
2. Discuss the various groove welds with backing and their aspects and terminology. DOK3 a. Discuss proper square groove welds. b. Discuss proper bevel groove welds. c. Discuss proper V-groove welds. d. Discuss proper U-groove welds. e. Discuss proper J-groove welds. f. Discuss proper flare V-groove welds. g. Discuss proper flare bevel-groove welds.
3. Discuss and demonstrate proper SMAW equipment setup for making V-groove welds with backing. DOK3
4. Prepare materials to perform SMAW V-groove welds with backing. DOK3
5. Perform and analyze SMAW V-groove welds with backing in the 1G, 2G, 3G and 4G positions. DOK3
6. Properly store equipment and clean the work area after use. DOK3

Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a 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.
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.
Note: Welding symbols and welding detailed drawings will be incorporated into units throughout the year.

Unit 21: SMAW - Open-Root Groove Welds-Plate

Competencies and Suggested Objectives
1. Review safety hazards, protective devices used, and basic operation of SMAW equipment. DOK2
2. Discuss the various open V-groove welds and their aspects and terminology. DOK3 a. Discuss proper square groove welds. b. Discuss proper bevel groove welds. c. Discuss proper V-groove welds. d. Discuss proper U-groove welds. e. Discuss proper J-groove welds. f. Discuss proper flare V-groove welds. g. Discuss proper flare bevel groove welds.
3. Discuss and demonstrate proper SMAW equipment setup for making V-groove welds. DOK3
4. Prepare materials to perform SMAW V-groove welds. DOK3
5. Setup and perform SMAW V-groove welds in the 1G, 2G, 3G and 4G positions. DOK3
6. Properly store equipment and clean the work area after use. DOK3

Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a 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.
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.
Note: Welding symbols and welding detailed drawings will be incorporated into units throughout the year.

Unit 22: Gas Metal Arc Welding (GMAW) and Flux Core Arc Welding (FCAW)

Competencies and Suggested Scenarios
1. Explain the GMAW and FCAW welding processes. DOK3 a. Explain the characteristics of welding current and power sources. b. Explain the use of GMAW and FCAW shielding gases, filler metals, and consumables. c. Discuss the safety precautions to observe when operating GMAW and FCAW equipment.
2. Explain the use of GMAW and FCAW equipment parts and modes. DOK3 a. Discuss spray transfer mode. b. Discuss globular mode. c. Discuss short-circuiting mode. d. Discuss pulse mode.
3. Demonstrate proper and safe setup of GMAW and FCAW equipment. DOK3
4. Set up and perform GMAW-S (short-circuit) beads and multiple-pass fillet welds on carbon steel plate coupons in multiple positions, using solid or composite wire and shielding gas. DOK3
5. Set up and perform GMAW-S (short-circuit) multiple-pass V-groove welds on carbon steel plate coupons in multiple positions (with or without backing), using solid or composite wire and shielding gas. DOK3
6. Set up and perform FCAW beads and multiple-pass fillet welds on carbon steel plate coupons in multiple positions, using flux-cored wire and, if required, shielding gas. DOK3
7. Set up and perform FCAW multiple-pass V-groove welds on carbon steel plate coupons in multiple positions (with or without backing) using flux-cored wire and, if required, shielding gas. DOK3
8. Properly store equipment and clean the work area after use. DOK3

Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a 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.
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.
Note: Welding symbols and welding detailed drawings will be incorporated into units throughout the year.

Unit 23: Gas Tungsten Arc Welding (GTAW)

Competencies and Suggested Scenarios
1. Explain the GTAW welding process including safety procedures. DOK3
2. Identify the various parts, functions, and assembly of GTAW equipment. DOK3 a. Identify and describe the function of the various GTAW torches. b. Identify and describe the function of the gas nozzles used in GTAW. c. Identify and describe the function of tungsten electrodes used in GTAW. d. Identify and describe the function of the shielding gas used in GTAW.
3. Identify the various types and appropriate uses of GTAW filler metals. DOK3 a. Discuss carbon steel and low-alloy steel. b. Discuss stainless steel, aluminum, and aluminum alloy.
4. Demonstrate the proper setup of GTAW equipment. DOK3
5. Setup and perform multiple-pass GTAW fillet and groove welds on carbon steel plate coupons in various positions using carbon steel filler metal. DOK3
6. Properly store equipment and clean the work area after use. DOK3

Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a 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.
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.
Note: Welding symbols and welding detailed drawings will be incorporated into units throughout the year.

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: Build Your Future in Construction		
	1.	Describe local program and center expectations, policies, and procedures.
	2.	Investigate work-based learning opportunities related to program areas.
	3.	Discuss the history, mission, and purpose of student organizations, including SkillsUSA.
	4.	Explore the advantages of membership in a student organization.
	5.	Discuss the organization's brand resources.
	6.	Apply leadership skills to class and work-related situations and 21st Century Skills.
	7.	Utilize teambuilding skills in class and work-related situations.
	8.	Discuss the various competitions offered through the program area student organization.
Unit 2: Basic Safety		
	1.	Describe, define, and illustrate general safety rules for working in a shop/lab and how they relate to welding and the manufacturing industry.
	2.	Identify and apply safety around welding operations.
	3.	Display appropriate safety precautions to take around common jobsite hazards.
	4.	Demonstrate the appropriate use and care of personal protective equipment (PPE).
	5.	Explain fall protection, ladder, stair, and scaffold procedures and requirements.
	6.	Explain the safety data sheet (SDS).
	7.	Display appropriate safety procedures related to fires.
	8.	Explain safety in and around electrical situations.
Unit 3: Introduction to Construction Math		
	1.	Apply the four basic math skills using whole numbers, fractions, decimals, and percentages, both with and without a calculator.
Unit 4: Hand Tools		
	1.	Demonstrate the use and maintenance of hand tools.
	2.	Explore measurement and layout tools.

Unit 5: Power Tools		
	1.	Demonstrate the use and maintenance of power tools.
Unit 6: Introduction to Construction Drawings		
	1.	Read, analyze, and understand basic components of a blueprint.
	2.	Interpret symbols from a blueprint.
	3.	Examine various detail drawings.
Unit 7: Communication Skills		
	1.	Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations.
	2.	Discuss the importance of good listening skills in on-the-job situations.
Unit 8: Employability Skills		
	1.	Describe employment opportunities in the welding and construction industry.
	2.	Examine the Mississippi Department of Employment Security (MDES) website and its applications relating to employment opportunities.
	3.	Demonstrate appropriate interview skills.
	4.	Describe basic employee responsibilities and appropriate work ethics.
Unit 9: Introduction to Materials Handling		
	1.	Safely handle and store materials.
	2.	Choose appropriate materials-handling equipment for the task.
Unit 10: Oxyfuel Cutting		
	1.	Identify and describe the basic equipment, setup, and safety rules for proper use of equipment, and prepare base metal for oxyfuel cutting.
	2.	Demonstrate the assembly and disassembly of oxyfuel equipment and associated consumables.
Unit 11: Shielded Metal Arc Welding (SMAW) - Equipment and Setup		
	1.	Demonstrate shielded metal arc welding (SMAW)-related safety practices and recognize how electrical characteristics apply to SMAW.
	2.	Identify and describe SMAW equipment to include welding cable, connectors, and common tools used to clean various welds.
	3.	Explain and demonstrate how to set up and start SMAW equipment.
Unit 12: SMAW - Electrodes		
	1.	Explain the SMAW electrode classification system and how to select the proper electrode for the task.
	2.	Explain how to select electrodes and describe their proper care and handling.
Unit 13: SMAW - Beads and Fillet Welds		
	1.	Demonstrate and explain how to prepare for SMAW welding and how to strike an arc.
	2.	Demonstrate and explain how to successfully complete various types of beads and fillet welds.

Unit 14: Orientation and Welding Safety Review		
	1.	Describe local program and career and technical center policies and procedures.
	2.	Describe employment opportunities and responsibilities of the welder.
	3.	Explore leadership skills and personal development opportunities.
	4.	Describe general safety rules for working in a welding shop/lab and an industrial setting.
Unit 15: Base Metal Preparation		
	1.	Identify safe practices related to preparation of various types of base metals.
	2.	Identify and describe basic weld joint design and types of welds.
	3.	Prepare joints for welding.
Unit 16: Joint Fit-up and Alignment		
	1.	Identify fit-up gauges and measuring devices to check joint fit-up.
	2.	Demonstrate the use of fit-up gauges and measuring devices to check joint fit-up.
	3.	Discuss the various fit-up tools.
	4.	Demonstrate the proper way to fit-up joints using the various fit-up tools.
Unit 17: Weld Quality		
	1.	Explore regulations and job code specifications for welding, base metal cleaning, joint designs, and their purpose.
Unit 18: Plasma Arc Cutting (PAC)		
	1.	Explain the plasma arc cutting (PAC) process.
	2.	Identify PAC equipment and accessories.
	3.	Set up and perform various types of cuts using PAC equipment.
	4.	Properly store equipment and clean the work area after use.
Unit 19: Air-Carbon Arc Cutting (A-CAC) and Gouging		
	1.	Explain the air carbon arc cutting (A-CAC) process.
	2.	Identify the various A-CAC electrodes.
	3.	Perform washing and gouging activities using A-CAC equipment.
	4.	Properly store equipment and clean the work area after use.
Unit 20: SMAW - Groove Welds with Backing		
	1.	Review safety hazards, protective devices used, and basic operation of SMAW equipment.
	2.	Discuss the various groove welds with backing and their aspects and terminology.
	3.	Discuss and demonstrate proper SMAW equipment setup for making V-groove welds with backing.
	4.	Prepare materials to perform SMAW V-groove welds with backing.
	5.	Perform and analyze SMAW V-groove welds with backing in the 1G, 2G, 3G and 4G positions.

	6.	Properly store equipment and clean the work area after use.
Unit 21: SMAW Open Root Groove Welds-Plate		
	1.	Review safety hazards, protective devices used, and basic operation of SMAW equipment.
	2.	Discuss the various open V-groove welds and their aspects and terminology.
	3.	Discuss and demonstrate proper SMAW equipment setup for making V-groove welds.
	4.	Prepare materials to perform SMAW V-groove welds.
	5.	Setup and perform SMAW V-groove welds in the 1G, 2G, 3G and 4G positions.
	6.	Properly store equipment and clean the work area after use.
Unit 22: Gas Metal Arc Welding (GMAW) and Flux Core Arc Welding (FCAW)		
	1.	Explain the GMAW and FCAW welding processes.
	2.	Explain the use of GMAW and FCAW equipment parts and modes.
	3.	Demonstrate proper and safe setup of GMAW and FCAW equipment.
	4.	Set up and perform GMAW-S (short-circuit) beads and multiple-pass fillet welds on carbon steel plate coupons in multiple positions, using solid or composite wire and shielding gas.
	5.	Set up and perform GMAW-S (short-circuit) multiple-pass V-groove welds on carbon steel plate coupons in multiple positions (with or without backing), using solid or composite wire and shielding gas.
	6.	Set up and perform FCAW beads and multiple-pass fillet welds on carbon steel plate coupons in multiple positions, using flux-cored wire and, if required, shielding gas.
	7.	Set up and perform FCAW multiple-pass V-groove welds on carbon steel plate coupons in multiple positions (with or without backing) using flux-cored wire and, if required, shielding gas.
	8.	Properly store equipment and clean the work area after use.
Unit 23: Gas Tungsten Arc Welding (GTAW)		
	1.	Explain the GTAW welding process including safety procedures.
	2.	Identify the various parts, functions, and assembly of GTAW equipment.
	3.	Identify the various types and appropriate uses of GTAW filler metals.
	4.	Demonstrate the proper setup of GTAW equipment.
	5.	Setup and perform multiple-pass GTAW fillet and groove welds on carbon steel plate coupons in various positions using carbon steel filler metal.
	6.	Properly store equipment and clean the work area after use.

Appendix A: National Center for Construction Education and Research (NCCER) - National Craft Assessment and Certification Program – Core, Welding I, and Welding II Standards

	Units	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Standards																								
Core																								
BFC		X							X						X									
BSM			X		X	X			X	X	X	X		X	X	X			X	X	X	X	X	X
ICM				X	X																			
IHT					X																			
IPT						X																		
BLU							X																	
COM								X																
EMP									X															
IMH										X														
Welding – Level 1																								
WSM			X		X	X										X								
OCM			X		X	X					X													
PAC			X		X	X				X									X					
A-CAC			X		X	X														X				
BMP			X		X	X										X								
WQM			X				X									X		X						
SES			X									X												
SEM			X										X											
SBF			X									X		X										
JFA			X													X	X							
SGW			X									X			X	X					X			
SOR			X									X			X	X						X		
Welding – Level 2																								
WWS							X									X								
WDD							X									X								
PPM			X													X								
HTM			X													X								
GFE			X		X	X																	X	
GFP			X		X	X																	X	
FFP			X		X	X																	X	
GTE			X		X	X																		X
GTP			X		X	X																		X

National Center for Construction Education and Research (NCCER) - National Craft Assessment and Certification Program – Level Test Specifications

NCCER Core 6th Edition

1. BFC – Build Your Future in Construction (00100)
2. BSM - Basic Safety (00101)
3. ICM - Introduction to Construction Math (00102)
4. IHT - Introduction to Hand Tools (00103)
5. IPT - Introduction to Power Tools (00104)
6. BLU - Introduction to Construction Drawings (00105)
7. COM - Basic Communication Skills (00107)

8. EMP - Basic Employability Skills (00108)
9. IMH - Introduction to Materials Handling (00109)

Welding Level 1 5th Edition

1. WSM - Welding Safety (29101)
2. OCM - Oxyfuel Cutting (29102)
3. PAC - Plasma Arc Cutting (29103)
4. A-CAC - Air Carbon Arc Cutting and Gouging (29104)
5. BMP - Base Metal Preparation (29105)
6. WQM - Weld Quality (29106)
7. SES - SMAW - Equipment and Setup (29107)
8. SEM - SMAW Electrodes (29108)
9. SBF - SMAW - Beads and Fillet Welds (29109)
10. JFA - Joint Fit-Up and Alignment (29110)
11. SGW - SMAW - Groove Welds with Backing (29111)
12. SOR - SMAW - Open Root Groove Welds-Plate (29112)

Welding Level 2 5th Edition

1. WWS - Welding Symbols (29201)
2. WDD - Reading Welding Detail Drawings (29202)
3. PPM - Physical Characteristics and Mechanical Properties of Metals (29203)
4. HTM - Preheating and Post-weld Heat Treatment of Metal (29204)
5. GFE - GMAW AND FCAW: Equipment and Filler Metals (29205)
6. GFP - GMAW Plate (29209)
7. FFP -FCAW Plate (29210)
8. GTE - GTAW: Equipment and Filler Metals (29207)
9. GTP - GTAW - Plate (29208)

Appendix B: American Welding Society (AWS) S.E.N.S.E. EG2.0 Guidelines

	Units	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Standards																								
OO		X						X	X						X									
SHW			X		X	X				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
DWS							X				X	X	X	X	X	X	X	X	X	X	X	X	X	X
SMA																					X	X		
GMA																							X	
FCA																							X	
GTA																								X
TCP																	X							
MAO											X													
MEO											X													
MPA																			X					
MAC																				X				
WIT																		X	X	X	X	X	X	X

American Welding Society (AWS) S.E.N.S.E. EG2.0 Guidelines

AWS SENSE Guidelines

1. OO Occupational Orientation
2. SHW Safety and Health of Welders
3. DWS Drawing and Welding Symbol Interpretation
4. SMA Shielded Metal Arc Welding
5. GMA Gas Metal Arc Welding
6. FCA Flux Cored Arc Welding
7. GTA Gas Tungsten Arc Welding
8. TCP Thermal Cutting Process
9. MAO Unit 1 Manual Oxyfuel Gas Cutting (OFC)
10. MEO Unit 2 Mechanized Oxyfuel Gas Cutting (OFC)
11. MPA Unit 3 Manual Plasma Arc Cutting—PAC
12. MAC Unit 4 Manual Air Carbon Arc Cutting
13. WIT Welding Inspection and Testing

Appendix C: College and Career Ready Standards – Mathematics (8th Grade, Algebra I, Geometry, and Algebra II)

	Units	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Mathematics Standards																								
8th Grade																								
8.NS.1				X							X								X	X				
8.NS.2				X							X								X	X				
8.EE.1				X								X	X	X							X	X	X	X
8.EE.2				X								X	X	X							X	X	X	X
8.EE.3				X								X	X	X							X	X	X	X
8.EE.4				X								X	X	X							X	X	X	X
8.EE.5							X										X							X
8.EE.6							X										X							X
8.EE.7												X	X	X							X	X	X	X
8.EE.8												X	X	X							X	X	X	X
8.F.1																							X	X
8.F.2																							X	X
8.F.3																							X	X
8.F.4																							X	X
8.F.5																							X	X
8.G.1																	X							X
8.G.2																	X							X
8.G.3																	X							X
8.G.4																	X							X
8.G.5																	X							X
8.G.6																	X							X
8.G.7																	X							X
8.G.8																	X							X
8.G.9																							X	X
8.SP.1																							X	X
8.SP.2																							X	X
8.SP.3																							X	X
8.SP.4				X							X								X	X				
Algebra I																								
N-RN.3																								
N-Q.1				X	X	X	X		X	X	X	X	X	X		X	X	X	X	X	X	X	X	X
N-Q.2				X	X	X	X		X	X	X	X	X	X		X	X	X	X	X	X	X	X	X
N-Q.3				X	X	X	X		X	X	X	X	X	X		X	X	X	X	X	X	X	X	X
A-SSE.1				X			X																	
A-SSE.2																								
A-SSE.3																								
A-APR.1																								
A-APR.3																								
A-CED.1				X	X	X	X		X	X	X	X	X	X		X	X	X	X	X	X	X	X	X
A-CED.2				X	X	X	X		X	X	X	X	X	X		X	X	X	X	X	X	X	X	X
A-CED.3				X	X	X	X		X	X	X	X	X	X		X	X	X	X	X	X	X	X	
A-CED.4					X		X																	X
A-REI.1																								
A-REI.3																								
A-REI.4																					X	X		
A-REI.5																								
A-REI.6																								
A-REI.10																							X	X
A-REI.11																							X	X
A-REI.12																								
F-IF.1							X																	
F-IF.2							X																	

F-IF.3							X																
F-IF.4							X																
F-IF.5							X																
F-IF.6							X																
F-IF.7							X															X	X
F-IF.8							X																
F-IF.9							X																
F-BF.1																							
F-BF.3																							
F-LE.1																							
F-LE.2				X																		X	X
F-LE.5							X		X														
S-ID.1							X		X														
S-ID.2							X		X													X	X
S-ID.3							X		X														
S-ID.5							X		X														
S-ID.6							X		X													X	X
S-ID.7							X		X														
S-ID.8							X		X														
S-ID.9							X		X													X	X
Geometry																							
G-CO.1							X				X	X	X	X		X	X	X	X	X	X	X	X
G-CO.2							X				X	X	X	X		X	X	X	X	X	X	X	X
G-CO.3							X				X	X	X	X		X	X	X	X	X	X	X	X
G-CO.4							X										X						
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																							
G-SRT.1							X				X	X	X	X		X	X	X	X	X	X	X	X
G-SRT.2							X				X	X	X	X		X	X	X	X	X	X	X	X
G-SRT.3							X				X	X	X	X		X	X	X	X	X	X	X	X
G-SRT.4							X				X	X	X	X		X	X	X	X	X	X	X	X
G-SRT.5							X				X	X	X	X		X	X	X	X	X	X	X	X
G-SRT.6							X				X	X	X	X		X	X	X	X	X	X	X	X
G-SRT.7							X																
G-SRT.8																							
G-C.1																							
G-C.2																							
G-C.3																							
G-C.5																							
G-GPE.1							X										X						
G-GPE.4							X										X						
G-GPE.5							X										X						
G-GPE.6							X										X						
G-GPE.7																							
G-GMD.1																							
G-GMD.3																							
G-GMD.4																							
G-MG.1							X										X						
G-MG.2																							
G-MG.3							X										X						
Algebra II																							
N-RN.1																							
N-RN.2				X																			
N-Q.2				X			X																
N-CN.1																							
N-CN.2																							
N-CN.7																							
A-SSE.2																							

A-SSE.3																						X	X
A-SSE.4																							
A-APR.2																							
A-APR.3																							
A-APR.4																							
A-APR.6																							
A-CED.1				X			X		X	X	X	X	X	X		X	X	X	X	X	X	X	X
A-CED.2				X			X		X	X	X	X	X	X		X	X	X	X	X	X	X	X
A-CED.3																							X
A-REI.1																							
A-REI.2																				X	X		
A-REI.4																							
A-REI.6																							
A-REI.7																						X	X
A-REI.11																							
F-IF.3																							
F-IF.4				X			X															X	X
F-IF.6							X															X	X
F-IF.7							X															X	X
F-IF.8							X															X	X
F-IF.9				X																		X	X
F-BF.1				X																		X	X
F-BF.2																						X	X
F-BF.3																						X	X
F-BF.4				X																		X	X
F-LE.2				X																		X	X
F-LE.3				X																		X	X
F-LE.4				X																		X	X
F-LE.5																						X	X
F-TF.1																						X	X
F-TF.2							X															X	X
G-GPE.2																						X	X
S-ID.4																						X	X
S-ID.6																						X	X
S-IC.1																						X	X
S-IC.2																						X	X
S-IC.3																						X	X
S-IC.4																						X	X
S-IC.5																						X	X
S-IC.6																						X	X
S-CP.1																						X	X
S-CP.2																						X	X
S-CP.3																						X	X
S-CP.4																						X	X
S-CP.5																						X	X
S-CP.6																						X	X
S-CP.7				X							X								X	X			

2016 Mississippi College- and Career- Readiness Standards for Mathematics: Grade 8

NS The Number System

Know that there are numbers that are not rational, and approximate them by rational numbers

1. Know that numbers that are not rational are called irrational. Understand informally that every number has a decimal expansion; for rational numbers show that the decimal expansion repeats eventually and convert a decimal expansion which repeats eventually into a rational number.
2. Use rational approximations of irrational numbers to compare the size of irrational numbers, locate them approximately on a number line diagram, and estimate the value of expressions (e.g., rr^2). For example, by truncating the

decimal expansion of ✓2, show that ✓2 is between 1 and 2, then between 1.4 and 1.5, and explain how to continue on to get better approximations.

EE Expressions and Equations

Work with radicals and integer exponents.

1. Know and apply the properties of integer exponents to generate equivalent numerical expressions. For example, $3^2 \times 3^{-5} = 3^{-3} = 1/3^3 = 1/27$.
2. Use square root and cube root symbols to represent solutions to equations of the form $x^2 = p$ and $x^3 = p$, where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that ✓2 is irrational.
3. Use numbers expressed in the form of a single digit times an integer power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other. For example, estimate the population of the United States as 3×10^8 and the population of the world as 7×10^9, and determine that the world population is more than 20 times larger.
4. Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology.

Understand the connections between proportional relationships, lines, and linear equations.

5. Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed.
6. Use similar triangles to explain why the slope m is the same between any two distinct points on a non-vertical line in the coordinate plane; derive the equation $y = mx$ for a line through the origin and the equation $y = mx + b$ for a line intercepting the vertical axis at b.

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

7. Solve linear equations in one variable.
    a. Give examples of linear equations in one variable with one solution, infinitely many solutions, or no solutions. Show which of these possibilities is the case by successively transforming the given equation into simpler forms, until an equivalent equation of the form $x = a$, $a = a$, or $a = b$ results (where a and b are different numbers).
    b. Solve linear equations and inequalities with rational number coefficients, including those whose solutions require expanding expressions using the distributive property and collecting like terms.
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.

F Functions

Define, evaluate, and compare functions.

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.
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.
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 $A = s^2$ 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.

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.
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.

G Geometry

Understand congruence and similarity using physical models, transparencies, or geometry software.

1. Verify experimentally the properties of rotations, reflections, and translations
   a. Lines are taken to lines, and line segments to line segments of the same length.
   b. Angles are taken to angles of the same measure.
   c. Parallel lines are taken to parallel lines.
2. Understand that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections, and translations; given two congruent figures, describe a sequence that exhibits the congruence between them.
3. Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates.

4. Understand that a two-dimensional figure is similar to another if the second can be obtained from the first by a sequence of rotations, reflections, translations, and dilations; given two similar two-dimensional figures, describe a sequence that exhibits the similarity between them.
5. Use informal arguments to establish facts about the angle sum and exterior angle of triangles, about the angles created when parallel lines are cut by a transversal, and the angle-angle criterion for similarity of triangles. For example, arrange three copies of the same triangle so that the sum of the three angles appears to form a line, and give an argument in terms of transversals why this is so.

Understand and apply the Pythagorean Theorem

6. Explain a proof of the Pythagorean Theorem and its converse.
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. Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.

Solve real-world and mathematical problems involving volume of cylinders, cones, and spheres.

9. Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.

SP Statistics and Probability

Investigate patterns of association in bivariate data

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.
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.
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.
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?

2016 Mississippi College- and Career- Readiness Standards for Mathematics: High School—Algebra I

Number and Quantity

RN The Real Number System

Use properties of rational and irrational numbers

3. Explain why:
   a. the sum or product of two rational numbers is rational.
   b. the sum of a rational number and an irrational number is irrational; and
   c. the product of a nonzero rational number and an irrational number is irrational.

Q Quantities

Reason quantitatively and use units to solve problems.

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.
2. Define appropriate quantities for the purpose of descriptive modeling. [Refer to the Quantities section of the High School Number and Quantity Conceptual Category in the previous pages of this document.]
3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

Algebra

SSE Seeing Structure in Expressions

Interpret the structure of expressions

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.
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.

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.

APR Arithmetic with Polynomials and Rational Expressions

Perform arithmetic operations on polynomials

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

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 (limit to 1st- and 2nd- degree polynomials).

CED Creating Equations

Create equations that describe numbers or relationships

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.
2. Create equations in two variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. [Note this standard appears in future courses with a slight variation in the standard language.]
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.
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.

REI Reasoning with Equations and Inequalities

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

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

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

Solve systems of equations

5. Given a system of two equations in two variables, show and explain why the sum of equivalent forms of the equations produces the same solution as the original system.
6. Solve systems of linear equations algebraically, exactly, and graphically while focusing on pairs of linear equations in two variables.

Represent and solve equations and inequalities graphically

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).
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, quadratic, absolute value, and exponential functions.

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

IF Interpreting Functions

Understand the concept of a function and use function notation

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).
2. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.
3. Recognize that sequences are functions whose domain is a subset of the integers.

Interpret functions that arise in applications in terms of the context

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.
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.
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

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 functions (linear and quadratic) and show intercepts, maxima, and minima.
    b. Graph square root and piecewise-defined functions, including absolute value functions.
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.
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.

BF Building Functions

Build a function that models a relationship between two quantities

1. Write a function that describes a relationship between two quantities.
    a. Determine an explicit expression or steps for calculation from a context.

Build new functions from existing functions

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.

LE Linear, Quadratic, and Exponential Models

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

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.
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).

Interpret expressions for functions in terms of the situation they model

5. Interpret the parameters in a linear or exponential function in terms of a context.

Statistics and Probability

ID Interpreting Categorical and Quantitative Data

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

1. Represent and analyze data with plots on the real number line (dot plots, histograms, and box plots).
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.
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

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.
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

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

2016 Mississippi College- and Career- Readiness Standards for Mathematics: High School - Geometry

Geometry

CO Congruence

Experiment with transformations in the plane

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.
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).
3. Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.
4. Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.
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

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.
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.
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

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.
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.

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.

Make geometric constructions

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

SRT Similarity, Right Triangles, and Trigonometry

Understand similarity in terms of similarity transformations

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

Prove theorems involving similarity

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.
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

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.
7. Explain and use the relationship between the sine and cosine of complementary angles.
8. Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.

C Circles

Understand and apply theorems about circles

1. Prove that all circles are similar.

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.
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

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.

GPE Expressing Geometric Properties with Equations

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

1. 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

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, ✓3) lies on the circle centered at the origin and containing the point (0, 2).
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).
6. Find the point on a directed line segment between two given points that partitions the segment in a given ratio.
7. Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.

GMD Geometric Measurement and Dimension

Explain volume formulas and use them to solve problems

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.
3. Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.

Visualize relationships between two-dimensional and three-dimensional objects

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.

MG Modeling with Geometry

Apply geometric concepts in modeling situations

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).
2. Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).

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).

2016 Mississippi College- and Career- Readiness Standards for Mathematics: High School - Algebra II

Number and Quantity

RN The Real Number System

Extend the properties of exponents to rational exponents

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 $5^{1/3}$ to be the cube root of 5 because we want $[5^{1/3}]3 = 5^{(1/3)\ 3}$ to hold, so $[5^{1/3}]^3$ must equal 5.
2. Rewrite expressions involving radicals and rational exponents using the properties of exponents.

Q Quantities

Reason quantitatively and use units to solve problems

2. Define appropriate quantities for the purpose of descriptive modeling.

CN The Complex Number System

Perform arithmetic operations with complex numbers

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.
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

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

Algebra

SSE Seeing Structure in Expressions

Interpret the structure of expressions

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

3. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.
   a. Use the properties of exponents to transform expressions for exponential functions.
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.

APR Arithmetic with Polynomials and Rational Expressions

Understand the relationship between zeros and factors of polynomials

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).
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 (limit to 1st- and 2nd- degree polynomials).

Use polynomial identities to solve problems

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

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.

CED Creating Equations

Create equations that describe numbers or relationships

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.
2. Create equations in two or more variables to represent relationships between quantities, graph equations on coordinate axes with labels, and scales. [Note this standard appears in previous courses with a slight variation in the standard language.]
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.

REI Reasoning with Equations and Inequalities

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

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.
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

4. Solve quadratic equations in one variable.
    a. 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.

Solve systems of equations

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

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

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

IF Interpreting Functions

Understand the concept of a function and use function notation

3. Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. Interpret functions that arise in applications in terms of the context
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.
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

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 polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.
    b. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.
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 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.
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.

BF Building Functions

Build a function that models a relationship between two quantities

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.

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

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.
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.

LE Linear, Quadratic, and Exponential Models

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

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).
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.
4. For exponential models, express as a logarithm the solution to $ab^{ct} = d$ 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

5. Interpret the parameters in a linear or exponential function in terms of a context.

TF Trigonometric Functions

Extend the domain of trigonometric functions using the unit circle

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

Geometry

GPE Expressing Geometric Properties with Equations

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

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

Statistics and Probability

ID Interpreting Categorical and Quantitative Data

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

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

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.

IC Making Inferences and Justifying Conclusions

Understand and evaluate random processes underlying statistical experiments

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

3. Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.
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.
5. Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.
6. Evaluate reports based on data.

CP Conditional Probability and the Rules of Probability

Understand independence and conditional probability and use them to interpret data

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”).
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.
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.
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.

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

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.
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.