2016 Diesel Service Technician

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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.

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Standards

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

Industry Standards

National Automotive Technicians Education Foundation (NATEF) was founded in 1983 as an independent, nonprofit organization with a single mission: to evaluate technician training programs against standards developed by the transportation industry and recommend qualifying programs for certification (accreditation) by ASE, the National Institute for Automotive Service Excellence. For more information, visit http://www.natef.org. Reprinted with permission.

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 http://www.mde.k12.ms.us/MCCRS

International Society for Technology in Education Standards (ISTE)

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21st Century Skills and Information and Communication Technologies Literacy Standards

In defining 21st-century learning, the Partnership for 21st Century Skills has embraced five content and skill areas that represent the essential knowledge for the 21st century: global awareness; civic engagement; financial, economic, and business literacy; learning skills that encompass problem-solving, critical-thinking, and self-directional skills; and information and communication technology (ICT) literacy.

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: http://www.rcu.msstate.edu~~

~~Should you need additional instructions, please call 662.325.2510.~~

Executive Summary

Pathway Description

Diesel Service Technician is a pathway for students in the Transportation career cluster. This pathway is designed for students who wish to diagnose and repair the systems and components related to diesel engines. The pathway emphasizes the techniques and tools used in servicing diesel systems and components. Both theoretical learning and activity-based learning are provided for students who wish to develop and enhance their competencies and skills. The courses focus on the basic areas of diesel engine components, electrical and electronic systems, and hydraulics. Exposure to state-of-the-art equipment is given through expert advice from industry. The comprehensive project component provides practical experience toward developing a portfolio of work.

The pathway is aligned with the NATEF 2014 Medium/Heavy Truck program standards, which were retrieved October 15, 2014, from http://www.natef.org.

Industry Certification

The Diesel Service Technician pathway was written to incorporate the **National Automotive Technicians Education Foundation (NATEF)** learning objectives, content, and hours. Any student who successfully completes this pathway will be eligible to apply to obtain the ASE exams. ASE requires two years of employment before certificates are issued. Students receive one year of credit for completion of the secondary program. Students who take certifications before the two-year requirement is met will be granted certifications after they complete one year of diesel service employment. NATEF is a national certification recognized throughout the transportation service industry. Each district should implement a maximum student number due to the size of each lab.

Assessment

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

Student Prerequisites

In order 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 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 http://www.mde.k12.ms.us/educator-licensure

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

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Course Outlines

Option 1 – Four One-Carnegie-Unit Courses

This Diesel Service Technician Pathway option emphasizes industry-based content with time being allocated between lecture and lab activities. The content is aligned with National Institute for Automotive Service Excellence (ASE) standards to ensure that programs can be recommended for certification by National Automotive Technicians Educational Foundation (NATEF).

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

1. **Fundamentals of Diesel Systems and Components – Course Code: 997202**
2. **Applications of Diesel Electrical/Electronic Systems – Course Code: 997203**
3. **Theory of Diesel Engine Performance – Course Code: 997204**
4. **Advanced Skills of Diesel Auxiliary Components and Systems – Course Code: 997205**

Course Description: Fundamentals of Diesel Systems and Components
Fundamentals of Diesel Systems and Components contains information on safety, tool identification and use, employee information, estimating, service specification and service information, measurement, and personal and business finance.

Course Description: Applications of Diesel Electrical/Electronic Systems
The Electrical/Electronic Systems course contains electrical/electronic system theory, battery systems, starting systems, charging systems, concepts of gauges, warning devices, driver information systems, horn system, wiper/washer system, and accessories system diagnostic repair.

Course Description: Theory of Diesel Engine Performance
The Diesel Engine Performance course contains information on safety, employability skills, advanced diesel service, diesel engine components and theory of operation, concepts of computerized engine control systems, and ignition systems.

Course Description: Advanced Skills of Diesel Auxiliary Components and Systems
The Auxiliary Components and Systems course contains information and skills relating to hydraulics, Introductory Truck Brake Systems, Introductory Agriculture/Construction Power Train and Components, and Introductory Welding and Cutting.

Fundamentals of Diesel Systems and Components – Course Code: 997202

Unit	Unit Name	Hours
1	Fundamentals of Diesel Systems and Components	25
2	Diesel Systems, Theories, and Components	115
Total		140

Applications of Diesel Electrical/Electronic Systems – Course Code: 997203

Unit	Unit Name	Hours
3	Electrical/Electronic Systems	140
Total		140

Theory of Diesel Engine Performance – Course Code: 997204

Unit	Unit Name	Hours
4	Preventive Maintenance and Inspection	70
5	Advanced Diesel Engine Performance	70
Total		140

Advanced Skills of Diesel Auxiliary Components and Systems – Course Code: 997205

Unit	Unit Name	Hours
6	Auxiliary Components - Hydraulic Systems, Theories, and Components	70
7	Auxiliary Components - Introductory Truck Brake Systems and S/S	15
8	Auxiliary Components - Introductory Agriculture /Construction	15
9	Auxiliary Components - Introductory Welding and Cutting	40
Total		140

Option 2 – Two Two-Carnegie-Unit Courses

This Diesel Service Technician Pathway option emphasizes industry-based content with time being allocated between lecture and lab activities. The content is aligned with National Institute for Automotive Service Excellence (ASE) standards to ensure that programs can be recommended for certification by National Automotive Technicians Educational Foundation (NATEF).

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

1. **Diesel Service Technician I – Course Code: 997200**

2. **Diesel Service Technician II – Course Code: 997201**

Course Description: Diesel Service Technician I

Diesel Systems and Components contains information on safety, tool identification and use, employee information, estimating, service specification and information, measurement, and personal and business finance. It also contains Electrical/Electronic Systems content: electrical/electronic system theory, battery systems, starting systems, charging systems, concepts of gauges, warning devices, driver information systems, horn system, wiper/washer system, and accessories system diagnostic repair.

Course Description: Diesel Service Technician II

Performance course contains information on safety, employability skills, advanced diesel service, diesel engine components and theory of operation, concepts of computerized engine control systems, and ignition systems. It also contains Auxiliary Components and Systems content: information and skills relating to hydraulics, Introductory Truck Brake Systems, Introductory Agriculture/Construction Power Train and Components, and Introductory Welding and Cutting.

Diesel Service Technician I – Course Code: 997200

Unit	Unit Name	Hours
1	Fundamentals of Diesel Systems and Components	25
2	Diesel Systems, Theories, and Components	115
3	Electrical/Electronic Systems	140
Total		280

Diesel Service Technician II — Course Code: 997201

Unit	Unit Name	Hours
4	Preventive Maintenance and Inspection	70
5	Advanced Diesel Engine Performance	70
6	Auxiliary Components - Hydraulic Systems, Theories, and Components	70
7	Auxiliary Components - Introductory Truck Brake Systems and S/S	15
8	Auxiliary Components - Introductory Agriculture /Construction	15
9	Auxiliary Components - Introductory Welding and Cutting	40
Total		280

- Scheduling and operating more than one course in the same classroom/laboratory with the same teacher is not allowed.
- Students must complete the first year with a score of 80/C or higher in class work to advance to the next level.

Research Synopsis

Introduction

Diesel engines are the backbone of the American Infrastructure (Houston, 2008). Diesel engines are installed in all types of equipment that are vital to the economy of Mississippi and around the world. Some examples of these are pavers and rollers that are used to pave the roads that connect factories to distributors to consumers; semi-trucks that transport goods, cargo, and grain to local markets and ports; agriculture tractors and combines that produce the grain the world's population consumes; construction dozers and excavators that build the infrastructure; forestry skidders and log loaders of trees for furniture, lumber, and paper products; mining dump trucks and shovels for coal for electricity; railroad locomotives that transport materials and supplies across nations; and cargo ships and airplanes for transportation around the world. There are also numerous types of applications that use diesel engines: generators, boats, lawn mowers, etc.. These pieces of equipment are used to support the large equipment or are used in recreation or emergency situations. Diesel engines are an integral part of everyday life and pertinent to the global society. To keep these machines operating requires a highly skilled technician. The diesel service technician services and repairs all components to include the diesel engine, electrical/electronic systems, hydraulics, steering/suspensions, and brakes.

Needs of the Future Workforce

According to the Bureau of Labor and Statistics, employers prefer to hire high school graduates. To be prepared academically for these jobs, students need to enroll in academic courses, such as English, mathematics, and physics. For students to have a foundation in industry skills and knowledge, students should enroll in a secondary diesel technology program. The content for the secondary Diesel Service Technician program is based on the National Automotive Technician Education Foundation (NATEF) task list. NATEF and the Vocational-Technical Education Consortium of States (V-TECS) identified related academic skills that are embedded into the Medium/Heavy Truck Technician task list. These academic skills are embedded in the tasks that technicians perform. Technicians perform a wide variety of tasks: maintaining diesel engines and hydraulic systems, diagnosis and repair of electrical/electronic systems, transmission service/repair, suspension/steering components, and brake systems/components.

Data for this synopsis were compiled from the Mississippi Department of Employment Security (2014).

Table 1.1: Current and Projected Occupation Report

Description	Jobs, 2010	Projected Jobs, 2020	Change (Number)	Change (Percent)	Average Hourly Earning
Bus and Truck Mechanics and Diesel Engine Specialists	2,180	2,300	120	5.5	$17.54
Mobile Heavy Equipment Mechanics, Except Engines	980	1,040	60	6.1	$19.37

Automotive Service Technicians and Mechanics	4,280	4,450	170	4.0	$16.61
Farm Equipment Mechanics and Service Technicians	440	480	40	9.1	$16.29
Agricultural Equipment Operators	280	300	20	7.1	$12.94
Logging Equipment Operators	1,320	1,360	40	3.0	$15.67
Paving, Surfacing, and Tamping Equipment Operators	430	440	10	2.3	$14.79
Operating Engineers and Other Construction Equipment Operators	3,150	3,320	170	5.4	$16.83

Source: Mississippi Department of Employment Security; www.mdes.ms.gov (accessed August 5, 2014).

Perkins IV Requirements

Curriculum Content

Summary of Standards

The standards to be included in the Industrial Maintenance curriculum are the College and Career Ready 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 College and Career Ready Standards are designed to prep 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 http://www.mccb.edu/

Best Practices

Experiential Learning (SAE)

The Experiential Learning (SAE) has long been and continues to be the backbone of every industrial maintenance program. The experiential learning projects can be used in a variety of situations to reinforce and compliment classroom theory and content. The experiential learning project consists of entrepreneurship, placement, research/experimentation and exploratory.

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 Diesel Service Technician 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, for example, the Diesel Service Technician Teacher Learning 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 in Mississippi that will foster the types of learning expected from the Diesel Service Technician curriculum. SkillsUSA is the student's organization for Diesel Service Technician. SkillsUSA provides students with growth opportunities and competitive events. It also opens the doors to the world of transportation and scholarships opportunities.

Cooperative Learning

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

Conclusions

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

Professional Organizations

Association for Supervision and Curriculum Development (ASCD)
1703 North Beauregard Street
Alexandria, VA 22311-1714
(800) 933-ASCD
http://www.ascd.org

Association for Career and Technical Education (ACTE)
1410 King Street
Alexandria, VA 22314
(800) 826-9972
http://www.acteonline.org

Mississippi Association for Supervision and Curriculum Development (MASCD)
P.O. Box 13576
Jackson, MS 39236
(601) 591-2210
http://www.masced.com

Mississippi Department of Education (MDE)
Office of Vocational Education and Workforce Development
P.O. Box 771
Jackson, MS 39205
(601) 359-3940
http://www.mde.k12.ms.us/vocational/news/

SkillsUSA
14001 SkillsUSA Way
Leesburg, VA 20176
703-777-8810
FAX: 703-777-8999
http://www.skillsusa.org/

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.

Competencies and Suggested Objectives

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

Integrated Academic Topics, 21st Century Skills and Information and Communication Technology Literacy Standards, ACT College Readiness Standards, and Technology Standards for Students

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

References

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

Unit 1: Fundamentals of Diesel Systems and Components

Competencies and Suggested Objectives
1. Introduce, describe, and distinguish local program and vocational/career-technical center policies and procedures. DOK1, DST1, DST2, DST3, DST4 a. Describe local program and vocational/career-technical center policies and procedures including dress code, attendance, academic requirements, discipline, and the acceptable use policy for school technology, and transportation regulations. b. Compare and contrast local program policies, procedures, and expectations to industry policies, procedures, and expectations.
2. Introduce, describe, and express employment opportunities and responsibilities of the diesel service industry. DOK1, DST1, DST2, DST3, DST4 a. Introduce concepts associated with the diesel service industry; describe employment opportunities including potential earnings, employee benefits, job availability, place of employment, working conditions, and educational requirements. b. Describe basic employee responsibilities and how to communicate effectively in on-the-job situations. Identify and apply the practices that affect employer and employee decision making as it relates to identifying and applying appropriate algebraic formulas to personal finance situations, linear programming to business decisions, and algebraic formulas to personal and business investments. c. Discuss the history of the diesel service industry to include materials, terminology, and techniques. d. Research and report the computerized systems used by technicians in the diesel service industry.
3. Investigate and replicate leadership skills and personal development. DOK1, DST1, DST2, DST3, DST4 a. Demonstrate effective team-building and leadership skills. b. Model appropriate work ethics. c. Describe basic employee responsibilities. d. Design a resume and letter of application, and complete a job application. e. Demonstrate an understanding of the impact of consumer credit (advantages and disadvantages of installment loans, applying algebraic formulas to consumer credit). f. Design, collect, and apply information for planning a trip.
4. Model general safety rules for working in a shop/lab and an industry setting. DOK1, DST1, DST2, DST3, DST4 a. Explain the importance of following all safety rules and policies (report all on-the-job injuries and accidents), evacuation policy, substance abuse policy, and procedures when working near pressurized or high-temperature, and explain electrical hazards and the action to take when an electrical shock occurs when performing diesel service

operations (personal protective equipment, procedures for lifting heavy objects, and MSDS).

b. Explain the process by which fires start, fire prevention of various flammable liquids, the classes of fire, and the types of extinguishers.

c. Identify and demonstrate the safe and proper use of common hand tools.

5. Interpret and apply service specifications and information. DOK1, DST1, DST2, DST3, DST4

a. Locate and interpret service specifications and information, using both print and computerized service information references and vehicle and major component identification numbers (VIN, certification, and calibration labels).

b. Interpret and apply information to a specific job on a specific vehicle.

6. Demonstrate measurement practices used in the diesel service industry. DOK1, DST1, DST2, DST3, DST4

a. Measure the length of an object using a rule to the nearest 1/16 in. and 1 mm.

b. Identify the different types of bolts (grade, diameter, length, and thread pitch), nuts, and washers, and describe their appropriate uses.

7. Manage personal and business finances to include aspects of employer-employee decision making and consumer credit. DOK1, DST1, DST2, DST3, DST4

a. Design, analyze, and develop business finance concepts and skills.

Unit 2: Diesel, Systems, Theories, and Components

Competencies and Suggested Objectives
1. Inspect, analyze, and perform service to diesel engine systems and components. DOK3, DST1, DST2, DST3, DST4 a. Complete work order to include customer information, vehicle identifying information, customer concern, related service history, and causes and corrections; determine needed repairs. b. Identify and inspect diesel engine components and parts. c. Analyze and diagnose engine noises according to manufacturer's specifications.
2. Analyze, diagnose, and perform skills related to cylinder head and valve train. DOK3, DST1, DST2, DST3, DST4 a. Diagnose cylinder head components. b. Diagnose and perform procedures related to the valve trains. c. Inspect and repair various diesel engine components.
3. Inspect, determine correct procedures, and perform the repair technique(s) related to an engine block. DOK3, DST1, DST2, DST3, DST4 a. Diagnose various block components and the replacement/repair procedures. b. Identify and discuss factors related to block component failure. c. Identify and discuss factors related to block system failure.

Unit 3: Electrical/Electronics Systems

Competencies and Suggested Objectives
1. Identify, analyze, and perform repair procedures to general electrical systems. DOK3, DST1, DST2, DST3, DST4 a. Identify, analyze, and perform repair procedures to electrical/electronic systems and components. b. Analyze, evaluate, recommend, and perform necessary repairs to the components and systems related to the battery. c. Evaluate, recommend, and perform repair procedures as they relate to the starting system. d. Diagnose and repair charging system. e. Explore, analyze, and recommend proper repair procedures as they relate to lighting systems. f. Test and evaluate gauges and warning devices. g. Identify, evaluate, and recommend replacement or repair procedures of related electrical systems.

Unit 4: Preventive Maintenance and Inspection

Competencies and Suggested Objectives
1. Identify, evaluate, and repair engine systems and their components. DOK3, DST1, DST2, DST3, DST4 a. Identify and inspect, determine necessary action, and perform the procedure as it relates to diagnostic and repair operations to engine components. b. Identify, diagnose, recommend, and/or perform the necessary repair action as it relates to the fuel system. c. Identify, practice, and evaluate air induction and exhaust systems. d. Identify, practice, and evaluate cooling and lubrication systems.
2. Inspect, diagnose, and recommend repair procedures for components and systems related to the cab and hood. DOK 3, DST1 DST2, DST3, DST4 a. Identify and inspect; determine necessary procedures as they relate to the cab and hood. b. Identify, diagnose, and determine necessary procedures to electrical/electronic systems and components.

Unit 5: Advanced Diesel Engine Performance

Competencies and Suggested Objectives
1. Identify, inspect, determine the action, and perform the procedure as it pertains to lubrication systems, cooling systems, air induction, and exhaust systems. DOK3, DST1, DST2, DST3, DST4 a. Safety precautions, regulations, and guidelines for diesel engines. b. Analyze and demonstrate information for lubrication and cooling systems.
2. Determine failure cause(s), perform repair procedure, and evaluate procedure related to fuel systems and electronic fuel management systems. DOK3, DST1, DST2, DST3, DST4 a. Diagnose, inspect, practice, and determine necessary procedures for fuel management system maintenance and repair procedures. b. Inspect, analyze, and perform repairs related to engine brakes.

Unit 6: Auxiliary Components-Hydraulic Systems, Theories, and Components

Competencies and Suggested Objectives
1. Explore and analyze hydraulic systems, theories, and components. DOK3, DST1, DST2, DST3, DST4 a. Inspect, identify, and evaluate general hydraulic system control valves; actuators; and hoses, fittings, connections, pumps and filtration/reservoirs (tanks).

~~Unit 7: Auxiliary Components-Introductory Truck Brake System and Steering/Suspension~~

~~**Competencies and Suggested Objectives**~~
~~1. Identify and inspect truck brake systems and steering/suspension components.~~ ~~DOK2,~~ ~~DST1, DST2, DST3, DST4~~ ~~a. Identify, inspect, and analyze truck brake systems and steering/suspension components.~~

~~Unit 8: Auxiliary Components-Introductory Agriculture/Construction~~

~~**Competencies and Suggested Objectives**~~
~~1. Identify and evaluate agriculture/construction power train and components.~~ ~~DOK2, DST1, DST2, DST3, DST4~~
~~a. Inspect, identify, and diagnose agriculture/construction power trains and components.~~

Unit 9: Auxiliary Components-Introductory Welding and Cutting

Competencies and Suggested Objectives
1. Identify, perform, and analyze welding and cutting techniques. DOK2, DST1, DST2, DST3, DST4 a. Identify, analyze, and perform operations pertaining to welding.

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: Fundamentals of Diesel Systems and Components		
	1.	Introduce, describe, and distinguish local program and vocational/career-technical center policies and procedures.
	2.	Introduce, describe, and express employment opportunities and responsibilities of the diesel service industry.
	3.	Investigate and replicate leadership skills and personal development.
	4.	Model general safety rules for working in a shop/lab and an industry setting.
	5.	Interpret and apply service specifications and information.
	6.	Demonstrate measurement practices used in the diesel service industry.
	7.	Manage personal and business finances to include aspects of employer-employee decision-making and consumer credit.
Unit 2: Diesel, Systems, Theories, and Components		
	1.	Inspect, analyze, and perform service to diesel engine systems and components.
	2.	Analyze, diagnose, and perform skills related to cylinder head and valve train.
	3.	Inspect, determine correct procedures, and perform the repair technique(s) related to an engine block.
Unit 3: Electrical/Electronics Systems		
	1.	Identify, analyze, and perform repair procedures to general electrical systems.
Unit 4: Preventive Maintenance and Inspection		
	1.	Identify, evaluate, and repair engine systems and their components.
	2.	Inspect, diagnose, and recommend repair procedures for components and systems related to the cab and hood.
Unit 5: Advanced Diesel Engine Performance		
	1.	Identify, inspect, determine the action, and perform the procedure as it pertains to lubrication systems, cooling systems, air induction, and exhaust systems.
	2.	Determine failure cause(s), perform repair procedure, and evaluate procedure related to fuel systems and electronic fuel management systems.

~~Unit 6: Auxiliary Components-Hydraulic Systems, Theories, and Components~~		
	~~1.~~	~~Explore and analyze hydraulic systems, theories, and components.~~
~~Unit 7: Auxiliary Components-Introductory Truck Brake System and Steering/Suspension~~		
	~~1.~~	~~Identify and inspect truck brake systems and steering/suspension components.~~
~~Unit 8: Auxiliary Components-Introductory Agriculture/Construction~~		
	~~1.~~	~~Identify and evaluate agriculture/construction power train and components.~~
~~Unit 9: Auxiliary Components-Introductory Welding and Cutting~~		
	~~1.~~	~~Identify, perform, and analyze welding and cutting techniques.~~

Appendix A: Unit References

All of the Diesel Service Technician units use the same resources for each unit. You will find suggested resources listed below.

Journals

Association of Diesel Specialists. (n.d.) *Nozzle chatter*. Retrieved November 10, 2014, from http://www.diesel.org/

Automotive Service Association. (n.d.). *AutoInc*. Retrieved November 10, 2014, from http://www.autoinc.org/

National Institute for Automotive Service Excellence. (n.d.). *ASE blue seal news tech news*. Retrieved November 10, 2014, from http://www.ase.com

Texts

Bennett, S., & Norman, I. (2006). *Heavy duty truck systems*. Clifton Park, NY: Thomson Delmar Learning. ISBN 1-4018-7064-3 (Workbook ISBN 1-4018-7065-1 and DVD 1-4018-7066-X available)

Daines, J. (2009). *Fluid power: Hydraulics and pneumatics*. Tinley Park, IL: Delmar Goodheart-Wilcox. ISBN: 978-1-60525-081-6. (Instructor's text, student workbook, and interactive DVD available)

Huzij, R., Spano, A., & Bennett, S., (2009). *MDT: Heavy equipment systems*. Clifton Park, NY: Thomson Delmar Learning. ISBN 14238319999

Norman, A., & Corinchock, J. (2008). *Diesel technology*. Tinley Park, IL: Delmar Goodheart-Wilcox. ISBN 978-1-59070-770-8. (Instructor's text, student workbook, and interactive DVD available)

Peterson, J., & deKryer, W. (2006). *Math for the automotive trades*. Clifton Park, NY: Thomson Delmar Learning. ISBN 10: 1-4180-3101-1

Schulz, E. & Evridge, B. (2008). *Diesel Mechanics* (with workbook), 4th Ed. ISBN: 0077238788/9780077238780

Videos

Films Media Group. (1993). *Diesel cylinder head service.* (Available in CD-ROM or DVD from Films Media Group, P.O. Box 2053, Princeton, NJ 08543, 1.800.257.5126, http://www.filmsmediagroup.com/)

Films Media Group. (2005).Diesel engine teardown. (Available in CD-ROM or DVD from Films Media Group, P.O. Box 2053, Princeton, NJ 08543, 1.800.257.5126, http://www.filmsmediagroup.com/)

Web Sites

Biodiesel. (n.d.). Retrieved November 10, 2014, from http://www.biodiesel.org/

Caterpillar. (n.d.). Retrieved November 10, 2014, from http://www.cat.com/

Cummins Engine Company. (n.d.). Retrieved November 10, 2014, from http://www.cumminsengines.com/

Detroit Diesel. (n.d.). Retrieved November 10, 2014, from http://www.detoitdiesel.com/

Diesel Power. (n.d.) Retrieved November 10, 2014, from http://www.dieselpowermag.com/

How stuff works. (n.d.). Retrieved November 10, 2014, from http://www.howstuffworks.com/

John Deere. (n.d.). Retrieved November 10, 2014, from http://www.deere.com/

National Institute for Automotive Service Excellence. (n.d.). Retrieved November 10, 2014, from http://www.ase.com/

Navistar International Corporation. (n.d.). Retrieved November 10, 2014, from http://www.navistar.com/

Paccar. (n.d.). Retrieved November 10, 2014, from http://www.paccar.com/

Appendix B: Industry Standards

The Diesel Service Technician program is written to incorporate the National Automotive Technicians Education Foundation (NATEF) learning objectives, content, and hours.

Crosswalk for Diesel Service Technician										
	Units	**Unit 1**	**Unit 2**	**Unit 3**	**Unit 4**	**Unit 5**	**Unit 6**	**Unit 7**	**Unit 8**	**Unit 9**
DST1		X	X							
DST2				X						
DST3					X	X				
DST4							X	X	X	X

DST1 - Diesel Systems and Components
DST2 - Electrical/Electronic Systems
DST3 - Diesel Engine Performance
DST4 - Auxiliary Components and Systems

Appendix C: 21st Century Skills[1]

21st Century Crosswalk for Diesel Service Technician										
	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9
21st Century Standards										
CS1		X								
CS2		X								
CS3		X								
CS4		X								
CS5		X								
CS6		X	X							
CS7		X	X							
CS8		X	X							
CS9			X							
CS10			X							
CS11			X							
CS12										
CS13		X	X							
CS14		X	X	X	X	X	X	X	X	X
CS15		X	X	X	X	X	X	X	X	X
CS16		X	X	X	X	X	X	X	X	X

CSS1-21st Century Themes

CS1 Global Awareness

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

CS2 Financial, Economic, Business, and Entrepreneurial Literacy

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

CS3 Civic Literacy

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

CS4 Health Literacy

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

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

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 D: 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
RL.11.4		X	X	X	X	X	X	X	X	X
RI.11.3		X	X	X	X	X	X	X	X	X
RI.11.4		X	X	X	X	X	X	X	X	X
RI.11.7		X	X	X	X	X	X	X	X	X
RI.11.9		X	X	X	X	X	X	X	X	X
W.11.1		X	X	X	X	X	X	X	X	X
W.11.2		X	X	X	X	X	X	X	X	X
W.11.3		X	X	X	X	X	X	X	X	X
W.11.6		X	X	X	X	X	X	X	X	X
W.11.8		X	X	X	X	X	X	X	X	X
SL.11.1		X	X	X	X	X	X	X	X	X
SL.11.2		X	X	X	X	X	X	X	X	X
SL.11.3		X	X	X	X	X	X	X	X	X
SL.11.4		X	X	X	X	X	X	X	X	X
L.11.1		X	X	X	X	X	X	X	X	X
L.11.2		X	X	X	X	X	X	X	X	X
L.11.3		X	X	X	X	X	X	X	X	X

College and Career Readiness 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.

College and Career Readiness 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.

College and Career Readiness English I

Reading Informational Text Key Ideas and Details

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

Craft and Structure

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

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

Integration of Knowledge and Ideas

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

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

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

College and Career Readiness 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.

College and Career Readiness 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.

College and Career Readiness English I

W.9.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.
W.9.9 Draw evidence from literary or informational texts to support analysis, reflection, and research.
W.9.9a Apply grades 9–10 Reading standards to literature (e.g., "Analyze how an author draws on and transforms source material in a specific work [e.g., how Shakespeare treats a theme or topic from Ovid or the Bible or how a later author draws on a play by Shakespeare]").
W.9.9b Apply grades 9–10 Reading standards to literary nonfiction (e.g., "Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is valid and the evidence is relevant and sufficient; identify false statements and fallacious reasoning").

Range of Writing

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

College and Career Readiness 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.

College and Career Readiness 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.)

College and Career Readiness English I
Language
Conventions of Standard English

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

Knowledge of Language

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

Vocabulary Acquisition and Use

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

College and Career Readiness English I

L.9.4c Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning, its part of speech, or its etymology.

L.9.4d Verify the preliminary determination of the meaning of a word or phrase (e.g., by checking the inferred meaning in context or in a dictionary).

L.9.5 Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.

L.9.5a Interpret figures of speech (e.g., euphemism, oxymoron) in context and analyze their role in the text.

L.9.5b Analyze nuances in the meaning of words with similar denotations.

L.9.6 Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

College and Career Readiness 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
N-Q.3		X	X	X	X	X	X	X	X	X
A-REI.7		X	X	X	X	X	X	X	X	X
F-BF.4		X	X	X	X	X	X	X	X	X
G-CO.1			X	X		X	X	X	X	X

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 $[1.151/12] 12t \approx 1.01212t$ 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 $n \geq 1$.

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.* 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 ≥ 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, √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 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.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.

Integrated Mathematics III

Create equations that describe numbers or relationships

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

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

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

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

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

Represent and solve equations and inequalities graphically

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

Interpret functions that arise in applications in terms of the context

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

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

Analyze functions using different representations

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

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

Build new functions from existing functions

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

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

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

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

Extend the domain of trigonometric functions using the unit circle

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

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

Model periodic phenomena with trigonometric functions

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

Prove and apply trigonometric identities

F-TF.8 Prove the Pythagorean identity sin (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.

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, √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)

ISTE Crosswalk for Diesel Service Technician										
	Course	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9
ISTE Standards										
T1			X	X		X	X	X	X	X
T2		X			X					
T3		X	X		X	X				
T4			X	X		X	X	X	X	X
T5		X	X	X	X	X	X	X	X	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.

2023 Diesel Service Technician

Program CIP: 47.0605 — Diesel Mechanics Technology/Technician

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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 intellectual and professional development of Mississippi students and educators while applying knowledge and educational research to the lives of the people of the state. The RCU works within the contexts of curriculum development and revision, research, assessment, professional development, and industrial training.

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Standards

Standards and alignment crosswalks are referenced in the appendix. 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 diesel service technician curriculum is aligned to the following standards:

Automotive Service Excellence (ASE), Education Foundation Standards
The ASE Education Foundation is a nonprofit organization that evaluates and accredits entry–level automotive technology education programs against standards developed by the automotive service industry. It also develops career–readiness education for students that fuse local partnerships, rigorous standard–based education, workplace experience, and mentorship together. aseeducationfoundation.org

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
Diesel Service Technician is a pathway in the transportation career cluster. This pathway is designed for students who wish to diagnose and repair the systems and components related to diesel engines. The pathway emphasizes the techniques and tools used in servicing diesel systems and components. Both theoretical learning and activity-based learning are provided for students who wish to develop and enhance their competencies and skills. The courses focus on the following basic areas of diesel engine components: cab; brakes; suspension and steering systems; drive trains; heating, ventilation, and air conditioning (HVAC); electrical and electronic systems; and hydraulics.

College, Career, and Certifications
The Diesel Service Technician pathway is designed as a secondary program for preparation to enter the field of diesel inspection, maintenance, and minor repair. The purpose of the course is to prepare students to continue study in a postsecondary automotive repair program or to begin work as an entry-level diesel services technician. The diesel units in this curriculum are written to the National Institute for ASE Inspection, Maintenance, and Minor Repair (IMMR) credentialing standards in conjunction with the ASE Education Foundation.

Grade Level and Class Size Recommendations
It is recommended that students enter this program as 10th graders. 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. This is a classroom-based course.

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 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/curriculumdownload.

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 that should be completed in the following sequence:

1. **Fundamentals of Diesel Systems and Components—Course Code: 997202**
2. **Applications of Diesel Electrical/Electronic Systems—Course Code: 997203**
3. **Theory of Diesel Engine Performance—Course Code: 997204**
4. **Advanced Skills of Diesel Auxiliary Components and Systems—Course Code: 997205**

Course Description: Fundamentals of Diesel Systems and Components
This course contains an introduction to shop operations, safety, tools, and equipment, and preparing the vehicle for both service and the customer. The engine repair unit focuses on the overall internal combustion engine, cylinder head and valve train, and lubrication and cooling systems. It also contains an introduction to air induction, exhaust systems, and fuel systems. This is a 1-Carnegie Unit course.

Course Description: Applications of Diesel Electrical/Electronic Systems
This course contains an introduction to electrical/electronic information and terminology including electrical/electronic system theory, battery systems, starting systems, and charging systems. The electrical/electronic systems unit contains information on lighting systems, concepts of gauges, warning devices, driver information systems, battery systems and testing/charging components, and starting systems. This course also includes information for the service and maintenance to the cab and hydraulic systems and should only be taken after students successfully pass Fundamentals of Diesel Systems and Components.

Course Description: Theory of Diesel Engine Performance
This course contains a review on shop operations, safety, tools, and equipment, and preparing the vehicle for both service and the customer. Students will learn concepts on general suspension/steering theory; steering system inspection, diagnosis, and repair; concepts of steering columns, and steering pump and gear units. This course contains information related to brake systems including air brakes, hydraulic brakes, power assist systems, and wheel bearings and should only be taken after students successfully pass Applications of Diesel Electrical/Electronic Systems.

Course Description: Advanced Skills of Diesel Auxiliary Components and Systems
This course contains an introduction to the service and maintenance of drivetrain components. It also covers heating, ventilation, and engine cooling systems. In addition, it also completes the coverage of concepts regarding suspension and steering systems such as wheel alignment, wheels and tires, and frame coupling. This 1-Carnegie Unit course should only be taken after students successfully pass Theory of Diesel Engine Performance.

Fundamentals of Diesel Systems and Components — Course Code: 997202

Unit	Unit Title	Hours
1	Orientation	10
2	Workplace Employability Skills	10
3	Automotive Shop and Personal Safety	10
4	Tools and Equipment	10
5	Preparing a Vehicle for Service	10
6	Diesel Engines – General	20
7	Diesel Engines – Cylinder Head and Valve Train	10
8	Diesel Engines – Engine Block	10
9	Diesel Engines – Lubrication Systems	10
10	Diesel Engines – Cooling Systems	15
11	Diesel Engines – Air Induction and Exhaust Systems	10
12	Diesel Engines – Fuel Systems	15
Total		**140**

Applications of Diesel Electrical/Electronic Systems — Course Code: 997203

Unit	Unit Title	Hours
13	Diesel Engines – Engine Brakes	10
14	Electrical/Electronic Systems – General	25
15	Electrical/Electronic Systems – Battery System	10
16	Electrical/Electronic Systems – Starting System	10
17	Electrical/Electronic Systems – Charging System	10
18	Electrical/Electronic Systems – Lighting Systems	10
19	Electrical/Electronic Systems – Instrument Cluster and Driver Information Systems	10
20	CAB – General	10
21	CAB – Instruments and Controls	10
22	CAB – Safety Equipment	10
23	CAB – Hardware	15
24	Hydraulics – General	10
Total		**140**

Theory of Diesel Engine Performance — Course Code: 997204

Unit	Unit Title	Hours
25	Orientation – Review and Reinforcement	5
26	Brakes – General	10
27	Brakes – Air Brakes: Air Supply and Service Systems	10
28	Brakes – Air Brakes: Mechanical/Foundation Brake System	15
29	Brakes – Air Brakes: Parking Brake System	10
30	Brakes – Hydraulic Brakes: Hydraulic System	10
31	Brakes – Hydraulic Brakes: Mechanical/Foundation Brake System	10
32	Brakes – Hydraulic Brakes: Parking Brake System	10
33	Brakes – Power Assist Systems	10
34	Brakes – Vehicle Dynamic Brake Systems (Air and Hydraulic): Antilock Brake System (ABS), Automatic Traction Control (ATC) System, and Electronic Stability Control (ESC) System	10
35	Brakes – Wheel Bearings	10
36	Suspension and Steering Systems – General	10
37	Suspension and Steering Systems – Steering Column	10
38	Suspension and Steering Systems – Steering Pump and Gear Units	10
Total		**140**

Advanced Skills of Diesel Auxiliary Components and Systems — Course Code: 997205

Unit	Unit Title	Hours
39	Suspension and Steering Systems – Steering Linkage	10
40	Suspension and Steering Systems – Suspension Systems	10
41	Suspension and Steering Systems – Wheel Alignment	10
42	Suspension and Steering Systems – Wheels and Tires	10
43	Suspension and Steering Systems – Frame and Coupling Devices	10
44	Drive Train – General	10
45	Drive Train – Clutch	10
46	Drive Train – Transmission	10
47	Drive Train – Driveshaft and Universal Joints	10
48	Drive Train – Drive Axles	10
49	Heating, Ventilation, and Air Conditioning (HVAC) – General	10
50	Heating, Ventilation, and Air Conditioning (HVAC) – Refrigeration System Components	10
51	Heating, Ventilation, and Air Conditioning (HVAC) – Heating, Ventilation, and Engine Cooling Systems	10
52	Heating, Ventilation, and Air Conditioning (HVAC) – Operating Systems and Related Controls	10
Total		**140**

Option 2 — Two 2-Carnegie Unit Courses

This curriculum consists of two 2–credit courses that should be completed in the following sequence:

1. **Diesel Service Technician I—Course Code: 997200**
2. **Diesel Service Technician II—Course Code: 997201**

Course Description: Diesel Service Technician I
This course contains an introduction to shop operations, safety, tools, and equipment, and preparing the vehicle for both service and the customer. The engine repair unit focuses on the overall internal combustion engine, cylinder head and valve train, and lubrication and cooling systems. An introduction to air induction, exhaust systems, and fuel systems are included in this course. It also contains an introduction to electrical/electronic information and terminology including electrical/electronic system theory, battery systems, starting systems, and charging systems. The electrical/electronic systems unit contains information on lighting systems, concepts of gauges, warning devices, driver information systems, battery systems and testing/charging components, and starting systems. It includes information for the service and maintenance to the cab and hydraulic systems. This is a 2-Carnegie Unit course.

Course Description: Diesel Service Technician II
This course contains a review on shop operations, safety, tools, and equipment, and preparing the vehicle for both service and the customer. It contains general suspension/steering theory; steering system inspection, diagnosis, and repair; concepts of steering columns, and steering pump and gear units. Introductions to brake systems including air brakes, hydraulic brakes, power assist systems, and wheel bearings are also covered in this course. It contains an introduction to the service and maintenance of drivetrain components. Additionally, this course covers heating, ventilation, and engine cooling systems and completes the introduction of concepts regarding suspension and steering systems such as wheel alignment, wheels and tires, and frame coupling. This 2-Carnegie Unit course should only be taken after students successfully pass the diesel service technician I course.

Diesel Service Technician I — Course Code: 997200

Unit	Unit Title	Hours
1	Orientation	10
2	Workplace Employability Skills	10
3	Automotive Shop and Personal Safety	10
4	Tools and Equipment	10
5	Preparing a Vehicle for Service	10
6	Diesel Engines – General	20
7	Diesel Engines – Cylinder Head and Valve Train	10
8	Diesel Engines – Engine Block	10
9	Diesel Engines – Lubrication Systems	10
10	Diesel Engines – Cooling Systems	15
11	Diesel Engines – Air Induction and Exhaust Systems	10
12	Diesel Engines – Fuel Systems	15

13	Diesel Engines – Engine Brakes	10
14	Electrical/Electronic Systems – General	25
15	Electrical/Electronic Systems – Battery System	10
16	Electrical/Electronic Systems – Starting System	10
17	Electrical/Electronic Systems – Charging System	10
18	Electrical/Electronic Systems – Lighting Systems	10
19	Electrical/Electronic Systems – Instrument Cluster and Driver Information Systems	10
20	CAB – General	10
21	CAB – Instruments and Controls	10
22	CAB – Safety Equipment	10
23	CAB – Hardware	15
24	Hydraulics – General	10
Total		**140**

Diesel Service Technician II — Course Code: 997201

Unit	Unit Title	Hours
25	Orientation – Review and Reinforcement	5
26	Brakes – General	10
27	Brakes – Air Brakes: Air Supply and Service Systems	10
28	Brakes – Air Brakes: Mechanical/Foundation Brake System	15
29	Brakes – Air Brakes: Parking Brake System	10
30	Brakes – Hydraulic Brakes: Hydraulic System	10
31	Brakes – Hydraulic Brakes: Mechanical/Foundation Brake System	10
32	Brakes – Hydraulic Brakes: Parking Brake System	10
33	Brakes – Power Assist Systems	10
34	Brakes – Vehicle Dynamic Brake Systems (Air and Hydraulic): Antilock Brake System (ABS), Automatic Traction Control (ATC) System, and Electronic Stability Control (ESC) System	10
35	Brakes – Wheel Bearings	10
36	Suspension and Steering Systems – General	10
37	Suspension and Steering Systems – Steering Column	10
38	Suspension and Steering Systems – Steering Pump and Gear Units	10
39	Suspension and Steering Systems – Steering Linkage	10
40	Suspension and Steering Systems – Suspension Systems	10
41	Suspension and Steering Systems – Wheel Alignment	10
42	Suspension and Steering Systems – Wheels and Tires	10
43	Suspension and Steering Systems – Frame and Coupling Devices	10
44	Drive Train – General	10
45	Drive Train – Clutch	10
46	Drive Train – Transmission	10
47	Drive Train – Driveshaft and Universal Joints	10
48	Drive Train – Drive Axles	10
49	Heating, Ventilation, and Air Conditioning (HVAC) – General	10

50	Heating, Ventilation, and Air Conditioning (HVAC) – Refrigeration System Components	10
51	Heating, Ventilation, and Air Conditioning (HVAC) – Heating, Ventilation, and Engine Cooling Systems	10
52	Heating, Ventilation, and Air Conditioning (HVAC) – Operating Systems and Related Controls	10
Total		**140**

Career Pathway Outlook

Overview

Diesel engines are installed in all types of equipment that are vital to the economy of Mississippi and around the world. Some examples of these are pavers and rollers that are used to pave the roads that connect factories to distributors to consumers; semi-trucks that transport goods, cargo, and grain to local markets and ports; agriculture tractors and combines that produce the grain the world's population consumes; construction dozers and excavators that build the infrastructure; forestry skidders and log loaders of trees for furniture, lumber, and paper products; mining dump trucks and shovels for coal for electricity; railroad locomotives that transport materials and supplies across nations; and cargo ships and airplanes for transportation around the world. There are also numerous types of applications that use diesel engines: generators, boats, lawn mowers, etc. These pieces of equipment are used to support the large equipment or are used in recreation or emergency situations. Diesel engines are an integral part of everyday life and pertinent to the global society. To keep these machines operating requires a highly skilled technician. The diesel service technician services and repairs all components to include the diesel engine, electrical/electronic systems, hydraulics, steering/suspensions, and brakes.

Needs of the Future Workforce

Data for this synopsis were compiled from the Mississippi Department of Employment Security (2022). Employment opportunities for each of the occupations are listed below:

Table 1.1: Current and Projected Occupation Report

Description	Jobs, 2018	Projected Jobs, 2028	Change (Number)	Change (Percent)	Average Hourly Earnings, Year
Bus and Truck Mechanics and Diesel Engine Specialists	2,730	2,840	110	4.0%	$20.41, 2021
Mobile Heavy Equipment Mechanics, Except Engines	1,610	1,650	40	2.5%	$25.51, 2021
Farm Equipment Mechanics and Service Technicians	710	720	10	1.4%	$19.84, 2021
Agricultural Equipment Operators	860	930	70	8.1%	$11.50, 2021
Paving, Surfacing, and Tamping Equipment Operators	810	880	70	8.6%	$19.77, 2021
Operating Engineers and Other Construction Equipment Operators	2,810	3,060	250	8.9%	$18.47, 2021

Source: Mississippi Department of Employment Security; mdes.ms.gov (2022).

Perkins V Requirements and Academic Infusion

The diesel service technician curriculum meets Perkins V requirements of introducing students to and preparing them for high-skill, high-wage occupations in transportation fields. It also offers students a program of study, including secondary, postsecondary, and institutions of higher learning courses, that will further prepare them for transportation industry 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 diesel service technician 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 opportunity 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 Diesel Service Technician curriculum. SkillsUSA is an example of a student organization with many outlets for diesel services. Student organizations provide participants and members with growth opportunities and competitive events. They also open the doors to the world of diesel services technician 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 Diesel Service Technician 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 Diesel Service Technician curriculum provides opportunities for students to work together and help each other complete complex tasks. There are many field experiences within the diesel services curriculum that will allow and encourage collaboration with professionals currently in the diesel services field.

Work–Based Learning

Work-based learning (WBL) is an extension of understanding competencies taught in the diesel services technician 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. WBL should encompass ongoing and increasingly more complex involvement with local companies and industry professionals. Thus, supervised collaboration and immersion into the industry around the students are keys to students' success, knowledge, and skills development.

Professional Organizations

Association for Career and Technical Education (ACTE)
acteonline.org

Association of Diesel Specialists (ADS)
diesel.org

National Institute for Automotive Service Excellence (ASE)
aseeducationfoundation.org

SkillsUSA
skillsusa.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 Diesel Service Technician 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. It is the responsibility of the teacher to ensure all competencies for the selected quality indicator are covered throughout the year.

Unit 1: Orientation

Competencies and Suggested Objectives
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 including dress code, attendance, academic requirements, discipline, and transportation regulations.
2. Describe employment opportunities and responsibilities. DOK1 a. Describe employment opportunities including potential earnings, employee benefits, job availability, and place of employment, working conditions, and educational requirements. b. Describe basic employee responsibilities. c. Explain automotive industry pay scales including flat rate, salary, and hourly. d. Describe Automotive Service Excellence (ASE) certifications related to the automotive industry.
3. Explore leadership skills and personal development opportunities provided by the student organization SkillsUSA. DOK2 a. Demonstrate effective team building and leadership skills. b. Practice appropriate work ethics. c. Explain the purpose, mission, objectives, motto, colors, official dress, and other distinguishing characteristics of SkillsUSA. d. Explain how participation in SkillsUSA can promote lifelong responsibility for community service, professional growth, and development. e. Explore the local, state, and national opportunities available to students through participation in SkillsUSA including, but not limited to, conferences, competitions, community service, philanthropy, and other activities.

Unit 2: Workplace Employability Skills

Competencies and Suggested Objectives
1. Demonstrate the high-quality personal standards expected in the workforce. DOK1 a. Report to work on time daily, ready to take directions and demonstrate motivation to accomplish the task at hand. b. Dress appropriately and use language and manners suitable for the workplace. c. Maintain appropriate personal hygiene. d. Meet and maintain employment eligibility criteria such as drug/alcohol-free status, clean driving record, and so forth. e. Demonstrate honesty, integrity, and reliability.
2. Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations. DOK2 a. Comply with workplace policies/laws. b. Contribute to the success of the team, assist others, and request help when needed. c. Work well with all customers and coworkers. d. Negotiate solutions to interpersonal and workplace conflicts. e. Contribute ideas and demonstrate initiative. f. Follow directions. g. Communicate (written and verbally) effectively with customers and coworkers. h. Read and interpret workplace documents. Write clearly and concisely. i. Analyze and resolve problems that arise in completing assigned tasks. j. Organize and implement a productive plan of work. k. Use scientific, technical, engineering, and mathematics principles and reasoning to accomplish assigned tasks. l. Identify and address the needs of all customers. Provide helpful, courteous, and knowledgeable service and advice as needed. m. Communicate effectively with customers, colleagues, and employers to include conflict resolution.

Unit 3: Automotive Shop and Personal Safety

Competencies and Suggested Objectives
1. Identify and describe general safety rules. DOK1 a. Identify general shop safety rules and procedures. b. Utilize safe procedures for handling of tools and equipment. c. Identify and use proper placement of floor jacks and jack stands. d. Identify and use proper procedures for safe lift operation. e. Utilize proper ventilation procedures for working within the lab/shop area. f. Identify marked safety areas. g. Identify the location and the types of fire extinguishers and other fire safety equipment. h. Demonstrate knowledge of the procedures for using fire extinguishers and other fire safety equipment. i. Identify the location and use of eyewash stations. j. Identify the location of the posted evacuation routes. k. Comply with the required use of safety glasses, ear protection, gloves, and shoes during lab/shop activities. l. Identify and wear appropriate clothing for lab/shop activities. m. Secure hair and jewelry for lab/shop activities. n. Demonstrate awareness of the safety aspects of supplemental restraint systems (SRS), electronic brake control systems, and hybrid vehicle high-voltage circuits. o. Demonstrate awareness of the safety aspects of high-voltage circuits (e.g., high-intensity discharge [HID] lamps, ignition systems, injection systems, etc.). p. Locate and demonstrate knowledge of safety data sheets (SDS). q. Identify and explain the procedures for lifting heavy objects.

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 4: Tools and Equipment

Competencies and Suggested Objectives
1. Explore tools and equipment used in the automotive service industry. DOK2 a. Identify tools and their use in automotive applications. b. Identify standard and metric designation. c. Demonstrate safe handling and use of appropriate tools. d. Demonstrate proper cleaning, storage, and maintenance of tools and equipment. e. Demonstrate proper use of precision measuring tools (e.g., micrometer, dial indicator, dial caliper).

Unit 5: Preparing a Vehicle for Service

Competencies and Suggested Objectives
1. Explore the procedures for preparing a vehicle for automotive service. DOK2 a. Identify information needed and the service requested on a repair order. b. Identify purpose and demonstrate proper use of fender covers and mats. c. Demonstrate use of the three C's (i.e., concern, cause, and correction). d. Review the vehicle's service history. e. Complete a work order to include customer information, vehicle-identifying information, customer concern, related service history, problem causes, and corrections. f. Ensure the vehicle is prepared to return to customer per school/company policy (i.e., floor mats, steering wheel cover, etc.).

Unit 6: Diesel Engines – General

Competencies and Suggested Objectives
1. Inspect, analyze, and perform service to diesel engine systems and components. DOK3 a. Research vehicle service information, including fluid type, vehicle service history, service precautions, and technical service bulletins. b. Inspect level and condition of fuel, oil, diesel exhaust fluid (DEF), and coolant. c. Inspect engine assembly for fuel, oil, coolant, air, and other leaks. d. Check engine operation (starting and running), including: noise, vibration, smoke, etc. e. Use appropriate electronic service tool(s) and procedures to check, record, and clear diagnostic codes; check and record trip/operational data; reset maintenance monitor (if applicable); interpret digital multimeter (DMM) readings. f. Identify system components, configurations, and types of the following: cylinder head(s), valve train, engine block, engine lubrication, engine cooling, air induction, exhaust, fuel, and engine braking.

Note: For every task in the diesel engines competencies and suggested objectives, the following safety tasks must be strictly enforced: 1. Comply with personal and environmental safety practices associated with eye/foot/hand/hearing protection, clothing, hand tools, power equipment, lifting practices, and ventilation. 2. Handle, store, and dispose of fuels/chemicals/materials in accordance with federal, state, and local regulations.
Note: The first tasks within the diesel engines competencies and suggested objectives are as follows: listen to and verify the operator's concern, review past maintenance and repair documents, and determine necessary action.
Note: Diesel engines on engine stands that the students work with are not required to run. A vehicle with a working diesel engine could be used to complete the tasks. Some tasks could be taught by using topically relevant videos. Ideally, a running diesel vehicle would be readily available for all tasks within the diesel engine competencies and suggested objectives. If a working diesel vehicle is not available, the teacher could return to this section of the course to demonstrate these tasks once a working vehicle is becomes available.

Unit 7: Diesel Engines – Cylinder Head and Valve Train

Competencies and Suggested Objectives
1. Analyze, diagnose, and perform skills related to cylinder head and valve train. DOK3 a. Inspect electronic wiring harness and brackets for wear, bending, cracks, and looseness.

Unit 8: Diesel Engines – Engine Block

Competencies and Suggested Objectives
1. Inspect, determine correct procedures, and perform the repair technique(s) related to an engine block. DOK3 a. Inspect crankshaft vibration damper; inspect engine mounts.

Unit 9: Diesel Engines – Lubrication Systems

Competencies and Suggested Objectives
1. Identify, inspect, determine the action, and perform the procedure as it pertains to lubrication systems. DOK3 a. Test engine oil pressure and check operation of pressure sensor, gauge, and/or sending unit; test engine oil temperature and check operation of temperature sensor. b. Check engine oil level, condition, and consumption; take engine oil sample. c. Determine proper lubricant; perform oil and filter service.

Unit 10: Diesel Engines – Cooling Systems

Competencies and Suggested Objectives
1. Identify, inspect, determine the action, and perform the procedure as it pertains to cooling systems. DOK3 a. Check engine coolant type, level, condition, and test coolant for freeze protection and additive package concentration. b. Verify coolant temperature; check operation of temperature and level sensors, gauge, and/or sending unit. c. Inspect and reinstall/replace pulleys, tensioners and drive belts; adjust drive belts and check alignment. d. Recover coolant, flush, and refill with recommended coolant/additive package; bleed cooling system. e. Inspect coolant conditioner/filter assembly for leaks; inspect valves, lines, and fittings; replace as needed. f. Inspect water pump, hoses, and clamps. g. Inspect, and pressure test cooling system(s); pressure test cap, tank(s), and recovery systems; inspect radiator and mountings. h. Inspect thermostatic cooling fan system (hydraulic, pneumatic, and electronic) and fan shroud. i. Identify engine block heater(s).

Unit 11: Diesel Engines – Air Induction and Exhaust Systems

Competencies and Suggested Objectives
1. Identify, inspect, determine the action, and perform the procedure as it pertains to air induction, and exhaust systems. DOK3 a. Inspect turbocharger(s), wastegate(s), and piping systems. b. Check air induction system, including: cooler assembly, piping, hoses, clamps, and mountings; replace air filter as needed; reset restriction indicator (if applicable). c. Inspect intake manifold, gaskets, and connections. d. Inspect engine exhaust system, exhaust gas recirculation (EGR) system, and exhaust aftertreatment system for leaks, mounting, proper routing, and damaged or missing components. e. Inspect crankcase ventilation system; service as needed.

Unit 12: Diesel Engines – Fuel Systems

Competencies and Suggested Objectives
1. Identify, inspect, determine the action, and perform the procedure as it pertains to fuel systems. DOK3 a. Check fuel level and condition. b. Inspect fuel tanks, vents, caps, mounts, valves, screens, crossover system, hoses, lines, and fittings. c. Inspect low pressure fuel system components (fuel pump, pump drives, screens, fuel/water separators/indicators, hoses, lines, filters, heaters, coolers, ECM cooling plates, check valves, pressure regulator valves, restrictive fittings, and mounting hardware). d. Replace fuel filter; prime and bleed fuel system. e. Inspect high pressure fuel system components (fuel pump, pump drives, hoses, injection lines, filters, hold–downs, fittings, seals, and mounting hardware).

Unit 13: Diesel Engines – Engine Brakes

Competencies and Suggested Objectives
1. Identify and inspect engine brake systems. DOK2 a. Inspect engine compression and/or exhaust brake housing, valves, seals, lines, and fittings.

Unit 14: Electrical/Electronic Systems – General

Competencies and Suggested Objectives
1. Identify, analyze, and perform repair procedures to general electrical systems. DOK3 a. Research vehicle service information, including vehicle service history, service precautions, and technical service bulletins. b. Demonstrate knowledge of electrical/electronic series, parallel, and series–parallel circuits using principles of electricity (Ohm's Law). c. Demonstrate proper use of test equipment when measuring source voltage, voltage drop (including grounds), current flow, continuity, and resistance. d. Demonstrate knowledge of the causes and effects of shorts, grounds, opens, and resistance problems in electrical/electronic circuits. e. Use wiring diagrams to trace electrical/electronic circuits. f. Measure parasitic (key-off) battery drain. g. Demonstrate knowledge of the function, operation, and testing of fusible links, circuit breakers, relays, solenoids, diodes, and fuses. h. Inspect, repair (including solder repair), and/or replace connectors, seals, terminal ends, and wiring; verify proper routing and securement. i. Use appropriate electronic service tool(s) and procedures to check, record, and clear diagnostic codes; interpret digital multimeter (DMM) readings. j. Check for malfunctions caused by faults in the data bus communications network. k. Identify electrical/electronic system components and configuration.

Note: For every task in the electrical/electronic systems competencies and suggested objectives, the following safety tasks must be strictly enforced: 1. Comply with personal and environmental safety practices associated with eye/foot/hand/hearing protection, clothing, hand tools, power equipment, lifting practices, and ventilation. 2. Handle, store, and dispose of fuels/chemicals/materials in accordance with federal, state, and local regulations.
Note: The first tasks in the electrical/electronic systems competencies and suggested objectives are as follows: listen to and verify the operator's concern, review past maintenance and repair documents and determine necessary action.
Note: Trainers and workstations can be built to fit the needs of the course. There are many electrical trainers that can be used. Trainers can range from simple circuit construction up to and including every individual system on a diesel truck. It is recommended to begin by building or obtaining trainers for simple circuits and components.

Unit 15: Electrical/Electronic Systems – Battery System

Competencies and Suggested Objectives
1. Service and analyze battery systems. DOK3 a. Identify battery type and system configuration. b. Confirm proper battery capacity for application; perform battery state-of-charge test; perform battery capacity test, determine needed action. c. Inspect battery, battery cables, connectors, battery boxes, mounts, and hold-downs; determine needed action. d. Charge battery using appropriate method for battery type. e. Jump-start vehicle using a booster battery and jumper cables or using an appropriate auxiliary power supply. f. Identify low voltage disconnect (LVD) systems.

Unit 16: Electrical/Electronic Systems – Starting System

Competencies and Suggested Objectives
1. Inspect and analyze starting systems. DOK3 a. Demonstrate understanding of starter system operation. b. Perform starter circuit cranking voltage and voltage drop tests. c. Inspect starter control circuit switches, relays, connectors, terminals, wires, and harnesses (including over-crank protection).

Unit 17: Electrical/Electronic Systems – Charging System

Competencies and Suggested Objectives
1. Explore and analyze charging systems. DOK3 a. Identify and understand operation of the generator (alternator). b. Check instrument panel mounted voltmeters and/or indicator lamps. c. Inspect generator (alternator) drive belt condition; check pulleys and tensioners for wear; check fans and mounting brackets; verify proper belt alignment. d. Inspect cables, wires, and connectors in the charging circuit. e. Perform charging system voltage and amperage output tests; perform AC ripple test.

Unit 18: Electrical/Electronic Systems – Lighting Systems

Competencies and Suggested Objectives
1. Examine lighting systems. DOK2 a. Inspect for brighter-than-normal, intermittent, dim, or no-light operation; determine needed action. b. Test, replace, and aim headlights. c. Inspect cables, wires, and connectors in the lighting systems. d. Inspect tractor-to-trailer multi-wire connectors, cables, and holders.

Unit 19: Electrical/Electronic Systems – Instrument Cluster and Driver Information Systems

Competencies and Suggested Objectives
1. Classify instrument cluster and driver information systems. DOK2 a. Check gauge and warning indicator operation. b. Identify the sensor/sending units, gauges, switches, relays, bulbs/LEDs, wires, terminals, connectors, sockets, printed circuits, and control components/modules of the instrument cluster, driver information system, and warning systems.

Unit 20: CAB – General

Competencies and Suggested Objectives
1. Explore and analyze passenger compartment. DOK3 a. Research vehicle service information including vehicle service history, service precautions, and technical service bulletins. b. Use appropriate electronic service tool(s) and procedures to check, record, and clear diagnostic codes; check and record trip/operational data; reset maintenance monitor (if applicable); interpret digital multimeter (DMM) readings.

Note: For every task in the CAB competencies and suggested objectives, the following safety tasks must be strictly enforced: 1. Comply with personal and environmental safety practices associated with eye/foot/hand/hearing protection, clothing, hand tools, power equipment, lifting practices, and ventilation. 2. Handle, store, and dispose of fuels/chemicals/materials in accordance with federal, state, and local regulations.
Note: The first tasks in the CAB competencies and suggested objectives are as follows: listen to and verify the operator's concern, review past maintenance and repair documents, and record the condition on an appropriate document.
Note: CAB tasks within the competencies and suggested objectives must be taught using a vehicle.

Unit 21: CAB – Instruments and Controls

Competencies and Suggested Objectives
1. Analyze instruments and control systems. DOK4 a. Inspect mechanical key condition; check operation of ignition switch; check operation of indicator lights, warning lights and/or alarms; check instruments; record oil pressure and system voltage; check operation of electronic power take–off (PTO) and engine idle speed controls (if applicable). b. Check operation of all accessories. c. Understand operation of auxiliary power unit (APU)/electric power unit (EPU).

Unit 22: CAB – Safety Equipment

Competencies and Suggested Objectives
1. Examine safety equipment related to passenger compartments. DOK3 a. Check operation of horns (electric and air); check warning device operation (reverse, air pressure, etc.); check condition of spare fuses, safety triangles, fire extinguisher, and all required decals; inspect seat belts and sleeper restraints; inspect condition of wiper blades and arms.

Unit 23: CAB – Hardware

Competencies and Suggested Objectives
1. Service the components related to passenger compartment systems. DOK3 a. Check operation of wipers and washer; inspect windshield glass for cracks or discoloration; check sun visor; check seat condition, operation, and mounting; check door glass and window operation; verify operation of door and cab locks; inspect steps and grab handles; inspect mirrors, mountings, brackets, and glass. b. Record all physical damage. c. Lubricate all cab grease fittings; inspect and lubricate door and hood hinges, latches, strikers, lock cylinders, safety latches, linkages, and cables. d. Inspect cab mountings, hinges, latches, linkages, and ride height. e. Inspect quarter fender, mud flaps, and brackets.

Unit 24: Hydraulics – General

Competencies and Suggested Objectives
1. Explore and analyze hydraulic system, theories, and components. DOK3 a. Research vehicle service information, including vehicle service history, service precautions, fluid type, and technical service bulletins. b. Verify placement of equipment/component safety labels and placards; determine needed action. c. Identify hydraulic system components; locate filtration system components; service filters and breathers. d. Check fluid level and condition; take a hydraulic fluid sample for analysis. e. Inspect hoses and connections for leaks, proper routing, and proper protection; determine needed action.

Note: For every task in the hydraulics competencies and suggested objectives, the following safety tasks must be strictly enforced: 1. Comply with personal and environmental safety practices associated with eye/foot/hand/hearing protection, clothing, hand tools, power equipment, lifting practices, and ventilation. 2. Handle, store, and dispose of fuels/chemicals/materials in accordance with federal, state, and local regulations.
Note: The first tasks in the hydraulics competencies and suggested objectives are as follows: listen to and verify the operator's concern, review past maintenance and repair documents, and determine necessary action.
Note: Some of the hydraulics system tasks will need either a vehicle or piece of equipment with that includes a hydraulics system. However, a hydraulics training workstation could also be used to teach this competency.

Unit 25: Orientation – Review and Reinforcement

Competencies and Suggested Objectives
1. Examine local program and career and technical center policies and procedures. DOK3 a. Investigate local program and career and technical center policies and procedures including dress code, attendance, academic requirements, discipline, and transportation regulations.
2. Analyze employment opportunities and responsibilities. DOK3 a. Categorize employment opportunities including potential earnings, employee benefits, job availability, and place of employment, working conditions, and educational requirements. b. Point out basic employee responsibilities. c. Compare multiple automotive industry pay scales including flat rate, salary, and hourly. d. Classify ASE certifications related to the automotive industry.
3. Investigate leadership skills and personal development opportunities provided by the student organization SkillsUSA. DOK3 a. Role play effective team building and leadership skills. b. Point out appropriate work ethics. c. Reexamine the purpose, mission, objectives, motto, colors, official dress, and other distinguishing characteristics of SkillsUSA. d. Consider how participation in SkillsUSA can promote lifelong responsibility for community service, professional growth, and development. e. Investigate the local, state, and national opportunities available to students through participation in SkillsUSA including, but not limited to, conferences, competitions, community service, philanthropy, and other activities.

Unit 26: Brakes – General

Competencies and Suggested Objectives
1. Identify and interpret brake systems. DOK2 a. Research vehicle service information, including fluid type, vehicle service history, service precautions, and technical service bulletins. b. Identify brake system components and configurations (including air and hydraulic systems, parking brake, power assist, and vehicle dynamic brake systems). c. Identify brake performance problems caused by the mechanical/foundation brake system (air and hydraulic).

Note: For every task in the brakes competencies and suggested objectives, the following safety tasks must be strictly enforced: 1. Comply with personal and environmental safety practices associated with eye/foot/hand/hearing protection, clothing, hand tools, power equipment, lifting practices, and ventilation. 2. Handle, store, and dispose of fuels/chemicals/materials in accordance with federal, state, and local regulations.
Note: The first tasks in the brakes competencies and suggested objectives are as follows: listen to and verify the operator's concern, review past maintenance and repair documents, and determine necessary action.
Note: A vehicle equipped with air brakes can be used. However, air brake trainers can also be used for these tasks. The rear half of a drive axle trainer works well as a wheel end trainer. Wheel end trainers could be built or purchased to ensure the successful completion and comprehension of these tasks. Hydraulic brakes can be taught either on a vehicle equipped with hydraulic brakes or by incorporating purchased trainers along with ABS/ATC/ESC systems. Wheel bearing trainers can be easily made by obtaining older, used steering knuckles and by mounting them on a stand or in bench vice.

Unit 27: Brakes – Air Brakes: Air Supply and Service Systems

Competencies and Suggested Objectives
1. Explore and analyze air brake systems. DOK3 a. Inspect air supply system components such as compressor, governor, air drier, tanks, and lines; inspect service system components such as lines, fittings, mountings, and valves (hand brake/trailer control, brake relay, quick release, tractor protection, emergency/spring brake control/modulator, pressure relief/safety). b. Verify proper gauge operation and readings; verify low pressure warning alarm operation; perform air supply system tests such as pressure build-up, governor settings, and leakage; drain air tanks and check for contamination.

Unit 28: Brakes – Air Brakes: Mechanical/Foundation Brake System

Competencies and Suggested Objectives
1. Explore and analyze mechanical and foundation brake systems. DOK3 a. Inspect service brake chambers, diaphragms, clamps, springs, pushrods, clevises, and mounting brackets; determine needed action. b. Identify slack adjuster type; inspect slack adjusters; determine needed action. c. Check camshafts (S-cams), tubes, rollers, bushings, seals, spacers, retainers, brake spiders, shields, anchor pins, and springs; determine needed action. d. Inspect rotor and mounting surface; measure rotor thickness, thickness variation, and lateral runout; determine needed action. e. Inspect, clean, and adjust air disc brake caliper assemblies; inspect and measure disc brake pads; inspect mounting hardware; perform needed action. f. Remove brake drum; clean and inspect brake drum and mounting surface; measure brake drum diameter; measure brake lining thickness; inspect brake lining condition; determine needed action.

Unit 29: Brakes – Air Brakes: Parking Brake System

Competencies and Suggested Objectives
1. Explore and analyze parking brake systems. DOK3 a. Inspect and check parking (spring) brake chamber for leaks; determine needed action. b. Inspect and test parking (spring) brake; check valves, lines, hoses, and fittings; determine needed action. c. Inspect and test parking (spring) brake application and release valve; determine needed action. d. Manually release (cage) and reset (uncage) parking (spring) brakes.

Unit 30: Brakes – Hydraulic Brakes: Hydraulic System

Competencies and Suggested Objectives
1. Inspect and analyze hydraulic brake systems. DOK3 a. Check master cylinder fluid level and condition; determine proper fluid type for application. b. Inspect hydraulic brake system components for leaks and damage. c. Check hydraulic brake system operation including pedal travel, pedal effort, and pedal feel.

Unit 31: Brakes – Hydraulic Brakes: Mechanical/Foundation Brake System

Competencies and Suggested Objectives
1. Inspect and analyze hydraulic mechanical and foundation brake systems. DOK3 a. Inspect rotor and mounting surface; measure rotor thickness, thickness variation, and lateral runout; determine needed action. b. Inspect and clean disc brake caliper assemblies; inspect and measure disc brake pads; inspect mounting hardware; determine needed action. c. Remove brake drum; clean and inspect brake drum and mounting surface; measure brake drum diameter; measure brake lining thickness; inspect brake lining condition; inspect wheel cylinders; determine needed action.

Unit 32: Brakes – Hydraulic Brakes: Parking Brake System

Competencies and Suggested Objectives
1. Inspect and analyze hydraulic parking brake systems. DOK3 a. Check parking brake operation; inspect parking brake application and holding devices.

Unit 33: Brakes – Power Assist Systems

Competencies and Suggested Objectives
1. Inspect and analyze brake power assist systems. DOK3 a. Check brake assist/booster system (vacuum or hydraulic) hoses and control valves; check fluid level and condition (if applicable). b. Check operation of emergency (back–up/reserve) brake assist system.

Unit 34: Brakes – Vehicle Dynamic Brake Systems (Air and Hydraulic): Antilock Brake System (ABS), Automatic Traction Control (ATC) System, and Electronic Stability Control (ESC) System

Competencies and Suggested Objectives
1. Inspect and analyze Vehicle Dynamic Brake Systems (Air and Hydraulic): Antilock Brake System (ABS), Automatic Traction Control (ATC) System, and Electronic Stability Control (ESC) System. DOK2 a. Observe antilock brake system (ABS) warning light operation including trailer and dash mounted trailer ABS warning light. b. Observe automatic traction control (ATC) and electronic stability control (ESC) warning light operation.

Unit 35: Brakes – Wheel Bearings

Competencies and Suggested Objectives
1. Identify, inspect, and assemble wheel bearings. DOK3 a. Clean, inspect, lubricate, and/or replace wheel bearings and races/cups; replace seals and wear rings; inspect spindle/tube; inspect and replace retaining hardware; adjust wheel bearings; check hub assembly fluid level and condition; verify end play with dial indicator method. b. Identify, inspect, and/or replace unitized/preset hub bearing assemblies.

Unit 36: Suspension and Steering Systems – General

Competencies and Suggested Objectives
1. Identify and inspect suspension and steering systems. DOK2 a. Research vehicle service information, including fluid type, vehicle service history, service precautions, and technical service bulletins. b. Disable and enable supplemental restraint system (SRS); verify indicator lamp operation. c. Identify suspension and steering system components and configurations.

Note: For every task in the suspension and steering competencies and suggested objectives, the following safety tasks must be strictly enforced: 1. Comply with personal and environmental safety practices associated with eye/foot/hand/hearing protection, clothing, hand tools, power equipment, lifting practices, and ventilation. 2. Handle, store, and dispose of fuels/chemicals/materials in accordance with federal, state, and local regulations.
Note: The first tasks in the suspension and steering competencies and suggested objectives are as follows: listen to and verify the operator's concern, review past maintenance and repair documents, and determine necessary action.
Note: Suspension and steering tasks are ideally taught on a vehicle. However, having some older, used steering and suspension components along with tires could be helpful for students to identify and operate these components. Multiple workstations can be set up using older, used components.

Unit 37: Suspension and Steering Systems – Steering Column

Competencies and Suggested Objectives
1. Inspect steering columns. DOK3 a. Check steering wheel for free play, binding, and proper centering; inspect and service steering shaft U–joint(s), slip joint(s), bearings, bushings, and seals; phase steering shaft. b. Check operation of tilt and telescoping steering column. c. Check cab mounting.

Unit 38: Suspension and Steering Systems – Steering Pump and Gear Units

Competencies and Suggested Objectives
1. Service power steering systems. DOK3 a. Check power steering pump and gear operation, mountings, lines, and hoses; check fluid level and condition; service filter; inspect system for leaks. b. Flush and refill power steering system; purge air from system.

Unit 39: Suspension and Steering Systems – Steering Linkage

Competencies and Suggested Objectives
1. Inspect steering linkages. DOK2 a. Inspect tie rod ends, ball joints, kingpins, pitman arms, idler arms, and other steering linkage components; lubricate as needed.

Unit 40: Suspension and Steering Systems – Suspension Systems

Competencies and Suggested Objectives
1. Inspect suspension systems. DOK3 a. Inspect shock absorbers, bushings, brackets, and mounts; determine needed action. b. Inspect leaf springs, center bolts, clips, pins, bushings, shackles, U–bolts, insulators, brackets, and mounts; determine needed action. c. Inspect axle and axle aligning devices such as: radius rods, track bars, stabilizer bars, and torque arms; inspect related bushings, mounts, and shims. d. Inspect tandem suspension equalizer components. e. Inspect and test air suspension pressure regulator and height control valves, lines, hoses, dump valves, and fittings; check and record ride height. f. Inspect air springs, mounting plates, springs, suspension arms, and bushings.

Unit 41: Suspension and Steering Systems – Wheel Alignment

Competencies and Suggested Objectives
1. Explore and analyze wheel alignments. DOK2 a. Demonstrate understanding of alignment angles.

Unit 42: Suspension and Steering Systems – Wheels and Tires

Competencies and Suggested Objectives
1. Inspect and service wheel assemblies. DOK3 a. Inspect tire condition; identify tire wear patterns; measure tread depth; verify tire matching (diameter and tread); inspect valve stem and cap; set tire pressure. b. Identify wheel/tire vibration, shimmy, pounding, and hop (tramp) problems. c. Check wheel mounting hardware; check wheel condition; remove and install wheel/tire assemblies (steering and drive axle); torque fasteners to manufacturer's specification using torque wrench.

Unit 43: Suspension and Steering Systems – Frame and Coupling Devices

Competencies and Suggested Objectives
1. Inspect frame and coupling devices. DOK2 a. Inspect, service, and/or adjust fifth wheel, pivot pins, bushings, locking mechanisms, mounting hardware, air lines, and fittings. b. Inspect frame and frame members for cracks, breaks, corrosion, distortion, elongated holes, looseness, and damage. c. Inspect frame hangers, brackets, and cross members. d. Check pintle hook and mounting (if applicable).

Unit 44: Drive Train – General

Competencies and Suggested Objectives
1. Identify and inspect drive train components. DOK2 a. Research vehicle service information, including fluid type, vehicle service history, service precautions, and technical service bulletins. b. Identify drive train components, transmission type, and configuration.

Note: For every task in the drive train competencies and suggested objectives, the following safety tasks must be strictly enforced: 1. Comply with personal and environmental safety practices associated with eye/foot/hand/hearing protection, clothing, hand tools, power equipment, lifting practices, and ventilation. 2. Handle, store, and dispose of fuels/chemicals/materials in accordance with federal, state, and local regulations.
Note: The first tasks in the drive train competencies and suggested objectives are as follows: listen to and verify the operator's concern, review past maintenance and repair documents, and determine necessary action.
Note: A vehicle equipped with a complete drive train to cover these tasks would be ideal. If a vehicle is not available there are alternatives that could aid in completing the tasks. The clutch related tasks will be difficult without the availability of a vehicle. A relevant video and a service information assignment would be useful until a vehicle becomes available and a proper inspection can be performed. Most of the transmission related tasks could be taught by using an older, used transmission. The driveshaft and universal joints related tasks could be taught using an older, used driveshaft assembly. Drive axles from the rear half of an older model used truck could work well and they will need to be set up on jack stands. These can also be used for some of the brake systems related tasks.

Unit 45: Drive Train – Clutch

Competencies and Suggested Objectives
1. Identify and inspect drive train clutch components. DOK3 a. Inspect and adjust clutch, clutch brake, linkage, cables, levers, brackets, bushings, pivots, springs, and clutch safety switch (includes push-type and pull-type); check pedal height and travel; determine needed action. b. Inspect clutch master cylinder fluid level; check clutch master cylinder, slave cylinder, lines, and hoses for leaks and damage; determine needed action.

Unit 46: Drive Train – Transmission

Competencies and Suggested Objectives
1. Identify and inspect drive train transmission components. DOK3 a. Inspect transmission shifter and linkage; inspect transmission mounts, insulators, and mounting bolts. b. Inspect transmission for leakage; determine needed action. c. Replace transmission cover plates, gaskets, seals, and cap bolts; inspect seal surfaces and vents; determine needed action. d. Check transmission fluid level and condition; determine needed action. e. Inspect transmission breather; inspect transmission oil filters, coolers and related components; determine needed action. f. Inspect speedometer components. g. Inspect and test function of reverse light, neutral start, and warning device circuits.

Unit 47: Drive Train – Driveshaft and Universal Joints

Competencies and Suggested Objectives
1. Identify and inspect driveshaft and universal joint components. DOK2 a. Inspect, service, and/or replace driveshafts, slip joints, yokes, drive flanges, support bearings, universal joints, boots, seals, and retaining/mounting hardware; check phasing of all shafts.

Unit 48: Drive Train – Drive Axles

Competencies and Suggested Objectives
1. Explore and service drive axles. DOK3 a. Check for fluid leaks; inspect drive axle housing assembly, cover plates, gaskets, seals, vent/breather, and magnetic plugs. b. Check drive axle fluid level and condition; check drive axle filter; determine needed action. c. Inspect air-operated power divider (inter-axle differential) assembly including: diaphragms, seals, springs, yokes, pins, lines, hoses, fittings, and controls. d. Inspect drive axle shafts; determine needed action. e. Remove and replace wheel assembly; check rear wheel seal and axle flange for leaks; determine needed action.

Unit 49: Heating, Ventilation, and Air Conditioning (HVAC) – General

Competencies and Suggested Objectives
1. Describe heating, ventilation, and air conditioning system components. DOK2 a. Research vehicle service information, including refrigerant/oil type, vehicle service history, service precautions, and technical service bulletins. b. Identify heating, ventilation, and air conditioning (HVAC) components and configuration. c. Use appropriate electronic service tool(s) and procedures to check, record, and clear diagnostic codes; interpret digital multimeter (DMM) readings.

Note: For every task in the heating, ventilation, and air conditioning (HVAC) competencies and suggested objectives, the following safety tasks must be strictly enforced: 1. Comply with personal and environmental safety practices associated with eye/foot/hand/hearing protection, clothing, hand tools, power equipment, lifting practices, and ventilation. 2. Handle, store, and dispose of fuels/chemicals/materials in accordance with federal, state, and local regulations.
Note: The first tasks in the heating, ventilation, and air conditioning (HVAC) competencies and suggested objectives are as follows: listen to and verify the operator's concern, review past maintenance and repair documents and determine necessary action.
Note: All practices and procedures must be performed according to current mandates, standards, and regulations.
Note: Tasks related to the heating, ventilation, and air conditioning (HVAC) can be taught either on a vehicle or on a trainer.

Unit 50: Heating, Ventilation, and Air Conditioning (HVAC) – Refrigeration System Components

Competencies and Suggested Objectives
1. Examine and analyze refrigeration system components. DOK3 a. Inspect A/C compressor drive belts, pulleys, and tensioners; verify proper belt alignment. b. Check A/C system operation including system pressures; visually inspect A/C components for signs of leaks; check A/C monitoring system (if applicable). c. Inspect A/C condenser for airflow restrictions; determine needed action.

Unit 51: Heating, Ventilation, and Air Conditioning (HVAC) – Heating, Ventilation, and Engine Cooling Systems

Competencies and Suggested Objectives
1. Inspect and diagnose issues regarding heating, ventilation, and engine cooling systems. DOK3 a. Inspect engine cooling system and heater system hoses and pipes; determine needed action. b. Inspect HVAC system-heater ducts, doors, hoses, cabin filters, and outlets; determine needed action. c. Identify the source of A/C system odors.

Unit 52: Heating, Ventilation, and Air Conditioning (HVAC) – Operating Systems and Related Controls

Competencies and Suggested Objectives
1. Identify operating systems and related controls. DOK3 a. Verify blower motor operation; confirm proper air distribution; confirm proper temperature control; determine needed action.

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 career and technical center policies and procedures.
	2.	Describe employment opportunities and responsibilities.
	3.	Explore leadership skills and personal development opportunities provided by the student organization SkillsUSA.
Unit 2: Workplace Employability Skills		
	1.	Demonstrate the high-quality personal standards expected in the workforce.
	2.	Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations.
Unit 3: Automotive Shop and Personal Safety		
	1.	Identify and describe general safety rules.
Unit 4: Tools and Equipment		
	1.	Explore tools and equipment used in the automotive service industry.
Unit 5: Preparing a Vehicle for Service		
	1.	Explore the procedures for preparing a vehicle for automotive service.
Unit 6: Diesel Engines – General		
	1.	Inspect, analyze, and perform service to diesel engine systems and components.
Unit 7: Diesel Engines – Cylinder Head and Valve Train		
	1.	Analyze, diagnose, and perform skills related to cylinder head and valve train.
Unit 8: Diesel Engines – Engine Block		
	1.	Inspect, determine correct procedures, and perform the repair technique(s) related to an engine block.
Unit 9: Diesel Engines – Lubrication Systems		
	1.	Identify, inspect, determine the action, and perform the procedure as it pertains to lubrication systems.
Unit 10: Diesel Engines – Cooling Systems		
	1.	Identify, inspect, determine the action, and perform the procedure as it pertains to cooling systems.

Unit 11: Diesel Engines – Air Induction and Exhaust Systems		
	1.	Identify, inspect, determine the action, and perform the procedure as it pertains to air induction, and exhaust systems.
Unit 12: Diesel Engines – Fuel Systems		
	1.	Identify, inspect, determine the action, and perform the procedure as it pertains to fuel systems.
Unit 13: Diesel Engines – Engine Brakes		
	1.	Identify and inspect engine brake systems.
Unit 14: Electrical/Electronic Systems – General		
	1.	Identify, analyze, and perform repair procedures to general electrical systems.
Unit 15: Electrical/Electronic Systems – Battery System		
	1.	Service and analyze battery systems.
Unit 16: Electrical/Electronic Systems – Starting System		
	1.	Inspect and analyze starting systems.
Unit 17: Electrical/Electronic Systems – Charging System		
	1.	Explore and analyze charging systems.
Unit 18: Electrical/Electronic Systems – Lighting Systems		
	1.	Examine lighting systems.
Unit 19: Electrical/Electronic Systems – Instrument Cluster and Driver Information Systems		
	1.	Classify instrument cluster and driver information systems.
Unit 20: CAB – General		
	1.	Explore and analyze passenger compartment.
Unit 21: CAB – Instruments and Controls		
	1.	Analyze instruments and control systems.
Unit 22: CAB – Safety Equipment		
	1.	Examine safety equipment related to passenger compartments.
Unit 23: CAB – Hardware		
	1.	Service the components related to passenger compartment systems.
Unit 24: Hydraulics – General		
	1.	Explore and analyze hydraulic system, theories, and components.
Unit 25: Orientation – Review and Reinforcement		
	1.	Examine local program and career and technical center policies and procedures.
	2.	Analyze employment opportunities and responsibilities.
	3.	Investigate leadership skills and personal development opportunities provided by the student organization SkillsUSA.

Unit 26: Brakes – General		
	1.	Identify and interpret brake systems.
Unit 27: Brakes – Air Brakes: Air Supply and Service Systems		
	1.	Explore and analyze air brake systems.
Unit 28: Brakes – Air Brakes: Mechanical/Foundation Brake System		
	1.	Explore and analyze mechanical and foundation brake systems.
Unit 29: Brakes – Air Brakes: Parking Brake System		
	1.	Explore and analyze parking brake systems.
Unit 30: Brakes – Hydraulic Brakes: Hydraulic System		
	1.	Inspect and analyze hydraulic brake systems.
Unit 31: Brakes – Hydraulic Brakes: Mechanical/Foundation Brake System		
	1.	Inspect and analyze hydraulic mechanical and foundation brake systems.
Unit 32: Brakes – Hydraulic Brakes: Parking Brake System		
	1.	Inspect and analyze hydraulic parking brake systems.
Unit 33: Brakes – Power Assist Systems		
	1.	Inspect and analyze brake power assist systems.
Unit 34: Brakes – Vehicle Dynamic Brake Systems (Air and Hydraulic): Antilock Brake System (ABS), Automatic Traction Control (ATC) System, and Electronic Stability Control (ESC) System		
	1.	Inspect and analyze Vehicle Dynamic Brake Systems (Air and Hydraulic): Antilock Brake System (ABS), Automatic Traction Control (ATC) System, and Electronic Stability Control (ESC) System.
Unit 35: Brakes – Wheel Bearings		
	1.	Identify, inspect, and assemble wheel bearings
Unit 36: Suspension and Steering Systems – General		
	1.	Identify and inspect suspension and steering systems.
Unit 37: Suspension and Steering Systems – Steering Column		
	1.	Inspect steering columns.
Unit 38: Suspension and Steering Systems – Steering Pump and Gear Units		
	1.	Service power steering systems.
Unit 39: Suspension and Steering Systems – Steering Linkage		
	1.	Inspect steering linkages
Unit 40: Suspension and Steering Systems – Suspension Systems		
	1.	Inspect suspension systems
Unit 41: Suspension and Steering Systems – Wheel Alignment		
	1.	Explore and analyze wheel alignments.

Unit 42: Suspension and Steering Systems – Wheels and Tires		
	1.	Inspect and service wheel assemblies.
Unit 43: Suspension and Steering Systems – Frame and Coupling Devices		
	1.	Inspect frame and coupling devices.
Unit 44: Drive Train – General		
	1.	Identify and inspect drive train components.
Unit 45: Drive Train – Clutch		
	1.	Identify and inspect drive train clutch components.
Unit 46: Drive Train – Transmission		
	1.	Identify and inspect drive train transmission components.
Unit 47: Drive Train – Driveshaft and Universal Joints		
	1.	Identify and inspect driveshaft and universal joint components.
Unit 48: Drive Train – Drive Axles		
	1.	Explore and service drive axles.
Unit 49: Heating, Ventilation, and Air Conditioning (HVAC) – General		
	1.	Describe heating, ventilation, and air conditioning system components.
Unit 50: Heating, Ventilation, and Air Conditioning (HVAC) – Refrigeration System Components		
	1.	Examine and analyze refrigeration system components.
Unit 51: Heating, Ventilation, and Air Conditioning (HVAC) – Heating, Ventilation, and Engine Cooling Systems		
	1.	Inspect and diagnose issues regarding heating, ventilation, and engine cooling systems.
Unit 52: Heating, Ventilation, and Air Conditioning (HVAC) – Operating Systems and Related Controls		
	1.	Identify operating systems and related controls.

Appendix A: Industry 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	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Standards																																																				
IMMR-DE-A		X	X	X	X	X	X	X	X	X	X	X	X	X			X				X			X	X	X	X	X			X						X	X		X				X	X	X	X		X	X		
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IMMR-DE-G			X	X			X			X	X		X															X		X																	X			X	
IMMR-DE-H			X				X							X														X		X																			X		
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IMMR-TE-A		X	X	X	X	X	X	X							X	X	X	X	X	X	X				X	X	X	X			X					X	X				X		X			X		X			
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IMMR-TE-C			X	X				X							X	X	X																																			
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IMMR-CC-C			X	X						X	X																																						X	X		X	
IMMR-CC-D			X	X																																														X			X
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IMMR-TC-B			X	X											X	X	X				X	X	X														X									X					X
IMMR-TC-C			X	X											X						X	X		X													X									X					
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IMMR-HY-A		X	X	X	X	X				X															X	X	X	X			X					X	X	X	X				X	X	X	X	X	X	X	

ASE – Automotive Service Excellence Education Foundation Medium/Heavy Truck Series Standards for Inspection, Maintenance, and Minor Repair (IMMR)

IMMR-DE-A Diesel Engines (DE) - General

1. Research vehicle service information, including fluid type, vehicle service history, service precautions, and technical service bulletins. P-1

2. Inspect level and condition of fuel, oil, diesel exhaust fluid (DEF), and coolant. P-1
3. Inspect engine assembly for fuel, oil, coolant, air, and other leaks. P-1
4. Check engine operation (starting and running) including: noise, vibration, smoke, etc. P-2
5. Use appropriate electronic service tool(s) and procedures to check, record, and clear diagnostic codes; check and record trip/operational data; reset maintenance monitor (if applicable); interpret digital multimeter (DMM) readings. P-1
6. Identify system components, configurations, and types of the following: cylinder head(s), valve train, engine block, engine lubrication, engine cooling, air induction, exhaust, fuel, and engine braking. P-1

IMMR-DE-B Diesel Engines (DE) - Cylinder Head and Valve Train

1. Inspect electronic wiring harness and brackets for wear, bending, cracks, and looseness. P-1

IMMR-DE-C Diesel Engines (DE) - Engine Block

1. Inspect crankshaft vibration damper; inspect engine mounts. P-1

IMMR-DE-D Diesel Engines (DE) - Lubrication Systems

1. Test engine oil pressure and check operation of pressure sensor, gauge, and/or sending unit; test engine oil temperature and check operation of temperature sensor. P-1
2. Check engine oil level, condition, and consumption; take engine oil sample. P-1
3. Determine proper lubricant; perform oil and filter service. P-1.

IMMR-DE-E Diesel Engines (DE) - Cooling System

1. Check engine coolant type, level, condition, and test coolant for freeze protection and additive package concentration. P-1
2. Verify coolant temperature; check operation of temperature and level sensors, gauge, and/or sending unit. P-1
3. Inspect and reinstall/replace pulleys, tensioners and drive belts; adjust drive belts and check alignment. P-1
4. Recover coolant, flush, and refill with recommended coolant/additive package; bleed cooling system. P-1
5. Inspect coolant conditioner/filter assembly for leaks; inspect valves, lines, and fittings; replace as needed. P-1
6. Inspect water pump, hoses, and clamps. P-1
7. Inspect, and pressure test cooling system(s); pressure test cap, tank(s), and recovery systems; inspect radiator and mountings. P-1
8. Inspect thermostatic cooling fan system (hydraulic, pneumatic, and electronic) and fan shroud. P-1
9. Identify engine block heater(s). P-2

IMMR-DE-F Diesel Engines (DE) - Air Induction and Exhaust Systems

1. Inspect turbocharger(s), wastegate(s), and piping systems. P-2
2. Check air induction system including: cooler assembly, piping, hoses,

clamps, and mountings; replace air filter as needed; reset restriction indicator (if applicable). P-1
3. Inspect intake manifold, gaskets, and connections. P-1
4. Inspect engine exhaust system, exhaust gas recirculation (EGR) system, and exhaust aftertreatment system for leaks, mounting, proper routing, and damaged or missing components. P-1
5. Inspect crankcase ventilation system; service as needed. P-1

IMMR-DE-G **Diesel Engines (DE) - Fuel System**

1. Check fuel level and condition. P-1
2. Inspect fuel tanks, vents, caps, mounts, valves, screens, crossover system, hoses, lines, and fittings. P-1
3. Inspect low pressure fuel system components (fuel pump, pump drives, screens, fuel/water separators/indicators, hoses, lines, filters, heaters, coolers, ECM cooling plates, check valves, pressure regulator valves, restrictive fittings, and mounting hardware). P-1
4. Replace fuel filter; prime and bleed fuel system. P-1
5. Inspect high pressure fuel system components (fuel pump, pump drives, hoses, injection lines, filters, hold-downs, fittings, seals, and mounting hardware). P-1

IMMR-DE-H **Diesel Engines (DE) - Engine Brakes**

1. Inspect engine compression and/or exhaust brake housing, valves, seals, lines, and fittings. P-1

IMMR-DT-A **Drive Train (DT) - General**

1. Research vehicle service information, including fluid type, vehicle service history, service precautions, and technical service bulletins. P-1
2. Identify drive train components, transmission type, and configuration. P-1

IMMR-DT-B **Drive Train (DT) - Clutch**

1. Inspect and adjust clutch, clutch brake, linkage, cables, levers, brackets, bushings, pivots, springs, and clutch safety switch (includes push-type and pull-type); check pedal height and travel; determine needed action. P-1
2. Inspect clutch master cylinder fluid level; check clutch master cylinder, slave cylinder, lines, and hoses for leaks and damage; determine needed action. P-1

IMMR-DT-C **Drive Train (DT) - Transmission**

1. Inspect transmission shifter and linkage; inspect transmission mounts, insulators, and mounting bolts. P-1
2. Inspect transmission for leakage; determine needed action. P-1
3. Replace transmission cover plates, gaskets, seals, and cap bolts; inspect seal surfaces and vents; determine needed action. P-1
4. Check transmission fluid level and condition; determine needed action. P-1
5. Inspect transmission breather; inspect transmission oil filters, coolers and related components; determine needed action. P-2

6. Inspect speedometer components. P-2
7. Inspect and test function of REVERSE light, neutral start, and warning device circuits. P-1

IMMR-DT-D **Drive Train (DT) - Driveshaft and Universal Joints**

1. Inspect, service, and/or replace driveshafts, slip joints, yokes, drive flanges, support bearings, universal joints, boots, seals, and retaining/mounting hardware; check phasing of all shafts. P-1

IMMR- DT-E **Drive Train (DT) - Drive Axles**

1. Check for fluid leaks; inspect drive axle housing assembly, cover plates, gaskets, seals, vent/breather, and magnetic plugs. P-1
2. Check drive axle fluid level and condition; check drive axle filter; determine needed action. P-1
3. Inspect air-operated power divider (inter-axle differential) assembly including: diaphragms, seals, springs, yokes, pins, lines, hoses, fittings, and controls. P-2
4. Inspect drive axle shafts; determine needed action. P-2
5. Remove and replace wheel assembly; check rear wheel seal and axle flange for leaks; determine needed action. P-1

IMMR-TB-A **Brakes (TB) - General**

1. Research vehicle service information, including fluid type, vehicle service history, service precautions, and technical service bulletins. P-1
2. Identify brake system components and configurations (including air and hydraulic systems, parking brake, power assist, and vehicle dynamic brake systems). P-1
3. Identify brake performance problems caused by the mechanical/foundation brake system (air and hydraulic). P-1

IMMR-TB-B **Brakes (TB) - Air Brakes: Air Supply and Service Systems**

1. Inspect air supply system components such as compressor, governor, air drier, tanks, and lines; inspect service system components such as lines, fittings, mountings, and valves (hand brake/trailer control, brake relay, quick release, tractor protection, emergency/spring brake control/modulator, pressure relief/safety). P-1
2. Verify proper gauge operation and readings; verify low pressure warning alarm operation; perform air supply system tests such as pressure build-up, governor settings, and leakage; drain air tanks and check for contamination. P-1

IMMR-TB-C **Brakes (TB) - Air Brakes: Mechanical/Foundation Brake System**

1. Inspect service brake chambers, diaphragms, clamps, springs, pushrods, clevises, and mounting brackets; determine needed action. P-1
2. Identify slack adjuster type; inspect slack adjusters; determine needed action. P-1
3. Check camshafts (S-cams), tubes, rollers, bushings, seals, spacers, retainers, brake spiders, shields, anchor pins, and springs; determine needed action. P-1

4. Inspect rotor and mounting surface; measure rotor thickness, thickness variation, and lateral runout; determine needed action. P-1
5. Inspect, clean, and adjust air disc brake caliper assemblies; inspect and measure disc brake pads; inspect mounting hardware; perform needed action. P-1
6. Remove brake drum; clean and inspect brake drum and mounting surface; measure brake drum diameter; measure brake lining thickness; inspect brake lining condition; determine needed action. P-1

IMMR-TB-D **Brakes (TB) - Air brakes: Parking Brake System**

1. Inspect and check parking (spring) brake chamber for leaks; determine needed action. P-1
2. Inspect and test parking (spring) brake check valves, lines, hoses, and fittings; determine needed action. P-1
3. Inspect and test parking (spring) brake application and release valve; determine needed action. P-1
4. Manually release (cage) and reset (uncage) parking (spring) brakes. P-1

IMMR-TB-E **Brakes (TB) - Hydraulic Brakes: Hydraulic System**

1. Check master cylinder fluid level and condition; determine proper fluid type for application. P-1
2. Inspect hydraulic brake system components for leaks and damage. P-1
3. Check hydraulic brake system operation including pedal travel, pedal effort, and pedal feel. P-1

IMMR-TB-F **Brakes (TB) - Hydraulic Brakes: Mechanical/Foundation Brake System**

1. Inspect rotor and mounting surface; measure rotor thickness, thickness variation, and lateral runout; determine needed action. P-1
2. Inspect and clean disc brake caliper assemblies; inspect and measure disc brake pads; inspect mounting hardware; determine needed action. P-1
3. Remove brake drum; clean and inspect brake drum and mounting surface; measure brake drum diameter; measure brake lining thickness; inspect brake lining condition; inspect wheel cylinders; determine needed action. P-1

IMMR-TB-G **Brakes (TB) - Hydraulic Brakes: Parking Brake System**

1. Check parking brake operation; inspect parking brake application and holding devices. P-1

IMMR-TB-H **Brakes (TB) - Power Assist Systems**

1. Check brake assist/booster system (vacuum or hydraulic) hoses and control valves; check fluid level and condition (if applicable). P-1
2. Check operation of emergency (back-up/reserve) brake assist system. P-1

IMMR-TB-I **Brakes (TB) - Vehicle Dynamic Brake Systems (Air and Hydraulic): Antilock Brake System (ABS), Automatic Traction Control (ATC) System, and Electronic Stability Control (ESC) System**

1. Observe antilock brake system (ABS) warning light operation including trailer and dash mounted trailer ABS warning light. P-1
2. Observe automatic traction control (ATC) and electronic stability control (ESC) warning light operation. P-2

IMMR-TB-J **Brakes (TB) - Wheel Bearings**

1. Clean, inspect, lubricate, and/or replace wheel bearings and races/cups; replace seals and wear rings; inspect spindle/tube; inspect and replace retaining hardware; adjust wheel bearings; check hub assembly fluid level and condition; verify end play with dial indicator method. P-1
2. Identify, inspect, and/or replace unitized/preset hub bearing assemblies. P-2

IMMR-TS-A **Suspension and Steering (TS) - General**

1. Research vehicle service information, including fluid type, vehicle service history, service precautions, and technical service bulletins. P-1
2. Disable and enable supplemental restraint system (SRS); verify indicator lamp operation. P-1
3. Identify suspension and steering system components and configurations. P-1

IMMR-TS-B **Suspension and Steering (TS) - Steering Column**

1. Check steering wheel for free play, binding, and proper centering; inspect and service steering shaft U-joint(s), slip joint(s), bearings, bushings, and seals; phase steering shaft. P-1
2. Check operation of tilt and telescoping steering column. P-1
3. Check cab mounting. P-2

IMMR-TS-C **Suspension and Steering (TS) - Steering Pump and Gear Units**

1. Check power steering pump and gear operation, mountings, lines, and hoses; check fluid level and condition; service filter; inspect system for leaks. P-1
2. Flush and refill power steering system; purge air from system. P-2

IMMR-TS-D **Suspension and Steering (TS) - Steering Linkage**

1. Inspect tie rod ends, ball joints, kingpins, pitman arms, idler arms, and other steering linkage components; lubricate as needed. P-1

IMMR-TS-E **Suspension and Steering (TS) - Suspension Systems**

1. Inspect shock absorbers, bushings, brackets, and mounts; determine needed action. P-1
2. Inspect leaf springs, center bolts, clips, pins, bushings, shackles, U-bolts, insulators, brackets, and mounts; determine needed action. P-1
3. Inspect axle and axle aligning devices such as: radius rods, track bars, stabilizer bars, and torque arms; inspect related bushings, mounts, and shims. P-1
4. Inspect tandem suspension equalizer components. P-3
5. Inspect and test air suspension pressure regulator and height control valves, lines, hoses, dump valves, and fittings; check and record ride height. P-1

6. Inspect air springs, mounting plates, springs, suspension arms, and bushings. P-1

IMMR-TS-F **Suspension and Steering (TS) - Wheel Alignment**

1. Demonstrate understanding of alignment angles. P-3

IMMR-TS-G **Suspension and Steering (TS) - Wheels and Tires**

1. Inspect tire condition; identify tire wear patterns; measure tread depth; verify tire matching (diameter and tread); inspect valve stem and cap; set tire pressure. P-1
2. Identify wheel/tire vibration, shimmy, pounding, and hop (tramp) problems. P-2
3. Check wheel mounting hardware; check wheel condition; remove and install wheel/tire assemblies (steering and drive axle); torque fasteners to manufacturer's specification using torque wrench. P-1

IMMR-TS-H **Suspension and Steering (TS) - Frame and Coupling Devices**

1. Inspect, service, and/or adjust fifth wheel, pivot pins, bushings, locking mechanisms, mounting hardware, air lines, and fittings. P-1
2. Inspect frame and frame members for cracks, breaks, corrosion, distortion, elongated holes, looseness, and damage. P-1
3. Inspect frame hangers, brackets, and cross members. P-3
4. Check pintle hook and mounting (if applicable). P-1

IMMR-TE-A **Electrical/Electronic Systems (TE) - General**

1. Research vehicle service information, including vehicle service history, service precautions, and technical service bulletins. P-1
2. Demonstrate knowledge of electrical/electronic series, parallel, and series-parallel circuits using principles of electricity (Ohm's Law). P-1
3. Demonstrate proper use of test equipment when measuring source voltage, voltage drop (including grounds), current flow, continuity, and resistance. P-1
4. Demonstrate knowledge of the causes and effects of shorts, grounds, opens, and resistance problems in electrical/electronic circuits. P-1
5. Use wiring diagrams to trace electrical/electronic circuits. P-1
6. Measure parasitic (key-off) battery drain. P-1
7. Demonstrate knowledge of the function, operation, and testing of fusible links, circuit breakers, relays, solenoids, diodes, and fuses. P-1
8. Inspect, repair (including solder repair), and/or replace connectors, seals, terminal ends, and wiring; verify proper routing and securement. P-1
9. Use appropriate electronic service tool(s) and procedures to check, record, and clear diagnostic codes; interpret digital multimeter (DMM) readings. P-2
10. Check for malfunctions caused by faults in the data bus communications network. P-2
11. Identify electrical/electronic system components and configuration. P-1

IMMR-TE-B **Electrical/Electronic Systems (TE) - Battery System**

1. Identify battery type and system configuration. P-1

2. Confirm proper battery capacity for application; perform battery state-of-charge test; perform battery capacity test, determine needed action. P-1
3. Inspect battery, battery cables, connectors, battery boxes, mounts, and hold-downs; determine needed action. P-1
4. Charge battery using appropriate method for battery type. P-1
5. Jump-start vehicle using a booster battery and jumper cables or using an appropriate auxiliary power supply. P-1
6. Identify low voltage disconnect (LVD) systems. P-2

IMMR-TE-C **Electrical/Electronic Systems (TE) - Starting System**

1. Demonstrate understanding of starter system operation. P-1
2. Perform starter circuit cranking voltage and voltage drop tests. P-1
3. Inspect starter control circuit switches, relays, connectors, terminals, wires, and harnesses (including over-crank protection). P-1

IMMR-TE-D **Electrical/Electronic Systems (TE) - Charging System**

1. Identify and understand operation of the generator (alternator). P-1
2. Check instrument panel mounted voltmeters and/or indicator lamps. P-1
3. Inspect generator (alternator) drive belt condition; check pulleys and tensioners for wear; check fans and mounting brackets; verify proper belt alignment. P-1
4. Inspect cables, wires, and connectors in the charging circuit. P-1
5. Perform charging system voltage and amperage output tests; perform AC ripple test. P-1

IMMR-TE-E **Electrical/Electronic Systems (TE) - Lighting Systems**

1. Inspect for brighter-than-normal, intermittent, dim, or no-light operation; determine needed action. P-1
2. Test, replace, and aim headlights. P-1
3. Inspect cables, wires, and connectors in the lighting systems. P-1
4. Inspect tractor-to-trailer multi-wire connectors, cables, and holders. P-1

IMMR-TE-F **Electrical/Electronic Systems (TE) - Instrument Cluster and Driver Information Systems**

1. Check gauge and warning indicator operation. P-1
2. Identify the sensor/sending units, gauges, switches, relays, bulbs/LEDs, wires, terminals, connectors, sockets, printed circuits, and control components/modules of the instrument cluster, driver information system, and warning systems. P-2

IMMR-CC-A **Heating, Ventilation, and Air Conditioning (CC) - General**

1. Research vehicle service information, including refrigerant/oil type, vehicle service history, service precautions, and technical service bulletins. P-1
2. Identify heating, ventilation, and air conditioning (HVAC) components and configuration. P-1

3. Use appropriate electronic service tool(s) and procedures to check, record, and clear diagnostic codes; interpret digital multimeter (DMM) readings. P-1

IMMR-CC-B **Heating, Ventilation, and Air Conditioning (CC) - Refrigeration System Components**

1. Inspect A/C compressor drive belts, pulleys, and tensioners; verify proper belt alignment. P-1
2. Check A/C system operation including system pressures; visually inspect A/C components for signs of leaks; check A/C monitoring system (if applicable). P-1
3. Inspect A/C condenser for airflow restrictions; determine needed action. P-1

IMMR-CC-C **Heating, Ventilation, and Air Conditioning (CC) - Heating, Ventilation, and Engine Cooling Systems**

1. Inspect engine cooling system and heater system hoses and pipes; determine needed action. P-1
2. Inspect HVAC system-heater ducts, doors, hoses, cabin filters, and outlets; determine needed action. P-1
3. Identify the source of A/C system odors. P-2

IMMR-CC-D **Heating, Ventilation, and Air Conditioning (CC) - Operating Systems and Related Controls**

1. Verify blower motor operation; confirm proper air distribution; confirm proper temperature control; determine needed action. P-1

IMMR-TC-A **CAB (TC) - General**

1. Research vehicle service information including, vehicle service history, service precautions, and technical service bulletins. P-1
2. Use appropriate electronic service tool(s) and procedures to check, record, and clear diagnostic codes; check and record trip/operational data; reset maintenance monitor (if applicable); interpret digital multimeter (DMM) readings. P-1

IMMR-TC-B **CAB (TC) - Instruments and Controls**

1. Inspect mechanical key condition; check operation of ignition switch; check operation of indicator lights, warning lights and/or alarms; check instruments; record oil pressure and system voltage; check operation of electronic power take-off (PTO) and engine idle speed controls (if applicable). P-1
2. Check operation of all accessories. P-1
3. Understand operation of auxiliary power unit (APU)/electric power unit (EPU). P-3

IMMR-TC-C **CAB (TC) - Safety Equipment**

1. Check operation of horns (electric and air); check warning device operation (reverse, air pressure, etc.); check condition of spare fuses, safety triangles, fire extinguisher, and all required decals; inspect seat belts and sleeper restraints; inspect condition of wiper blades and arms. P-1

IMMR-TC-D **CAB (TC) - Hardware**

1. Check operation of wipers and washer; inspect windshield glass for cracks or discoloration; check sun visor; check seat condition, operation, and mounting; check door glass and window operation; verify operation of door and cab locks; inspect steps and grab handles; inspect mirrors, mountings, brackets, and glass. P-1
2. Record all physical damage. P-2
3. Lubricate all cab grease fittings; inspect and lubricate door and hood hinges, latches, strikers, lock cylinders, safety latches, linkages, and cables. P-2
4. Inspect cab mountings, hinges, latches, linkages, and ride height. P-1
5. Inspect quarter fender, mud flaps, and brackets. P-1

IMMR-HY-A Hydraulics (HY) - General

1. Research vehicle service information, including vehicle service history, service precautions, fluid type, and technical service bulletins. P-3
2. Verify placement of equipment/component safety labels and placards; determine needed action. P-3
3. Identify hydraulic system components; locate filtration system components; service filters and breathers. P-3
4. Check fluid level and condition; take a hydraulic fluid sample for analysis. P-3
5. Inspect hoses and connections for leaks, proper routing, and proper protection; determine needed action. P-3