Massachusetts Department of Elementary & Secondary Education

Office for Career/Vocational Technical Education

Vocational Technical Education Framework

ଌ

Transportation Occupational Cluster

Automotive Technology (VAUTO)

CIP Code 470604

June 2014

Massachusetts Department of Elementary and Secondary Education
Office for Career/Vocational Technical Education
75 Pleasant Street, Malden, MA 02148-4906
781-338-3910
www.doe.mass.edu/cte/

This document was prepared by the
Massachusetts Department of Elementary and Secondary Education
Mitchell D. Chester, Ed.D.
Commissioner

This document printed on recycled paper

Massachusetts Department of Elementary and Secondary Education
75 Pleasant Street, Malden, MA 02148-4906
Phone 781-338-3000 TTY: N.E.T. Relay 800-439-2370
www.doe.mass.edu

Table of Contents

Acknowledgements

The Massachusetts Department of Elementary and Secondary Education, Office for Career/ Vocational Technical Education, launched the Vocational Technical Education Framework Revision Project in April 2012. This Framework is the result of that effort and of the contributions of many educators across the state. The Department of Elementary and Secondary Education wishes to thank all of the Massachusetts groups that contributed to the development of these standards and all the individual teachers, administrators, and private sector advisory committee members who provided valuable employer validation of the standards for the Automotive Technology Framework of the Transportation Occupational Cluster.

Contributors to the 2012 Automotive Technology Framework (VAUTO) Strands 2, 3 and 6:

Project Administrator:
Heidi Riccio, CTE Director, Greater Lawrence Technical High School
Dale Hollingshead, Grants Coordinator, Greater Lawrence Technical High School

Framework Team Leader:
Michael R. Ouellette, Automotive Technology Teacher, Greater Lawrence Technical High School

Technical Teachers:
John .C Mare, Old Colony Regional Vocational Technical High School
David Lucier, Peabody Veterans Memorial High School
Marc Darisse, Salem High School
Jonathan A. Yourga, Smith Vocational and Agricultural High School
Robert Vinskus, Southeastern Regional Vocational Technical High School

Academic Teachers:
Pamela Rogers, ELA Greater Lawrence Technical School
Treacy Sheilds, Math Greater Lawrence Technical School
Robert Aldape, Science Greater Lawrence Technical School

Program Advisory Members:
Peter E. Goldstein, Automotive Technician/Foreman, DeLuca Chrysler/Jeep/Dodge
Greg Marchand, President/Technician, Automotive Aftermarket Training, Inc.
Charles McAllister Jr., President/Owner/Technician, Sutton Street Service
Charles R. Pearson Jr., Special Assistant to the Dean, MassBay Community College, Automotive Technologies

Administrative Assistance:
Suzanne Ouellette, Greater Lawrence Technical High School

CVTE Frameworks Project Advisory Committee

Roger Bourgeois, Superintendent/Director
Essex Agricultural and Technical High School
Christine Shaw, Executive Director
Northeast Regional Readiness Center
Peter Dewar, Director of Professional Development
Massachusetts Association of Vocational Administrators
John McDonagh, Grants Coordinator
Southeastern Regional Vocational Technical High School

Massachusetts Department of Elementary and Secondary Education
Patricia Gregson, Associate Commissioner
Vocational, Workforce and College Readiness Programs

Office for Career/Vocational and Technical Education – Framework Revision Strands 2, 3 and 6
Lisa Sandler, Acting State Director of Career/Vocational Technical Education

Maura Russell
Lisa Weinstein
Ramona Foster
Margie Roberts
Karen DeCoster
Janice Crocker

Consultants

Dr. Frank Llamas
Maura McMahon

Contributors to the 2014 Automotive Technology Framework (VAUTO) Strands 1, 4 and 5:

Project Administrator
Thomas Hickey, Superintendent
South Shore Vocational Technical High School

Project Managers
Rebecca Buck, Northern Berkshire Vocational Regional School District
Kristin Steiner, Northern Berkshire Vocational Regional School District

MAVA Consultants
Kathy Conole Deborah DePaolo John McDonagh

Massachusetts Department of Elementary and Secondary Education
Patricia Gregson, Associate Commissioner
Vocational, Workforce and College Readiness Programs

Office for Career/Vocational and Technical Education – Framework Revision Strands 1, 4 and 5
Lisa Sandler, Massachusetts Methods of Administration Coordinator
Gary Gomes, Accountability & Monitoring Supervisor
Marnie Jain, Education Specialist

Framework Strand 1 Leader:
Michael Nixon, MassBay Community College

Team Members:
Patricia Allen, Greater New Bedford Regional Technical High School
Cheryl Bomal, Greater Lowell Technical High School
Deborah Brightman, Greater New Bedford Regional Technical High School
Martin Dooley, Lower Pioneer Valley Career and Technical Education Center
Darla Hartung, Taunton High School
Rhonda Moran, Lower Pioneer Valley Career and Technical Education Center
John Morash, Plymouth South High School
John Taylor, Greater Lowell Technical High School

Resource Experts:
Anne Gilligan, DESE-Learning Support Service, Safe and Healthy Schools Coordinator
David Edmonds, DESE-CVTE, Education Specialist
Lisa Sandler, DESE-CVTE, Massachusetts Methods of Administration Coordinator

Framework Strand 4 Leader:
Marcia Kessler, Old Colony Regional Vocational Technical High School

Team Members:
Erin Carerra, Taunton High School
Gillian Granger, Blackstone Valley Regional Vocational Technical High School
Carol Hartnett, Blue Hills Regional Technical High School
Christina Melvin, Worcester Technical High School
Cecilia Smith, Greater Lawrence Technical School
EJ Smith, Blackstone Valley Regional Vocational Technical High School
Michael Viggiano, Madison Park High School

Resource Experts:

Gary Gomes, DESE-CVTE, Accountability and Monitoring
Elizabeth Hennessy, Blackstone Valley Regional Vocational Technical High School, Dir. of Counseling
Marnie Jain, DESE-CVTE,
Judith McKinstry, Business Professionals of America Director
Lisa Sandler, DESE – CVTE, Massachusetts Methods of Administration Coordinator
Shailah Stewart, DESE - College & Career Readiness, Connecting Activities Coordinator
Karen Ward, SkillsUSA Director

Framework Strand 5 Leader:

Margaret Ellis, JP Keefe Technical High School

Team Members:

Lori Alie, Blackstone Valley Regional Vocational Technical High School
Lori Carr, Taunton High School
Barbara-jean Chauvin, Norfolk County Agricultural High School
Cheryl Hackenson, Tantasqua Regional High School
Clifford Keirstead, Whittier Regional Technical High School
Lynn McKiernan, Assabet Valley Regional Technical High School
John Oldham, Old Colony Regional Vocational Technical High School
Arlene Thompson, Worcester Technical High School

Resource Experts:

Jennifer Green, Network For Teaching Entrepreneurship Executive Director
Donna McFadden, MA DECA Director
Lisa Sandler, DESE –CVTE, Massachusetts Methods of Administration Coordinator

Massachusetts Department of Elementary and Secondary Education

75 Pleasant Street, Malden, Massachusetts 02148-4906 Telephone: (781) 338-3000
TTY: N.E.T. Relay 1-800-439-2370

Mitchell D. Chester, Ed.D.
Commissioner

July 2014

Dear Colleagues,

I am pleased to present to you the *Massachusetts Vocational Technical Education Frameworks*, adopted by the Department of Elementary and Secondary Education in June 2014. These frameworks, one for each of the 44 vocational technical programs, include standards in multiple strands representing all aspects of the industries that students in the vocational technical education program are preparing to enter.

The frameworks also include a crosswalk between the technical standards and relevant standards in Massachusetts Curriculum Frameworks to support effective integration of academic and technical content.

The comments and suggestions received during revision of the 2007 *Massachusetts Vocational Technical Education Frameworks* have strengthened these frameworks. We will continue to work with schools and districts to implement the 2014 *Massachusetts Vocational Technical Education Frameworks* over the next several years, and we encourage your comments.

I want to thank everyone who worked with us to create challenging learning standards for Massachusetts students. I am proud of the work that has been accomplished.

Sincerely,

Mitchell D. Chester, Ed.D.
Commissioner of Elementary and Secondary Education

Introduction

Overview & Organization and Key Changes

Overview

The Massachusetts Department of Elementary and Secondary Education understands the necessity of maintaining current Vocational Technical Education Frameworks which ensure career/vocational technical education students across the Commonwealth are taught the most rigorous standards aligned to the needs of business and industry.

With the advent of the Massachusetts Teaching & Learning System the Office for Career/Vocational Technical Education (CVTE) recognized the significance of including career/vocational technical education in the system and developed a comprehensive plan for including vocational technical education. The plan was designed in a Two Phase Process. Phase One included the revision of strands two, three, and six, of all of the Vocational Technical Education Frameworks. Phase Two consisted of three major components (projects) all equally crucial;

1. The revision of Strands One, Four, and Five to complete the revision of all six strands of the Vocational Technical Education Frameworks;

2. Statewide Professional Development on all revised strands, with training on strands two, three, and six delivered fall 2013, and training on strands one, four, and five delivered spring 2014;

3. The creation and development of additional Model Curriculum Unit (MCU) Teams.

The Office for Career/Vocational Technical Education Framework Team, with support from consultants, began Phase One in the 2012-2013 school year, to revise three of the six strands contained in all of the Vocational Technical Education (VTE) Frameworks. The state was organized into "Collaborative Partnerships" comprised of teams of project administrators, highly qualified subject matter educators, and business and industry partners, whose task was to revise Strand Two – Technical, Strand Three – Embedded Academics, and Strand Six – Technology Literacy. Each team met with a vocational advisory committee which included business and industry representatives and postsecondary education professionals, whose mission was to review and revise the team's draft document during the revisionary process. Once strand two was revised, academic teachers (typically one English Language Arts teacher, one Mathematics teacher, and one Science teacher) worked with the technical subject matter teachers to develop a crosswalk between academic curricula standards and the technical standards, and provided examples of embedded academic content.

The Office for Career/Vocational Technical Education solicited statewide input from technical and academic teachers and administrators at the annual Massachusetts Association of Vocational Administrators (MAVA)/Massachusetts Vocational Association (MVA) - Connecting for Success Conference. Each framework team met with their content colleagues and reviewed the draft revisions and obtained valuable feedback. Additionally, all drafts were reviewed and revised by the Massachusetts Vocational Technical Teacher Testing Program, to ensure appropriate measurable language.

Project consultants designed a new template to ensure all framework teams entered new standards and additional resources in a consistent manner. The framework teams created an "Appendix" listing potential industry recognized credentials attainable by secondary students; lists of professional, student, and relevant government organizations; and useful resources and websites. ** It is important to note that although most Framework Teams provided information for the "Appendix", not all teams did. Therefore, sub-headings within the "Appendix" without information have been deleted. Disclaimer: Reference in the Appendices Section to any specific commercial products, processes, or services, or the use of any trade, firm or corporation name is for the information and convenience of the public, and does not constitute endorsement or recommendation by the Massachusetts Department of Elementary and Secondary Education.*

The Office for Career/Vocational Technical Education facilitated a comprehensive vetting process throughout the Commonwealth. During the fall of 2012 districts throughout Massachusetts solicited feedback from each Vocational Program's Advisory Committee members at the Fall Board meetings. Additionally, the Office for Career/Vocational Technical Education met with various licensing boards at the Massachusetts Division of Professional Licensure and provided the applicable draft framework to each board for review. All framework drafts were posted on the CVTE website for public comment. Comments and suggested revisions received were shared with each framework team for response and edits, as appropriate.

The Phase I Process was completed on an accelerated timetable and resulted in all Vocational Technical Education Frameworks; Stand Two and Strand Six, revised with current, rigorous, relevant standards. Strand Three has been redesigned into a crosswalk which directly correlates academic and technical standards. An appendix of useful material for technical teachers recommended by their peers was added to each framework.

Phase II of the Framework Revision Process consisted of three major projects;

1. The Strands One, Four & Five Project, to complete the revision of all six strands of the Vocational Technical Education Frameworks;
2. Statewide Professional Development on all revised strands, with training on strands two, three, and six delivered fall 2013, and training on strands one, four, and five delivered spring 2014;
3. The creation and development of additional Model Curriculum Unit (MCU) Teams.

The Strands One, Four, & Five Project began in the fall of 2013 with the formation of a leadership team and three work groups. Co-Managers led the leadership team comprised of three Strand Coordinators who facilitated work teams and reviewed, researched, and revised these common strands. All skills specific to the vocational technical program have been included into Strand Two Technical.

The Strand One Team revised the safety knowledge and skills that all students need to acquire. The team included relevant issues (i.e., bullying, climate), laws, regulations, guidelines and policies pertaining to safety.

The Strand Four Team revised the Employability Knowledge and Skills that all students need to acquire. Teams considered current research on career readiness, including the work of the College Career Readiness Task Force convened by the Department, changes in workplace, technological changes that impact how people perform their work (i.e., communications methods), and included standards that

emphasize the need for lifelong learning and adaptability given the multiple career changes over and an individual's working life. The team recommended this strand be renamed to: Career Readiness.

The Strand Five Team revised the Management & Entrepreneurship Knowledge and Skills that all students need to acquire. All business owners and employees must possess management and financial skills to be productive members of society. Skills included financial knowledge and basic business management skills.

All Strand One, Four and Five Project Teams worked collaboratively with staff from the Department of Elementary and Secondary Education and the Advisors of the Massachusetts Career and Technical Student Organizations to crosswalk standards to national Career & Technical Student Organizations Curricula, as applicable.

The Office for Career/Vocational Technical Education contracted the MAVA Consultant Team to work closely with the office to complete all of the work accomplished during Phase II of the Project.

A remarkable amount of work was accomplished through the efforts of hundreds of professionals who collaborated and diligently supported this work. The Office for Career/Vocational Technical Education is grateful for all the support received from the field, particularly all of the teachers (technical and academic), administrators, advisory committee members, business and industry representatives, the Division of Professional Licensure - boards, the Massachusetts Association of Vocational Administrators, the MAVA Consultants, and the Massachusetts Vocational Association, whose contributions were tremendous.

Special thanks to all staff in the Office for Career/Vocational Technical Education and the CVTE Framework Revision Team who provided guidance and numerous contributions during Phase One of the project.

Organization and Key Changes

This section contains the following:

- Highlights of Changes to the Vocational Technical Education Frameworks; which includes a summary of changes made to each strand.
- Organization of the Frameworks – Strand Two illustrates structure of topic headings, standards and objectives, and performance examples.

Highlights of Changes to the Vocational Technical Education Frameworks:

Strand One:

Safety and Health Knowledge and Skills have been revised to contain the safety standards that are common to all programs. The Strand One Team worked collaboratively with staff from the Department of Elementary and Secondary Education and the Advisors of the Career and Technical Student Organizations (CTSO) to crosswalk standards to national CTSO Curricula, as applicable.

- No objectives were deleted, only modified.
- Language and wording was clarified.
- Additions included a focus on maintaining a safe school and workplace in terms of creating a positive climate/environment.
- Student safety credential program has been revised.
- Safety attire has been revised.
- Emergency equipment and fire safety has been revised.
- Many new Performance Examples have been included.
- Within each strand, standards and objectives were grouped under Topic Headings, which are displayed in bold. Each standard is followed by a performance example. See the section below titled: "Organization of the Frameworks – Strand Two". All strands were organized in that manner, with the exception of the former Strand Three.

Strand Two:

The Technical Standards Knowledge and Skills have been revised to reflect business and industry changes since the adoption of the 2007 Vocational Technical Education Frameworks (VTEF). There are additional changes to Strand Two below:

- The Technical Knowledge and Skills (Strand Two) section contains standards specific to the particular vocational program; suffix "a" (as common to all programs) and suffix "c" (as common within a cluster) have been removed.
- Each VTEF Strand Two begins with safety and health knowledge and skills specific to the particular vocational program.
- Within each strand, standards and objectives were grouped under Topic Headings, which are displayed in bold. Each standard is followed by a performance example. See the section below titled: "Organization of the Frameworks – Strand Two". All strands were organized in that manner, with the exception of the former Strand Three.

- Strand Two of the Frameworks for Animal Science, Environmental Science and Technology, and Horticulture, begin with core standards required for all participants in the programs, followed by a series of standards organized in concentrations. See the section below titled: "Organization of the Frameworks – Strand Two" for more information.
- An update to some of the vocational programs framework is the addition of advanced or supplemental standards which are noted in Strand Two by an asterisk (*). *These standards are not required, but are provided as suggestions that districts may choose to use to increase the depth of a particular topic, or add additional topics, particularly for advanced students or for those seniors who do not participate in cooperative education.* See the section below titled: "Organization of the Frameworks – Strand Two" for more information.

Strand Three:

Since the purpose of Strand Three was to correlate academic content that was *embedded* in the knowledge and skills necessary to perform certain technical skills, it was logical to highlight those connections through a crosswalk between the academic curriculum standards and the technical standards (Strand Two). The crosswalk directly correlates the English Language Arts (2011) and Mathematics (2011) Frameworks, incorporating the Common Core Standards and the Science and Technology/Engineering Frameworks. The crosswalk can be found in the appendix of each vocational framework. The crosswalk also includes performance examples which illustrate integrated academic and technical content.

- Embedded Academics has been replaced with a crosswalk between the academic curriculum standards and the technical knowledge and skills standards. The crosswalk is located in the Appendices.

Strand Four:

Employability (and Career Readiness) Knowledge and Skills focused on providing students with general knowledge and skills to be college and career ready. The Strand Four Team worked collaboratively with staff from the Department of Elementary and Secondary Education and the Advisors of the Career and Technical Student Organizations to crosswalk standards to national CTSO Curricula, as applicable.

- Language and wording were clarified.
- Additions included a focus on providing students with skills for employability/career readiness.
- Modifications included Career Exploration & Navigation, Communication in the Workplace, and Work Ethic & Professionalism.
- New Performance Examples have been included.
- Within each strand, standards and objectives were grouped under Topic Headings, which are displayed in bold. Each standard is followed by a performance example. See the section below titled: "Organization of the Frameworks – Strand Two". All strands were organized in that manner, with the exception of the former Strand Three.

Strand Five:

Strand Five contains Management and Entrepreneurship Knowledge and Skills that are general for all students. The Strand Five Team worked collaboratively with staff from the Department of Elementary and Secondary Education and the Advisors of the Massachusetts Career and Technical Student Organizations to crosswalk standards to national Career & Technical Student Organizations Curricula, as applicable.

- Language and wording were clarified and organized into a logical format.
- The Strand Five Team felt that the 2007 curriculum remained valid.
- Additions included a focus on providing students with skills for management and entrepreneurship applicable to all vocational programs.
- Modifications included Starting and Managing a Business, Marketing, and Financial Concepts & Applications in Business, and Legal/Ethical/Social Responsibilities.
- New Performance Examples have been included.
- Within each strand, standards and objectives were grouped under Topic Headings, which are displayed in bold. Each standard is followed by a performance example. See the section below titled: "Organization of the Frameworks – Strand Two". All strands were organized in that manner, with the exception of the former Strand Three.

Strand Six

Strand Six Technology Literacy Knowledge and Skills has been replaced with the 2008 Massachusetts Technology Literacy Standards and Expectations Framework.

Appendix[1]

Each framework contains an "Appendix" section which includes an Embedded Academic Crosswalk, Industry Recognized Credentials, Statewide Articulation Agreements, Professional, Governmental, and Student Organizations, Resources, and relevant websites.

The Appendix[2] contains:

- Embedded Academic crosswalks for English Language Arts, Mathematics, and Science & Technology/Engineering.
- Statewide Articulations: Current statewide Articulation Agreements and/or Apprenticeship Programs available to the specific vocational program are listed on this page. The development of new statewide articulations continues, and therefore these pages will be revised as new agreements are finalized.

- Industry-Recognized Credentials: Technical Teacher Teams generated lists of credentials for the vocational programs. Program Advisory Committees throughout the state reviewed and provided recommendations through the validation process. *The credential list has been provided as a resource only and districts are not obligated to provide all of the specified credentials for students.*

- Other: These pages provide lists of reference materials, government agencies, professional and student organizations, and useful websites created by each framework team. These are intended as helpful resources for technical teachers, identified by peers. These are not recommended or required by the Department of Elementary & Secondary Education.

[1] *Note:* Although most Framework Teams provided information for the "Appendix", not all teams did. *Therefore, sub-headings within the "Appendix" without information have been deleted.*
Disclaimer: Reference in the Appendices Section to any specific commercial products, processes, or services, or the use of any trade, firm or corporation name is for the information and convenience of the public, and does not constitute endorsement or recommendation by the Massachusetts Department of Elementary and Secondary Education.

Organization of the Frameworks – Strand Two

The Vocational Technical Education Frameworks contain knowledge and skills covering all aspects of industry, reflected in six strands: Safety and Health, Technical, Embedded Academics, Employability, Management and Entrepreneurship, and Technological.

Within each strand, standards and objectives were grouped under topic headings, which are displayed in bold. Each standard is followed by a performance example. In the excerpt below, 2.A is the topic; 2.A.01 is the first standard and 2.A.01.01 and 2.A.01.02 are the objectives under that standard.

2.A Automotive Technology Specific Safety Practices

2.A.01 Identify and describe safety procedures when dealing with different types of automotive lifts according to current industry standards.

- 2.A.01.01 Demonstrate procedures for safe lift operations.
- 2.A.01.02 Demonstrate safe use, placement and storage of floor jacks and jack stands.

2.A.01 Performance Example:

- Student will set up lift using manufacturer's suggested lift points.

2.A.02 Demonstrate and describe safety procedures when dealing with high pressure systems including necessary ventilation according to current industry standards.

- 2.A.02.01 Describe and demonstrate the importance of safety procedures to be used when servicing high pressurized systems (fuel systems, brakes, air conditioning, suspension, hydraulic systems, etc.).
- 2.A.02.02 Describe and demonstrate safe use of oxygen/acetylene torches and electric welding equipment.
- 2.A.02.03 Demonstrate ventilation procedures to be followed when working in the lab/shop area.

2.A.02 Performance Example:

- Student will relieve fuel system pressure to perform necessary repairs.

2.A.03 Identify and describe safety procedures when dealing with electrical circuits according to current industry standards.

- 2.A.03.01 Describe safety procedures to be followed when servicing supplemental restraint systems.
- 2.A.03.02 Demonstrate safety awareness of high voltage circuits of electric or hybrid electric vehicles and related safety precautions.

2.A.03 Performance Example:

- Safely disable Supplemental Restraint System (SRS) air bag for repair using manufacturer's recommendations.

There are additional changes to some of the Frameworks Strand Two (Technical Knowledge and Skills). Specifically, Strand Two of the Frameworks for Animal Science, Environmental Science and Technology and Horticulture begin with core standards required for all participants in the programs, followed by a series of standards organized in concentrations. For example, Strand Two of the Horticulture Framework begins with the core standards required of all Horticulture students

(Topics 2.A through 2.I). These standards are followed by the three concentrations: Arboriculture (Topics 2.J through 2.L), Greenhouse Management and Floriculture (Topics 2.J. through 2.L) and Landscape and Turf Management (Topics 2.M through 2.Q).

Advanced / Supplemental Standards (Not Required)

Another variation that is new to the revised Strand Two Frameworks is the addition of advanced or supplemental standards which are noted with the use of an asterisk (*). *These standards are not required, but are provided as suggestions that districts may choose to use to increase the depth of a particular topic, or add additional topics, particularly for advanced students or for those seniors who do not participate in cooperative education.*

The following is an example from Automotive Technology, where entire topics were added:

Advanced Automotive Technology Technical Knowledge and Skills

Note: The following competencies are optional, supplementary competencies suitable for advanced students. These are not required.

2.CC Demonstrate appropriate engine repair techniques.

2.CC.01 Perform appropriate cylinder Head Repair.

2.CC.01.01* Diagnose, remove and replace cylinder head(s).

2.CC.01.02* Clean and visually inspect a cylinder head for cracks; check gasket surface areas for warpage and surface finish; check passage condition; determine necessary action.

The following is an example from the Strand Two Radio and Television Broadcasting Framework that shows the addition of an advanced objective, 2.B.04.08*:

2.B.04 Explain concepts fundamental to shooting in cinema and video.

2.B.04.01 Compare and contrast a single-camera and a multiple-camera production.
2.B.04.02 Explain the importance of shooting for the edit (i.e., match on action, sequencing, coverage).
2.B.04.03 Explain the importance of continuity.
2.B.04.04 Explain the 180° Rule line, and its application in various cinema scenarios.
2.B.04.05 Identify and establish a specific point-of-view when shooting from a script.
2.B.04.06 Analyze the methods in which specific shots can evoke emotion from an audience.
2.B.04.07 Define drop frame and non-drop frame code shooting and explain how to account for both when preparing for an edit.
2.B.04.08* Describe various cinematographic methods necessary when shooting scenes that incorporate post-production visual effect

2.B.04 Performance Examples:

- Students will list similarities and differences of single-camera and multiple-camera shoots.
- Students will describe multiple shooting considerations that are useful in streamlining the editing process.

Strand 1: Safety and Health Knowledge and Skills

1.A Fundamentals of Health and Safety

1.A.01 Describe and apply health and safety regulations.

- 1.A.01.01 Identify, describe and apply health and safety regulations that apply to specific tasks and jobs. Students must complete a safety credential program, e.g., Occupational Safety and Health Administration 10, CareerSafe and ServSafe.
- 1.A.01.02 Identify, describe and apply Environmental Protection Agency (EPA) and other environmental protection regulations that apply to specific tasks and jobs in the specific occupational area.
- 1.A.01.03 Identify, describe and apply Right-To-Know (Hazard Communication Policy) and other communicative regulations that apply to specific tasks and jobs in the specific occupational area.
- 1.A.01.04 Explain procedures for documenting and reporting hazards to appropriate authorities.
- 1.A.01.05 Identify and describe potential consequences for non-compliance with appropriate health and safety regulations.
- 1.A.01.06 Identify and list contact information for appropriate health and safety agencies and resources.

1. A.01 Performance Examples:

- List and define OSHA Health and Safety Regulations, EPA and other environmental protection regulations to occupational area.
- List and define Right-to-Know regulations and reporting of hazards and contact information for appropriate health and safety agencies.
- List the laws and rules of regulatory agencies governing sanitation and safety.
- Utilize OSHA as well as health and safety websites for purposes of research.

1.A.02 Demonstrate appropriate health and safety practices based on the specific occupational area.

- 1.A.02.01 Identify, describe and demonstrate the effective use of Safety Data Sheets (SDS).
- 1.A.02.02 Read and interpret chemical, product and equipment labels to determine appropriate health and safety considerations.
- 1.A.02.03 Identify, describe and demonstrate personal, shop and job site safety practices and procedures.
- 1.A.02.04 Demonstrate safe dress and use of relevant safety gear, personal protective equipment (PPE) and ergonomics, e.g., wrist rests, adjustable workspaces, equipment, gloves, proper footwear, earplugs, eye protection and breathing apparatus.
- 1.A.02.05 Demonstrate appropriate safe body mechanics, including appropriate lifting techniques and ergonomics.

1.A.02.06 Locate emergency equipment, first aid kit, SDS information directories and emergency action/response plan/escape routes in your lab, shop and classroom, including labels and signage that follow OSHA Hazard Communication Program (HAZCOM), eyewash stations, shower facilities, sinks, fire extinguishers, fire blankets, telephone, master power switches and emergency exits.

1.A.02.07 Demonstrate the safe use, storage, and maintenance of every piece of equipment in the lab, shop and classroom, e.g., the OSHA Lockout/Tagout Program (LOTO).

1.A.02.08 Describe safety practices and procedures to be followed when working with and around electricity, e.g., ground fault circuit interrupter (GFCI) and frayed wiring.

1.A.02.09 Handle, store, dispose of and recycle hazardous, flammable and combustible materials, according to EPA, OSHA and product specifications.

1.A.02.10 Demonstrate appropriate workspace cleaning, sanitation, disinfection and sterilization procedures required in specific occupational areas, e.g., Workplace Housekeeping OSHA Regulations.

1. A.02 Performance Examples:

- Identify, describe and demonstrate the use of SDS.
- List and demonstrate shop dress code, safety procedures and location of emergency equipment in labor classroom.
- Define and demonstrate safe storage and maintenance of equipment and proper disposal or recycling of hazardous, flammable and combustible materials.
- Identify, describe and demonstrate the Universal Precautions set of guidelines.

1.A.03 Demonstrate appropriate responses to situations that may threaten health and safety.

1.A.03.01 Describe First Aid procedures for potential injuries and other health concerns in the specific occupational area.

1.A.03.02 Describe the importance of emergency preparedness and an emergency action/response plan.

1.A.03.03 Describe procedures used to handle emergency situations, defensive measures and accidents, including identification, reporting, response, evacuation plans and follow-up procedures.

1.A.03.04 Identify, describe and demonstrate safety practices in specific occupational areas used to avoid accidents.

1.A.03.05 Identify and describe fire protection, protection, precautions and response procedures.

1.A.03.06 Discuss the role of the individual and the company/organization in ensuring workplace safety including transportation to and from school, school activities and the workplace.

1.A.03.07 Discuss ways to identify, prevent and report school and workplace violence, discrimination, harassment and bullying.

1.A.03.08 Demonstrate positive and appropriate behavior that contributes to a safe and healthy environment in school and the workplace.

1. A.03 Performance Example:
- Define first aid procedures and protocols used to handle emergency situations and practices used to avoid accidents.
- View safety videos and discuss the role of workplace safety.
- Attend or participate in a human rights alliance organization presentation.
- Observe and/or demonstrate the appropriate use of a fire extinguisher using the (PASS) technique: Pull, Aim, Squeeze, Sweep.
- Review and discuss specific policies, procedures and protocols regarding discrimination, harassment and bullying.
- Discuss and/or role-play proper and respectful behavior that contributes to a positive climate.
- Discuss and/or demonstrate behavior that contributes to a collaborative/teamwork environment.

Selected Websites

- Bullying Prevention and Intervention Resources : www.doe.mass.edu/bullying
- Centers for Disease Control and Prevention: www.cdc.gov
- Environmental Protection Agency : www.epa.gov
- "Lost Youth – Four Stories of Injured Young Workers"– WorkSafeBC: http://www2.worksafebc.com/Publications/Multimedia/Videos.asp?reportid=34291
- Massachusetts Department of Elementary and Secondary Education. (2011). Career/Vocational Technical Education Safety Guide: www.doe.mass.edu/cte
- Massachusetts Department of Elementary and Secondary Education: www.doe.mass.edu
- Massachusetts Emergency Management Agency: www.mass.gov/eopss/agencies/mema
- Massachusetts General Law: www.malegislature.gov
- Massachusetts Health and Human Services: www.mass.gov/dph
- Massachusetts Right to Know Law Summary: http://www.mass.gov/lwd/docs/dos/mwshp/hib397.pdf
- Safety Data Sheet: www. sdsonline.com
- National Fire Protection Association: www.nfpa.org
- Protection of Student Rights: Massachusetts General Law: https://malegislature.gov/Laws/GeneralLaws/PartI/TitleXII/Chapter76/Section5
- Occupational Safety and Health Administration: www.osha.gov
- Readiness and Emergency Management for Schools: www.rems.ed.gov
- Safe and Healthy Learning Environments: www.doe.mass.edu/ssce/safety.html

Strand 2: Technical Knowledge and Skills

2.A Automotive Technology Specific Safety Practices

2.A.01 Identify and describe safety procedures when dealing with different types of automotive lifts according to current industry standards.

- 2.A.01.01 Demonstrate procedures for safe lift operations.
- 2.A.01.02 Demonstrate safe use, placement and storage of floor jacks and jack stands.

2.A.01 Performance Example:

- Student will set up lift using manufacturer's suggested lift points.

2.A.02 Demonstrate and describe safety procedures when dealing with high pressure systems including necessary ventilation according to current industry standards.

- 2.A.02.01 Describe and demonstrate the importance of safety procedures to be used when servicing high pressurized systems (fuel systems, brakes, air conditioning, suspension, hydraulic systems, etc.).
- 2.A.02.02 Describe and demonstrate safe use of oxygen/acetylene torches and electric welding equipment.
- 2.A.02.03 Demonstrate ventilation procedures to be followed when working in the lab/shop area.

2.A.02 Performance Example:

- Student will relieve fuel system pressure to perform necessary repairs.

2.A.03 Identify and describe safety procedures when dealing with electrical circuits according to current industry standards.

- 2.A.03.01 Describe safety procedures to be followed when servicing supplemental restraint systems.
- 2.A.03.02 Demonstrate safety awareness of high voltage circuits of electric or hybrid electric vehicles and related safety precautions.

2.A.03 Performance Example:

- Safely disable Supplemental Restraint System (SRS) air bag for repair using manufacturer's recommendations.

2.B Hand Tools

2.B.01 Identify, describe and use various types of screwdrivers.

- 2.B.01.01 Demonstrate the use and knowledge of different Phillips screwdrivers.
- 2.B.01.02 Demonstrate the use and knowledge of standard screwdrivers.
- 2.B.01.03 Demonstrate the use and knowledge of torx screwdrivers.
- 2.B.01.04 Demonstrate the use and knowledge of reed and prince screwdrivers.
- 2.B.01.05 Demonstrate the use and knowledge of clutch screwdrivers.
- 2.B.01.06 Demonstrate the use and knowledge of pozidrive screwdrivers.

2.B.02 Identify, describe and use various types of pliers.

- 2.B.02.01 Demonstrate the use and knowledge of slip-joint pliers.
- 2.B.02.02 Demonstrate the use and knowledge of rib-joint pliers.
- 2.B.02.03 Demonstrate the use and knowledge of needle-nose pliers.
- 2.B.02.04 Demonstrate the use and knowledge of diagonal cutting pliers.
- 2.B.02.05 Demonstrate the use and knowledge of locking pliers.
- 2.B.02.06 Demonstrate the use and knowledge of snap ring pliers.

2.B.03 Identify, describe and use various types of combination wrenches.
- 2.B.03.01 Demonstrate the use and knowledge of open ended wrenches.
- 2.B.03.02 Demonstrate the use and knowledge of box-end wrenches.
- 2.B.03.03 Demonstrate the use and knowledge of combination wrenches.
- 2.B.03.04 Demonstrate the use and knowledge of tubing or line wrenches.
- 2.B.03.05 Demonstrate the use and knowledge of pipe wrenches.
- 2.B.03.06 Demonstrate the use and knowledge of adjustable wrenches.
- 2.B.03.07 Demonstrate the use and knowledge of Allen wrenches.

2.B.04 Identify, describe and use various types of socket wrenches.
- 2.B.04.01 Demonstrate the use and knowledge of socket drive size.
- 2.B.04.02 Demonstrate the use and knowledge of socket point type.
- 2.B.04.03 Demonstrate the use and knowledge of different types of socket handles.
- 2.B.04.04 Demonstrate the use and knowledge of extensions and swivels.

2.B.05 Identify, describe and use various types of hammering tools.
- 2.B.05.01 Demonstrate the use and knowledge of different types of hammers.
- 2.B.05.02 Demonstrate the use and knowledge of different types of punches.
- 2.B.05.03 Demonstrate the use and knowledge of different types of chisels.

2.B.06 Identify, describe and use various metal working tools.
- 2.B.06.01 Demonstrate the use and knowledge of various types of files.
- 2.B.06.02 Demonstrate the use and knowledge of different types of hacksaws.
- 2.B.06.03 Demonstrate the use and knowledge of various types of thread cutting taps.
- 2.B.06.04 Demonstrate the use and knowledge of various types of thread cutting dies.
- 2.B.06.05 Demonstrate the use and knowledge of a tubing cutter.
- 2.B.06.06 Demonstrate the use and knowledge of a double flaring tool.
- 2.B.06.07 Demonstrate the use and knowledge of an International Standards Organization (ISO) flaring tool.

2.B.07 Identify, describe and use various surface prep tools.
- 2.B.07.01 Demonstrate the use and knowledge of different types of gasket scrapers.
- 2.B.07.02 Demonstrate the use and knowledge of different types of wire brushes.

2.B.08 Identify, describe and use various types of holding tools.
- 2.B.08.01 Demonstrate the use and knowledge of various vises.
- 2.B.08.02 Demonstrate the use and knowledge of vise caps.
- 2.B.08.03 Demonstrate the use and knowledge of C-clamps.

2.B. Performance Example:
- Student will select and use the appropriate hand tool for the task assigned.

2.C Power Tools

2.C.01 Demonstrate and explain the use of electric power tools according to current industry standards.
- 2.C.01.01 Describe safety procedures to be followed when using a corded electric drill.
- 2.C.01.02 Describe safety procedures to be followed when using a cordless electric drill.
- 2.C.01.03 Drill holes to given specifications using a drill.
- 2.C.01.04 Describe the difference in drilling speeds used for different metals.

2.C.01 Performance Example:
- Student will drill a selected size hole observing proper safety procedures.

2.C.02 Demonstrate and explain the use of pneumatic power tools according to current industry standards.

- 2.C.02.01 Identify and explain the purpose of an air impact wrench.
- 2.C.02.02 Describe maintenance needs of an air impact wrench.
- 2.C.02.03 Demonstrate and describe safety procedures to follow when using an air impact wrench.
- 2.C.02.04 Identify and explain the purpose of impact sockets.

2.C.02 Performance Example:

- Student will remove lug nuts using an impact wrench, selecting appropriate size and type of socket.

2.C.03 Demonstrate and explain the use of electric automotive technology tools according to current industry standards.

- 2.C.03.01 Identify and explain the purpose of a bench grinder.
- 2.C.03.02 Demonstrate and describe safety procedures to follow when using a bench grinder.
- 2.C.03.03 Identify and explain the purpose of a drill press.
- 2.C.03.04 Demonstrate and describe the safety procedures to follow when using a drill press.

2.C.03 Performance Example:

- Student will operate a bench grinder according to current industry standards.

2.D Precision Measuring

2.D.01 Describe and demonstrate the use of commonly used low precision measuring tools.

- 2.D.01.01 Identify and demonstrate the use of inside and outside calipers.
- 2.D.01.02 Identify and demonstrate the use of a hole gauge.
- 2.D.01.03 Identify and demonstrate the use of a vernier caliper.
- 2.D.01.04 Identify and demonstrate the use of a steel rule, measuring tape, and combination square.

2.D.02 Describe commonly used high precision measuring tools.

- 2.D.02.01 Identify and demonstrate the use of an outside and inside micrometer.
- 2.D.02.02 Identify and demonstrate the use of a depth micrometer.
- 2.D.02.03 Identify and demonstrate the use of a dial indicator.

2.D Performance Example:

- Student will use a variety of measuring tools to verify accurate brake rotor dimensions.

2.E Fasteners

2.E.01 Identify and demonstrate the use of commonly used threaded fasteners.

- 2.E.01.01 Identify SAE bolt head markings.
- 2.E.01.02 Identify metric bolt head marking.
- 2.E.01.03 Identify commonly used nuts and washers.
- 2.E.01.04 Identify and describe the use of machine screws.

2.E.01 Performance Example:

- Student will distinguish between SAE and metric dimensional fasteners.

2.E.02 Identify and describe common fasteners.

- 2.E.02.01 Explain the need for flat washers and lock washers.
- 2.E.02.02 Identify and describe the use of snap rings.

2.E.02 Performance Example:

- Student will select the appropriate sized snap ring to secure a component.

2.E.03 Explain the concept of fastener torque.

2.E.03.01 Explain how to find fastener torque specifications.

2.E.03.02 Explain how to use a general fastener torque chart.

2.E.03.03 Explain what torque sequence refers to.

2.E.03.04 Explain and demonstrate the basic rules to follow when using a torque wrench.

2.E.03.05 Explain the concept of torque yield fasteners.

2.E.03 Performance Example:

- Student will torque wheel lug nuts to manufacturer's specifications using the specific tightening sequence.

2.F Vehicle Service Information

2.F.01 Access and use service information to perform step-to-step diagnosis and repair.

2.F.01.01 Research applicable vehicle and service information, such as suspension, steering system operation, vehicle service history, service precautions, technical service bulletins and recalls.

2.F.01.02 Locate and interpret vehicle and major component identification numbers (VIN, vehicle certification labels, calibration decals).

2.F.01 Performance Example:

- Student will research the vehicle identification number (VIN) of the vehicle being serviced to obtain correct engine size.

2.G Wheels and Tires

2.G.01 Conduct appropriate wheel and tire inspection.

2.G.01.01 Diagnose tire wear patterns and determine necessary action.

2.G.01.02 Inspect tires for sizing, tread wear and pattern. Determine necessary action. Check and adjust air pressure.

2.G.01.03 Measure wheel, tire, axle and hub run out.

2.G.01.04 Measure loaded run out and tire rigidity simultaneously using wheel balancing equipment.

2.G.01 Performance Example:

- Student will inspect tire size, compare with manufacturer tire size recommendations and determine necessary action.

2.G.02 Conduct appropriate wheel and tire mounting.

2.G.02.01 Dismount/mount tire on/off wheel rim.

2.G.02.02 Remove and install a tire and wheel assembly and torque lug nuts.

2.G.02.03 Inspect and replace wheel studs.

2.G.02.04 Rotate tires according to the manufacturer's recommendations.

2.G.02 Performance Example:

- Student will dismount and mount a tire on a wheel rim with tire pressure monitoring system (TPMS) and rotate according to manufacturer's recommendations.

2.G.03 Conduct appropriate wheel and tire balancing.

2.G.03.01 Balance wheel and tire assembly statically and dynamically.

2.G.03.02 Balance a tire on wheel, measure loaded run out and tire stiffness simultaneously to determine recommended location of wheel and tire assemblies to minimize tire pull.

2.G.03 Performance Example:
- Student will balance a wheel and tire assembly using different modes on a dynamic wheel balancer.

2.G.04 Diagnose and repair tire and tire pressure monitoring systems (TPMS) components.
- 2.G.04.01 Inspect a tire for leaks and repair a tire puncture.
- 2.G.04.02 Remove and replace a valve stem.
- 2.G.04.03 Identify tire pressure monitoring system equipped vehicles.
- 2.G.04.04 Identify different types (direct and indirect) of TPMS systems and components.
- 2.G.04.05 Set up and use tire pressure monitoring system, service and resetting equipment.

2.G.04 Performance Example:
- Student will verify if there is a TPMS sensor, then dismount, mount, and balance a new tire on the rim.

2.H Suspension Systems

2.H.01 Inspect suspension system for noises, body sway and uneven riding height concerns.
- 2.H.01.01 Inspect short and long arm suspension system for noises, body sway and uneven riding height concerns.
- 2.H.01.02 Inspect strut suspension system for noises, body sway and uneven riding height concerns.
- 2.H.01.03 Inspect leaf spring suspension system for noises, body sway and uneven riding height concerns.

2.H.01 Performance Example:
- Student will verify correct curb ride height using a tape measure and follow manufacturer's recommendations and specifications to determine necessary action.

2.H.02 Lubricate suspension and steering systems.
- 2.H.02.01 Lubricate suspension and steering systems per manufacturer's recommendations.

2.H.02 Performance Example:
- Student will identify and lubricate all applicable suspension components.

2.H.03 Remove, inspect and install suspension components.
- 2.H.03.01 Remove, inspect and install upper and lower control arms, bushings, shafts and rebound bumpers.
- 2.H.03.02 Remove, inspect and install strut rods (compression/tension) and bushings.
- 2.H.03.03 Remove, inspect and install upper and/or lower ball joints.
- 2.H.03.04 Remove, inspect and install steering knuckle assemblies.
- 2.H.03.05 Remove, inspect, and install short and long arm suspension system coil springs and spring insulators.

2.H.03.06 Remove, inspect, install and adjust suspension system torsion bars; inspect mounts.
2.H.03.07 Remove, inspect, and install stabilizer bar bushings, brackets and links.
2.H.03.08 Remove, inspect and install strut cartridge or assembly, strut coil spring, insulators (silencers) and upper strut bearings/mounts.
2.H.03.09 Remove, inspect and install coil springs and spring insulators.
2.H.03.10 Remove, inspect and install transverse links, control arms, bushings and mounts.
2.H.03.11 Remove, inspect and install leaf springs, leaf spring insulators (silencers), shackles, brackets, bushings and mounts.
2.H.03.12 Inspect, remove and replace shock absorbers.

2.H.03 Performance Example:
- Student will inspect suspension components for wear, replace and lubricate as necessary.

2.I Steering Systems

2.I.01 Identify and diagnose power steering concerns and perform necessary service.
2.I.01.01 Identify power steering gear (non-rack and pinion) binding, uneven turning effort, looseness, hard steering and fluid leakage.
2.I.01.02 Inspect power steering fluid levels and condition.
2.I.01.03 Flush, fill and bleed the power steering system.
2.I.01.04 Diagnose power steering fluid leakage; determine necessary action.
2.I.01.05 Remove, inspect, replace and adjust the power steering pump belt.
2.I.01.06 Remove and reinstall the power steering pump.
2.I.01.07 Inspect and replace power steering hoses and fittings.

2.I.01 Performance Example:
- Student will inspect steering system to locate source of binding.

2.I.02 Identify and diagnose mechanical steering concerns and perform necessary service.
2.I.02.01 Remove and replace manual or power rack and pinion steering gear; inspect mounting bushings and brackets.
2.I.02.02 Inspect and replace manual or power rack and pinion steering gear inner tie rod ends and bellows boot.
2.I.02.03 Inspect and replace pitman arm, center link/intermediate rod, idler arm, mountings and steering linkage dampener.
2.I.02.04 Inspect, replace and adjust the tie rod ends, tie rod sleeves and clamps on a linkage type steering system.

2.I.02 Performance Example:
- Student will inspect steering system for wear and replace faulty component.

2.I.03 Identify and interpret steering column concerns and perform necessary service.
2.I.03.01 Disable and enable supplemental restraint system (SRS).
2.I.03.02 Remove and replace the steering wheel; align supplemental restraint system (SRS) coil (clock spring).
2.I.03.03 Identify steering column noises, excessive play and binding concerns (including tilt mechanism).

2.I.03 Performance Example:
- Student will properly align SRS coil (clock spring) during steering column repair.

2.J Wheel Alignment

2.J.01 Conduct appropriate pre-alignment inspections.

- 2.J.01.01 Differentiate between steering and suspension concerns using principles of steering geometry (caster, camber, toe, etc.).
- 2.J.01.02 Inspect vehicle wander, drift, pull, hard steering, bump steer, memory steer, torque steer and steering return concerns.

2.J.01 Performance Example:

- Student will perform a pre-alignment inspection using a check list from either the vehicle manufacturer or the equipment manufacturer.

2.J.02 Conduct appropriate set-up and measure alignments.

- 2.J.02.01 Measure vehicle riding height.
- 2.J.02.02 Mount alignment measuring equipment to vehicle.
- 2.J.02.03 Check and measure caster.
- 2.J.02.04 Check and measure front and rear wheel camber.
- 2.J.02.05 Check and measure front and rear wheel toe.
- 2.J.02.06 Check steering wheel centering.
- 2.J.02.07 Check and measure toe-out-on-turns (turning radius).
- 2.J.02.08 Check and measure steering axis inclination (SAI) and included angle.
- 2.J.02.09 Check and measure rear wheel thrust angle.

2.J.02 Performance Example:

- Student will install alignment measuring equipment and measure caster, camber and toe.

2.J.03 Perform alignment angle adjustments.

- 2.J.03.01 Adjust vehicle riding height.
- 2.J.03.02 Adjust front and rear wheel camber.
- 2.J.03.03 Adjust caster.
- 2.J.03.04 Adjust front and rear wheel toe.
- 2.J.03.05 Adjust center steering wheel.
- 2.J.03.06 Adjust and/or determine necessary action to correct toe-out-on-turns (turning radius).
- 2.J.03.07 Adjust and/or determine necessary action to correct steering axis inclination (SAI) and included angle.
- 2.J.03.08 Adjust and determine necessary action to correct rear wheel thrust angle.
- 2.J.03.09 Determine necessary action to correct front wheel setback.

2.J.03 Performance Example:

- Student will adjust vehicle ride height, caster, camber and toe according to the vehicle manufacturer specifications.

2.K Automotive Basic Maintenance

2.K.01 Perform appropriate basic maintenance service skills.

- 2.K.01.01 Perform oil/filter change, check and fill all fluids.
- 2.K.01.02 Inspect air, cabin filters; determine necessary action.
- 2.K.01.03 Replace fuel filters.
- 2.K.01.04 Inspect exhaust system and undercarriage; determine necessary action.
- 2.K.01.05 Inspect transmission/transaxle, front and rear differential fluids; determine necessary action.

2.K.01.06 Inspect automotive drive belts and cooling system hoses; determine necessary action.

2.K.01 Performance Example:
- Student will perform a maintenance inspection to include an oil and filter change, as well as an undercarriage inspection.

2.L Automotive Refrigerant Theory

2.L.01 Describe and perform appropriate automotive refrigerant handling according to current industry standards.
- 2.L.01.01 Follow EPA regulations for refrigerant handling.
- 2.L.01.02 Identify refrigerant.
- 2.L.01.03 Reclaim and recharge refrigerant.
- 2.L.01.04 Recycle, label and store refrigerant.

2.L.01 Performance Example:
- Student will identify the refrigerant type in a vehicle using service information.

2.M Brake System Research and Service.

2.M.01 Research brake system concerns and vehicle information.
- 2.M.01.01 Identify and interpret brake system concern; determine necessary action.
- 2.M.01.02 Research applicable vehicle and service information, such as brake system operation, vehicle service history, service precautions and technical service bulletins.
- 2.M.01.03 Diagnose poor stopping, noise, pulling, grabbing, dragging or pedal pulsation concerns; determine necessary action.

2.M.01 Performance Example:
- Student uses automotive information system to research applicable brake-related technical service bulletins and report findings.

2.N Hydraulic Brake Systems

2.N.01 Diagnose and identify pressure concerns in the brake system using hydraulic principles (Pascal's Law).
- 2.N.01.01 Measure brake pedal height; determine necessary action.
- 2.N.01.02 Check master cylinder for internal and external leaks and proper operations; determine necessary action.
- 2.N.01.03 Remove, bench bleed and reinstall master cylinder.
- 2.N.01.04 Identify poor stopping, pulling or dragging concerns caused by malfunctions in the hydraulic system; determine necessary action.
- 2.N.01.05 Inspect brake lines, flexible hoses and fittings for leaks, dents, kinks, rust, cracks, bulging or wear; tighten loose fittings and supports; determine necessary action.

2.N.01 Performance Example:
- Student measures brake pedal height using a tape measure and compare the measurement to specifications.

2.N.02 Perform appropriate maintenance and repair of hydraulic brake systems.
- 2.N.02.01 Fabricate and/or install brake lines (double flare and ISO types); replace hoses, fittings and supports, as needed.
- 2.N.02.02 Select, handle, store and fill brake fluids to proper level.

2.N.02.03 Inspect, test, and/or replace components of brake warning light system.
2.N.02.04 Bleed (manual, pressure, vacuum or surge) brake system.
2.N.02.05 Flush hydraulic system.

2.N.02 Performance Example:
- Student selects the DOT rated brake fluid for the vehicle being serviced according to the vehicle manufacturer's recommendations.

2.O Drum Brake Systems

2.O.01 Remove and inspect brake drums; determine necessary action.
2.O.01.01 Remove, clean, inspect and measure brake drums; determine necessary action.
2.O.01.02 Refinish brake drum.

2.O.01 Performance Example:
- Student uses a precision measuring device to measure drum tolerance.

2.O.02 Remove and inspect brake shoes and drum brake components; determine necessary action.
2.O.02.01 Remove, clean and inspect brake shoes, springs, pins, clips, levers, adjusters/self-adjusters, other related brake hardware and backing support plates; lubricate and reassemble.
2.O.02.02 Remove, inspect and install wheel cylinders.
2.O.02.03 Pre-adjust brake shoes and parking brake before installing brake drums or drum/hub assemblies and wheel bearings.
2.O.02.04 Install wheel, torque lug nuts and make final checks and adjustments.

2.O.02 Performance Example:
- Student removes the brake drum, measures brake shoe lining and determines necessary action.

2.P Disc Brake Systems

2.P.01 Remove and inspect brake caliper assembly; determine necessary action.
2.P.01.01 Remove caliper assembly from mountings; clean and inspect for leaks and damage to caliper housing; determine necessary action.
2.P.01.02 Clean and inspect caliper mounting and slides for wear and damage; determine necessary action.
2.P.01.03 Remove, clean and inspect pads and retaining hardware; determine necessary action.
2.P.01.04 Adjust calipers equipped with an integrated parking brake system.
2.P.01.05 Reassemble, lubricate and reinstall caliper, pads and related hardware; seat pads and inspect for leaks.
2.P.01.06 Install wheel, torque lug nuts and make final checks and adjustments.

2.P.01 Performance Example:
- Student removes the brake calipers and checks the caliper slides for proper operation.

2.P.02 Remove and inspect brake rotors; determine necessary action.
2.P.02.01 Inspect and measure rotor with a dial indicator and a micrometer and compare readings to manufacturer's specifications; determine necessary action.
2.P.02.02 Remove and refinish rotor according to manufacturer's recommendations.
2.P.02.03 Prep hub mating surface and reinstall brake rotor.

2.P.02 Performance Example:
- Student removes the brake rotor and using a high precision measuring device measures the rotors brake surface in several locations comparing the highest to the lowest surface.

2.Q Power Brake Systems

2.Q.01 Identify and describe the operation of a vacuum brake assist unit.

- 2.Q.01.01 Test pedal free travel with and without engine running; check power assist operation.
- 2.Q.01.02 Check vacuum supply (manifold or auxiliary pump) to vacuum-type power booster.
- 2.Q.01.03 Inspect the vacuum-type power booster unit for vacuum leaks; inspect the check valve for proper operation; determine necessary action.

2.Q.01 Performance Example:

- Student will perform a test of the brake booster check valve and verify operation according to manufacturer's specifications.

2.Q.02 Identify and describe the operation of a brake hydraulic assist unit.

- 2.Q.02.01 Test pedal free travel with and without engine running; check power assist operation.
- 2.Q.02.02 Inspect and test hydro-boost system and accumulator for leaks and proper operation; determine necessary action.

2.Q.02 Performance Example:

- Student uses a high pressure gauge and compares reading to specification to verify proper operation of the hydro-boost system.

2.R Miscellaneous Brake Components and Systems

2.R.01 Diagnose and repair parking brake failures and concerns.

- 2.R.01.01 Check parking brake operation; determine necessary action.
- 2.R.01.02 Check parking brake cables and components for wear, rusting, binding and corrosion; clean, lubricate or replace as needed.

2.R.01 Performance Example:

- Student will apply and release parking brake and determine if cables are moving freely.

2.R.02 Diagnose and repair wheel bearing failures and concerns.

- 2.R.02.01 Diagnose wheel bearing noise, wheel shimmy and vibration concerns; determine necessary action.
- 2.R.02.02 Remove, clean, inspect, wheel bearings, seals, hub and spindle; determine necessary action.
- 2.R.02.03 Replace wheel bearing, race and seals.
- 2.R.02.04 Repack and install wheel bearings, replace seals, install hub and adjust wheel bearings.
- 2.R.02.05 Remove and reinstall sealed wheel bearing assembly.

2.R.02 Performance Example:

- Student will remove, clean and inspect wheel bearing and race for wear.

2.R.03 Diagnose and repair electrical brake circuit failures and concerns.

- 2.R.03.01 Check operation of parking brake indicator light system.
- 2.R.03.02 Check operation of brake stop light system; determine necessary action.

2.R.03 Performance Example:

- Student will apply service brake with the use of a brake depressor device, or assistance, and inspect brake lamps, including deck (high) mount for proper operation (illumination).

2.S Antilock Brake System

2.S.01 Identify, inspect and diagnose antilock brake system (ABS) components.

2.S.01.01 Diagnose antilock brake system (ABS) electronic control(s) and components using self-diagnosis and/or recommended test equipment.

2.S.01 Performance Example:
- Student will use the appropriate scan tool to retrieve possible ABS trouble codes.

2.S.02 Service antilock brake system high pressure hydraulic system to manufacturer's specifications.

2.S.02.01 Depressurize high-pressure components of the antilock brake systems (ABS).

2.S.02.02 Bleed the antilock brake system (ABS) front and rear hydraulic circuits.

2.S.02 Performance Example:
- Student will bleed an ABS system according to the manufacturer's recommendation.

2.T General Electrical Systems

2.T.01 Research and identify electrical system concern; determine necessary action.

2.T.01.01 Research applicable vehicle and service information, such as electrical/electronic system operation, vehicle service history, service precautions and technical service bulletins.

2.T.01.02 Identify electrical integrity for series, parallel and series-parallel circuits using principles of electricity (Ohm's Law).

2.T.01.03 Use wiring diagrams during diagnosis of electrical circuit problems.

2.T.01 Performance Example:
- Student will research and report applicable service information to obtain correct wiring diagram.

2.T.02 Perform basic diagnostic tests to electrical circuits.

2.T.02.01 Check electrical circuits with a test light; determine necessary action.

2.T.02.02 Measure source voltage and perform voltage drop tests in electrical circuits using the voltmeter scale on a digital multimeter (DMM); determine necessary action.

2.T.02.03 Measure current flow in electrical circuits and components using the ammeter scale on a DMM; determine necessary action.

2.T.02.04 Check continuity and measure resistance in electrical circuits and components using an ohmmeter scale on a DMM; determine necessary action.

2.T.02.05 Check electrical circuits using fused jumper wires; determine necessary action.

2.T.02.06 Locate shorts, grounds, opens and resistance problems in electrical; determine necessary action.

2.T.02.07 Measure and identify the possible cause(s) of excessive key-off battery drain (parasitic draw).

2.T.02 Performance Example:
- Student will measure circuit source voltage using a DMM.

2.T.03 Repair common electrical circuits.

2.T.03.01 Inspect and test fusible links, circuit breakers and fuses; determine necessary action.

2.T.03.02 Inspect wiring harnesses and connectors; determine necessary action.
2.T.03.03 Perform solder repair of electrical wiring.
2.T.03.04 Inspect and test switches, connectors, relays, devices and wires of electrical circuits; perform necessary action.

2.T.03 Performance Example:
- Student will repair a wire choosing the appropriate solder type and wire gauge necessary for the repair.

2.U Automotive Batteries

2.U.01 Identify, maintain and service the various types of commonly used automotive batteries.
2.U.01.01 Perform battery state-of-charge test; determine necessary action.
2.U.01.02 Perform battery capacity test; confirm proper battery capacity for vehicle application; determine necessary action.
2.U.01.03 Maintain or restore electronic memory functions.
2.U.01.04 Inspect, clean, fill and replace battery.
2.U.01.05 Perform slow/fast battery charge.
2.U.01.06 Inspect and clean battery cables, connectors, clamps and hold-downs; repair or replace as needed.
2.U.01.07 Start a vehicle using jumper cables and a battery or auxiliary power supply.

2.U.01 Performance Example:
- Student will determine cold cranking amps of battery and perform a battery load test.

2.V Automotive Starting System

2.V.01 Diagnose and repair starting systems.
2.V.01.01 Perform starter current draw tests; determine necessary action.
2.V.01.02 Perform starter circuit voltage drop tests; determine necessary action.
2.V.01.03 Inspect and test starter relays and solenoids; determine necessary action.
2.V.01.04 Remove and install starter in a vehicle.
2.V.01.05 Inspect and test switches, connectors and wires of starter control circuits; perform necessary action.
2.V.01.06 Differentiate between electrical and engine mechanical problems that cause a slow-crank or no-crank condition.

2.V.01 Performance Example:
- Student will perform a voltage drop test on the starter circuit to determine cause of no start condition.

2.W Automotive Charging System

2.W.01 Diagnose and repair charging systems.
2.W.01.01 Perform charging system output test; determine necessary action.
2.W.01.02 Diagnose charging system for the cause of undercharge, no-charge and overcharge conditions.
2.W.01.03 Inspect , adjust or replace generator (alternator) drive belts, pulleys and tensioners; check pulley and belt alignment.
2.W.01.04 Remove, inspect and install generator (alternator).
2.W.01.05 Perform charging circuit voltage drop tests; determine necessary action.

2.W.01 Performance Example:
- Student will perform various charging system test to determine cause of low alternator output.

2.X Electrical Accessories

2.X.01 Diagnose and repair lighting systems.

2.X.01.01 Diagnose the cause of brighter than normal, intermittent, dim, or no light operation; determine necessary action.

2.X.01.02 Inspect, replace and aim headlights and blubs.

2.X.01.03 Inspect and diagnose incorrect turn signal or hazard light operation; perform necessary action.

2.X.01 Performance Example:
- Student will replace a faulty headlight bulb and check for proper headlight aim.

2.X.02 Diagnose and repair gauges, warning devices and driver information systems.

2.X.02.01 Diagnose the cause of incorrect operation of warning devices and other driver information systems; determine necessary action.

2.X.02.02 Inspect and test sensors, connectors and wires of electronic instrument circuits; determine necessary action.

2.X.02 Performance Example:
- Student will test oil pressure gauge circuit and determine cause of failure.

2.X.03 Diagnose and repair horn and wiper/washer systems.

2.X.03.01 Diagnose incorrect horn operation; perform necessary action.

2.X.03.02 Diagnose incorrect wiper operation; diagnose wiper speed control and park problems; perform necessary action.

2.X.03.03 Diagnose incorrect washer operation; perform necessary action.

2.X.03 Performance Example:
- Student will replace horn assembly and recheck for proper operation.

2.X.04 Diagnose and repair accessories.

2.X.04.01 Diagnose incorrect operation of motor-driven accessory circuits; determine necessary action.

2.X.04.02 Diagnose incorrect heated glass operation; determine necessary action.

2.X.04.03 Diagnose incorrect electric lock operation; determine necessary action.

2.X.04.04 Diagnose incorrect operation of cruise control systems; determine necessary action.

2.X.04.05 Activate bi-directional controls when applicable using a scan tool.

2.X.04 Performance Example:
- Student will remove and replace a window motor and confirm operation according to manufacturer's specifications.

2.Y Basic Hybrid Theory

2.Y.01 Identify and describe hybrid electrical circuits.

2.Y.01.01 Identify and describe high-voltage circuits of electric or hybrid electric vehicle and related safety precautions.

2.Y.01.02 Identify and describe hybrid vehicle auxiliary (12v) battery service, repair and test procedures.
2.Y.01.03 Describe the operation of a regenerative braking system.
2.Y.01.04 Identify and describe hybrid vehicle power steering system electrical circuits and safety precautions.

2.Y.01 Performance Example:
- Student uses service information to determine the location of the 12 volt battery.

2.Y.02 Describe hybrid vehicle internal combustion engine service precautions.
2.Y.02.01 Research service information to identify location of high voltage disconnect switch.

2.Y.02 Performance Example:
- Student uses service information to properly identify service precautions necessary to perform basic maintenance.

2.Z General Engine Problems

2.Z.01 Identify, test and repair leaks, abnormal sounds and odors commonly associated with engine malfunctions.
2.Z.01.01 Inspect engine assembly for fuel, oil, coolant and other leaks; determine necessary action.
2.Z.01.02 Identify abnormal engine noise or vibration concerns; determine necessary action.
2.Z.01.03 Identify abnormal exhaust color, odor and sound; determine necessary action.
2.Z.01.04 Adjust valves on engines with mechanical or hydraulic lifters.

2.Z.01 Performance Example:
- Student will remove and replace a valve cover gasket to repair an engine oil leak.

2.Z.02 Perform general engine diagnostic procedures.
2.Z.02.01 Interpret engine performance concern; determine necessary action.
2.Z.02.02 Perform engine absolute (vacuum/boost) manifold pressure tests; determine necessary action.
2.Z.02.03 Inspect and test mechanical and electrical fuel pumps and pump control systems for pressure, regulation and volume; perform necessary action.
2.Z.02.04 Inspect the integrity and test the catalytic converter and heat shield(s); perform necessary action.
2.Z.02.05 Verify accurate camshaft timing.
2.Z.02.06 Perform cylinder power balance test; determine necessary action.
2.Z.02.07 Perform cylinder compression tests; determine necessary action.
2.Z.02.08 Perform cylinder leakage test; determine necessary action.
2.Z.02.09 Identify engine mechanical, electrical, fuel and ignition concerns with engine diagnostic equipment.
2.Z.02.10 Retrieve and record stored On the Board Diagnostics II (OBD II) diagnostic trouble codes; clear codes.

2.Z.02 Performance Example:
- Student will perform a fuel pressure test and determine necessary action.

2.Z.03 Inspect, diagnose and repair cooling system concerns.
- 2.Z.03.01 Verify engine operating temperature; determine necessary action.
- 2.Z.03.02 Remove and replace thermostat.
- 2.Z.03.03 Perform cooling system pressure tests; check coolant condition; inspect and test radiator, pressure cap, coolant recovery tank and hoses; perform necessary action.
- 2.Z.03.04 Inspect and test mechanical/electrical fans, fan clutch, fan shroud/ducting, air dams and fan control devices; perform necessary action.

2.Z.03 Performance Example:
- Student will pressurize a cooling system to locate the source of a leak.

2.AA Ignition Systems

2.AA.01 Diagnose and repair engine performance concerns relative to the ignition primary circuit.
- 2.AA.01.01 Inspect and test ignition primary circuit wiring and components; perform necessary action.
- 2.AA.01.02 Inspect and test ignition system pick-up sensor or triggering devices; perform necessary action.
- 2.AA.01.03 Inspect and test ignition coil(s); perform necessary action.
- 2.AA.01.04 Inspect, diagnose and repair coil over plug ignition systems (i.e., new).
- 2.AA.01.05 Identify ignition system related problems such as no-starting engine misfire, spark knock, power loss, concerns on vehicles with electronic ignition (i.e., distributor less and distributor) systems.

2.AA.01 Performance Example:
- Student will test for source voltage at ignition control module.

2.AA.02 Diagnose and repair engine performance concerns relative to the ignition secondary circuit.
- 2.AA.02.01 Inspect and test ignition system secondary circuit wiring and components; perform necessary action.

2.AA.02 Performance Example:
- Student will use a spark tester to determine secondary voltage output.

2.BB Emissions Control Systems

2.BB.01 Identify and diagnose common causes of positive crankcase ventilation and evaporative emissions system concerns.
- 2.BB.01.01 Diagnose oil leaks, emissions and drivability problems resulting from malfunctions in the positive crankcase ventilation (PCV) system; determine necessary action.
- 2.BB.01.02 Inspect, test and service positive crankcase ventilation (PCV) filter/breather cap, valve, tubes, orifices and hoses; perform necessary action.
- 2.BB.01.03 Identify emissions and drivability problems resulting from malfunctions in the evaporative emissions control system.
- 2.BB.01.04 Inspect and test components and hoses of evaporative emissions control system; perform necessary action.
- 2.BB.01.05 Interpret evaporative emission related diagnostic trouble codes (DTCs); determine necessary action.

2.BB.01 Performance Example:
- Student will use a vacuum gauge to test positive crankcase ventilation (PCV) system and determine necessary action.

2.BB.02 Identify and diagnose common causes of catalytic converter, secondary air and exhaust gas recirculation system concerns.

2.BB.02.01 Inspect and test catalytic converter performance.

2.BB.02.02 Inspect and test mechanical components of secondary air injection systems; perform necessary action.

2.BB.02.03 Inspect and test the operation of electrical components and circuits or air injection systems; perform necessary action.

2.BB.02.04 Identify emission and drivability problems caused by malfunctions in the exhaust gas recirculation (EGR) system.

2.BB.02.05 Inspect, test, service and replace components of the EGR system, including EGR tubing, exhaust passages, vacuum/pressure controls, filters and hoses; perform necessary action.

2.BB.02.06 Inspect and test electrical/electronic sensors, controls and wiring of exhaust gas recirculation (EGR) systems; perform necessary action.

2.BB.02 Performance Example:
- Student will remove the exhaust gas recirculation (EGR) valve, inspect the intake and exhaust passages, and determine necessary action.

Supplemental Automotive Technology Technical Knowledge and Skills

Note: The following competencies are optional, supplementary competencies suitable for advanced students. These are not required.

2.CC* Demonstrate appropriate engine repair techniques.

2.CC.01* Perform appropriate cylinder Head Repair.

2.CC.01.01* Diagnose, remove and replace cylinder head(s).

2.CC.01.02* Clean and visually inspect a cylinder head for cracks; check gasket surface areas for warpage and surface finish; check passage condition; determine necessary action.

2.CC.02* Demonstrate appropriate valve, valve train, and camshafts service techniques.

2.CC.02.01* Identify overhead cam, dual overhead cam, and overhead valve engines.

2.CC.02.02* Inspect pushrods, rocker arms, rocker arm pivots and shafts for wear, bending, cracks, looseness, and blocked oil passages (orifices); determine necessary action.

2.CC.02.03* Check drive gear wear and backlash, sprocket and chain wear, overhead cam drive sprocket(s), drive belt(s), belt tension, tensioners, camshaft reluctor ring/tone-wheel, and valve timing components; verify correct camshaft timing.

2.CC.02.04* Inspect and replace camshaft and drive belt/chain.

2.CC.02.05* Establish camshaft position sensor indexing.

2.CC.03* Identify, assess and repair cylinder block and internal components.

2.CC.03.01* Identify block cylinder arrangement.

2.CC.03.02* Identify abnormal sounds.

2.CC.03.03* Identify abnormal exhaust color.

2.CC.03.04* Remove, inspect, or replace crankshaft vibration damper (harmonic balancer).
2.CC.03.05* Measure crankshaft end play, compare to specification; determine necessary action.

2.CC.04* Assess and repair engine cooling systems.
2.CC.04.01* Perform cooling system pressure and dye tests to identify leaks; check coolant condition and level; inspect and test radiator, pressure cap, coolant recovery tank, and heater core; determine necessary action.
2.CC.04.02* Identify causes of engine overheating.
2.CC.04.03* Inspect, replace, and adjust drive belts, tensioners, and pulleys; check pulley and belt alignment.
2.CC.04.04* Inspect and test coolant; drain and recover coolant; flush and refill cooling system with recommended coolant; bleed air as required.
2.CC.04.05* Inspect, remove, and replace water pump.
2.CC.04.06* Remove and replace radiator.
2.CC.04.07* Inspect and test fan(s) (electrical or mechanical), fan clutch, fan shroud, and air dams.

2.CC.05* Engine Lubrication.
2.CC.05.01* Perform oil pressure tests; determine necessary action.
2.CC.05.02* Inspect auxiliary coolers; determine necessary action.
2.CC.05.03* Inspect, test, and replace oil temperature and pressure switches and sensors.

2.DD* Automatic Transmission/Transaxle

2.DD.01* Demonstrate appropriate vehicle service techniques.
2.DD.01.01* Identify and interpret transmission/transaxle concern, differentiate between engine performance and transmission/transaxle concerns; determine necessary action.
2.DD.01.02* Research applicable vehicle and service information fluid type, vehicle service history, service precautions, and technical service bulletins.
2.DD.01.03* Diagnose fluid loss condition concerns; determine necessary action.
2.DD.01.04* Check fluid level in a transmission or a transaxle equipped with a dip-stick.
2.DD.01.05* Check fluid level in a transmission or a transaxle not equipped with a dip-stick.
2.DD.01.06* Perform pressure tests (including transmissions/transaxles equipped with electronic pressure control); determine necessary action.
2.DD.01.07* Diagnose noise and vibration concerns; determine necessary action.
2.DD.01.08* Perform stall test; determine necessary action.
2.DD.01.09* Perform lock-up converter system tests; determine necessary action.
2.DD.01.10* Diagnose transmission/transaxle gear reduction/multiplication concerns using driving, driven, and held member (power flow) principles.
2.DD.01.11* Diagnose electronic transmission/transaxle control systems using appropriate test.
2.DD.01.12* Diagnose pressure concerns in a transmission using hydraulic principles (Pascal's Law).
2.DD.01.13* Inspect, adjust, and replace external manual valve shift linkage, transmission range sensor/switch, and park/neutral position switch.
2.DD.01.14* Inspect for leakage; replace external seals, gaskets, and bushings.
2.DD.01.15* Inspect, test, adjust, repair, or replace electrical/electronic components and circuits including computers, solenoids, sensors, relays, terminals, connectors, switches, and harnesses.

2.DD.02* Demonstrate appropriate out of vehicle service techniques.
- 2.DD.02.01* Remove and reinstall transmissions/transaxle and torque converter; inspect engine core plugs, rear crankshaft seal, dowel pins, dowel pin holes, and mating surfaces.
- 2.DD.02.02* Inspect, leak test, and flush or replace transmission/transaxle oil cooler, lines, and fittings.
- 2.DD.02.03* Inspect converter flex (drive) plate, converter attaching bolts, converter pilot, converter pump drive surfaces, converter end play, and crankshaft pilot.
- 2.DD.02.04* Describe the operational characteristics of a continuously variable transmission (CVT).

2.EE* Manual Transmission and Drive-Train.

2.EE.01* Demonstrate appropriate hub, joint, shaft, and yolk techniques.
- 2.EE.01.01* Diagnose constant-velocity (CV) joint noise and vibration concerns; determine necessary action.
- 2.EE.01.02* Diagnose universal joint noise and vibration concerns; perform necessary action.
- 2.EE.01.03* Inspect, remove, and replacer front wheel drive (FWD) bearings, hubs, and seals.
- 2.EE.01.04* Inspect, service, and replace shafts, yokes, boots, and universal/CV joints.
- 2.EE.01.05* Check shaft balance and phasing; measure shaft runout; measure and adjust driveline angles.

2.EE.02* Demonstrate appropriate differential repair and service techniques.
- 2.EE.02.01* Clean and inspect differential housing; check for leaks; inspect housing vent.
- 2.EE.02.02* Check and adjust differential housing fluid level.
- 2.EE.02.03* Drain and refill differential housing.
- 2.EE.02.04* Diagnose noise and vibration concerns; determine necessary action.
- 2.EE.02.05* Inspect and replace companion flange and pinion seal; measure companion flange run out.

2.FF* Drive Axles

2.FF.01* Perform appropriate axle shaft service techniques.
- 2.FF.01.01* Inspect and replace drive axle wheel studs.
- 2.FF.01.02* Remove and replace drive axle shafts.
- 2.FF.01.03* Inspect and replace drive axle shaft seals, bearings, and retainers.
- 2.FF.01.04* Measure drive axle flange runout and shaft end play; determine necessary action.
- 2.FF.01.05* Diagnose drive axle shafts, bearings, and seals for noise, vibration, and fluid leakage concerns; determine necessary action.

2.GG* Four Wheel Drive.

2.GG.01* Inspect, adjust, and repair transfer cases and locking hubs.
- 2.GG.01.01* Inspect, adjust, and repair shifting controls (mechanical, electrical, and vacuum), bushings, mounts, levers, and brackets.
- 2.GG.01.02* Inspect front-wheel bearings and locking hubs; perform necessary actions(s).
- 2.GG.01.03* Check for leaks at drive assembly seals; check vents; check lube level.
- 2.GG.01.04* Identify concerns related to variations in tire circumference and/or final drive ratios.
- 2.GG.01.05* Diagnose noise, vibration, and unusual steering concerns; determine necessary action.

2.GG.01.06* Diagnose, test, adjust, and replace electrical/electronic components of four-wheel drive systems.

2.HH* Manual Transmissions/Transaxle and Clutch Assembly.

2.HH.01* Assess and repair manual transmissions/transaxles.

2.HH.01.01* Identify and interpret Manual drive train concerns; determine necessary action.

2.HH.01.02* Research applicable vehicle and service information, fluid type, vehicle service history, service precautions, and technical service bulletins.

2.HH.01.03* Inspect, remove or replace manual transmission/transaxle.

2.HH.01.04* Describe the operational characteristics of an electronically-controlled Manual transmission/transaxle.

2.HH.01.05* Diagnose noise concerns through the application of transmission/transaxle power flow principles.

2.HH.01.06* Diagnose hard shifting and jumping out of gear concerns; determine necessary action.

2.HH.01.07* Diagnose transaxle final drive assembly noise and vibration concerns; determine necessary action.

2.HH.01.08* Inspect, remove or replace power-train mounts.

2.HH.02* Inspect, diagnose and repair clutch assembly.

2.HH.02.01* Diagnose clutch noise, binding, slippage, pulsation, and chatter; determine necessary action.

2.HH.02.02* Inspect clutch pedal linkage, cables, automatic adjuster mechanisms, brackets, bushings, pivots, and springs; perform necessary action.

2.HH.02.03* Inspect and replace clutch pressure plate assembly, clutch disc, release (throw-out) bearing and linkage, and pilot bearing/bushing.

2.HH.02.04* Bleed clutch hydraulic system.

2.HH.02.05* Check and adjust clutch master cylinder fluid level; check for leaks.

2.HH.02.06* Inspect flywheel and ring gear for wear and cracks; determine necessary action.

2.HH.02.07* Measure flywheel run-out and crankshaft end play; determine necessary action.

2.II* Heating and Air Conditioning.

2.II.01* Heating System.

2.II.01.01* Identify and interpret heating problems; determine necessary action.

2.II.01.02* Research applicable vehicle service information, vehicle service history, service precautions, and technical service bulletins.

2.II.01.03* Inspect and test heater control valve(s); perform necessary action.

2.II.01.04* Inspect heater blend door for proper operation.

2.II.02* Inspect, diagnose and repair air conditioning systems.

2.II.02.01* Conduct performance A/C system testing; identify problems.

2.II.02.02* Identify abnormal operating noises in the A/C system; determine necessary action.

2.II.02.03* Identify refrigerant type; select and connect gauge set; record temperature and pressure readings according to current industry standards.

2.II.02.04* Leak test A/C system; determine necessary action.

2.II.02.05* Inspect condition of refrigerant oil removed from A/C system; determine necessary action.

2.II.02.06* Identify the source of A/C system odors.

2.II.03* Inspect, diagnose and repair heating and air conditioning controls.

2.II.03.01* Inspect and test A/C-heater blower motors, resistors, switches, relays, wiring, and protection devices; perform necessary action.
2.II.03.02* Diagnose A/C compressor clutch control systems; determine necessary action.
2.II.03.03* Diagnose malfunctions in the vacuum, mechanical, and electrical components and controls of the heating, ventilation, and A/C (HVAC) system; determine necessary action.
2.II.03.04* Inspect and test A/C-heater control panel assembly; determine necessary action.
2.II.03.05* Inspect and test A/C-heater control cables, motors, and linkages; perform necessary action.
2.II.03.06* Inspect A/C-heater ducts, doors, hoses, cabin filters, and outlets; perform necessary action.
2.II.03.07* Diagnose temperature control problems in the heater/ventilation system; determine necessary action.
2.II.03.08* Check operation of automatic or semi-automatic heating, ventilation, and air-conditioning (HVAC) control systems; determine necessary action.

2.JJ* Engine Performance.

2.JJ.01* Inspect, diagnose and fix No Code Repairs.
2.JJ.01.01* Diagnose hot or cold no-starting, hard starting, poor drivability, incorrect idle speed, poor idle, flooding, hesitation, surging, engine misfire, power loss, stalling, poor mileage, dieseling, and emissions problems on vehicles.
2.JJ.01.02* Inspect throttle body, air induction system, intake manifold and gaskets for vacuum leaks and/or unmetered air.
2.JJ.01.03* Perform exhaust system back-pressure test; determine necessary action.
2.JJ.02* Inspect, diagnose and fix Code Repairs.
2.JJ.02.01* Check for module communication errors using a scan tool.
2.JJ.02.02* Obtain and interpret scan tool data.
2.JJ.02.03* Diagnose the causes of emissions or drivability concerns resulting from malfunctions in the computerized engine control system with stored diagnostic trouble codes.
2.JJ.02.04* Check for module communication errors using a scan tool.

Strand 3: Embedded Academics

Strand 3: Embedded Academics, a critical piece of a Vocational Technical Education Framework, are presented as Crosswalks between the Massachusetts Vocational Technical Education Frameworks and the Massachusetts Curriculum Frameworks. These Crosswalks are located in the Appendix of this Framework.

Academic Crosswalks

Appendix A: English Language Arts
Appendix B: Mathematics
Appendix C: Science and Technology/Engineering
Earth and Space Science
Life Science (Biology)
Physical Science (Chemistry and Physics)
Technology/Engineering

Strand 4: Employability and Career Readiness

4.A Career Exploration and Navigation

4.A.01 Develop a career plan and portfolio.

- 4.A.01.01 Develop and revise career plan annually based on workplace awareness and skill attainment.
- 4.A.01.02 Assess personal strengths and interest areas to determine potential careers, career pathways and career ladders.
- 4.A.01.03 Examine potential career field(s)/discipline(s) and identify criteria to select, secure and keep employment in chosen field(s).
- 4.A.01.04 Research and evaluate a variety of careers utilizing multiple sources of information and resources to determine potential career(s) and alternatives.
- 4.A.01.05 Identify training and education requirements that lead to employment in chosen field(s) and demonstrate skills related to evaluating employment opportunities.
- 4.A.01.06 Explore and evaluate postsecondary educational opportunities including degrees and certifications available, traditional and nontraditional postsecondary pathways, technical school and apprenticeships, cost of education, financing methods including scholarships and loans and the cost of loan repayment.
- 4.A.01.07 Create a portfolio showcasing academic and career growth including a career plan, safety credential, resume and a competency profile demonstrating the acquisition of the knowledge and skills associated with at least two years of full-time study in the Chapter 74 program.

4.A.02 Demonstrate job search skills.

- 4.A.02.01 Conduct a job search and complete written and electronic job applications, resumes, cover letters and related correspondence for a chosen career path.
- 4.A.02.02 Explore and evaluate postsecondary job opportunities and career pathways specific to career technical areas.
- 4.A.02.03 Identify role and use of social media and networking for staying current with career and employment trends as well as networking, job seeking and career development opportunities.
- 4.A.02.04 Demonstrate ability to use social media and networking to develop useful occupational contacts, job seeking and career development opportunities.

4.A.03 Demonstrate all phases of the job interview process.

- 4.A.03.01 Gather relevant information about potential employer(s) from multiple print and digital sources, assessing the credibility and accuracy of each source.
- 4.A.03.02 Identify employment eligibility criteria, such as drug/alcohol free status, clean driving record, etc.

4.A.03.03 Practice effective interviewing skills: appearance, inquiry and dialogue with interviewer, positive attitude and evidence of work ethic and skills.

4.A.03.04 Explore and evaluate employment benefit packages including wages, vacation, health care, union dues, cafeteria plans, tuition reimbursement, retirement and 401K.

4. A Performance Examples:

- Conduct research to analyze and present on specific careers within a cluster.
- Conduct web-based job search using sites such as Monster.com, CareerBuilder.com, Indeed.com, Snagajob.com, Simplyhired.com and others.
- Create profile on social media/networking site such as LinkedIn and/or LinkedIn University for postsecondary research and employment opportunities.
- Complete online job application.
- Conduct and videotape practice interviews for instructor and student analysis.
- Provide students with sample employment and benefit packages for evaluation.

4.B Communication in the Workplace

4.B.01 Demonstrate appropriate oral and written communication skills in the workplace.

4.B.01.01 Communicate effectively using the language and vocabulary appropriate to a variety of audiences within the workplace including coworkers, supervisors and customers.

4.B.01.02 Read technical and work-related documents and demonstrate understanding in oral discussion and written exercise.

4.B.01.03 Demonstrate professional writing skills in work-related materials and communications (e.g., letters, memoranda, instructions and directions, reports, summaries, notes and/or outlines).

4.B.01.04 Use a variety of writing/publishing/presentation applications to create and present information in the workplace.

4.B.01.05 Identify, locate, evaluate and use print and electronic resources to resolve issues or problems in the workplace.

4.B.01.06 Use a variety of financial and data analysis tools to analyze and interpret information in the workplace.

4.B.01.07 Orally present technical and work-related information to a variety of audiences.

4.B.01.08 Identify and demonstrate professional non-verbal communication.

4.B.02 Demonstrate active listening skills.

4.B.02.01 Listen attentively and respectfully to others.

4.B.02.02 Focus attentively, make eye contact or other affirming gestures, confirm understanding and follow directions.

4.B.02.03 Show initiative in improving communication skills by asking follow-up questions of speaker in order to confirm understanding.

4. B Performance Examples:

- Read and analyze technical instructions to learn what makes them effective.
- Read and analyze technical instructions to follow directions and/or solve a problem.
- Examine a technical document and use it to write a set of instructions for another student to follow and evaluate.
- Analyze websites for effective technical writing and design.
- Create brochures and presentations using software and/or Web 2.0 tools to convey technical information.
- Conduct research using the Internet, print documents, observations and interviews to create a technical guide.

4.C Work Ethic and Professionalism

4.C.01 Demonstrate attendance and punctuality.

- 4.C.01.01 Identify and practice professional time-management and attendance behaviors including punctuality, reliability, planning and flexibility.

4.C.02 Demonstrate proper workplace appearance.

- 4.C.02.01 Identify and practice professional appearance specific to the workplace.
- 4.C.02.02 Identify and practice personal hygiene appropriate for duties specific to the workplace.
- 4.C.02.03 Identify and wear required safety gear specific to the workplace.

4.C.03 Accepts direction and constructive criticism.

- 4.C.03.01 Demonstrate ability (both verbally and non-verbally) to accept direction and constructive criticism and to implement solutions to change behaviors.
- 4.C.03.02 Ask appropriate questions to clarify understanding of feedback.
- 4.C.03.03 Analyze own learning style and seek instructions in a preferred format that works best for their understanding (such as oral, written or visual instruction).

4.C.04 Demonstrate motivation and initiative.

- 4.C.04.01 Evaluate assigned tasks for time to completion and prioritization.
- 4.C.04.02 Demonstrate motivation through enthusiasm, engagement, accurate completion of tasks and activities.
- 4.C.04.03 Demonstrate initiative by requesting new assignments and challenges.
- 4.C.04.04 Explain proposed solutions to challenges observed in the workplace.
- 4.C.04.05 Demonstrate the ability to evaluate multiple solutions to problems and challenges using critical reasoning and workplace/industry knowledge and select the best solution to the problem.
- 4.C.04.06 Implement solution(s) to challenges and/or problem(s) observed in the workplace.
- 4.C.04.07 See projects through completion and check work for quality and accuracy.

4.C.05 Demonstrate awareness of workplace culture and policy.

4.C.05.01 Display ethical behavior in use of time, resources, computers and information.
4.C.05.02 Identify the mission of the organization and/or department.
4.C.05.03 Explain the benefits of a diverse workplace.
4.C.05.04 Demonstrate a respect for diversity and its benefit to the workplace.

4.C.06 Interact appropriately with coworkers.
4.C.06.01 Work productively with individuals and in teams.
4.C.06.02 Develop positive mentoring and collaborative relationships within work environment.
4.C.06.03 Show respect and collegiality, both formally and informally.
4.C.06.04 Explain and follow workplace policy on the use of cell phones and other forms of social media.
4.C.06.05 Maintain focus on tasks and avoid negative topics or excessive personal conversations in the workplace.
4.C.06.06 Negotiate solutions to interpersonal and workplace conflicts.

4. C Performance Examples:
- Complete a learning style analysis tool.
- Develop a rubric to assess work ethic and professionalism as detailed in the standards above.

Student Organizations

Business Professionals of America www.bpa.org

Selected Websites

- 5 Ways to Ace a Job Interview: http://kidshealth.org/teen/school_jobs/jobs/tips_interview.html
- America's Career Resource Network: http://acrn.ovae.org/teachers/careerexpclassrm.htm
- Career Cruiser – Florida Department of Education: http://www.fldoe.org/workforce/pdf/cruiser.pdf
- Career Development Guide and Glossary: http://www.doe.mass.edu/connect/cde.html
- Career One Stop: http://www.careeronestop.org/
- Career Plan: http://www.doe.mass.edu/cd/plan/intro.html
- Career Plan Model: http://www.doe.mass.edu/ccr/epp/samples/cpmodel_11x17.pdf
- Checklist: http://www.doe.mass.edu/cd/plan/checklist.pdf
- Career Tech: http://www.okcareertech.org/cac/Pages/resources_products/ethics_web_sites.htm
- Ethics Resource Center: http://www.ethics.org/
- Interaction in the Workplace: http://hrweb.berkeley.edu/guides/managing-hr/interaction/communication
- Individual Learning Plans: How-to Guide: "Promoting Quality Individualized Learning Plans: A How to Guide on the High School Years" http://www.ncwd-youth.info/ilp/how-to-guide

- ILP Fact Sheet: http://www.ncwd-youth.info/fact-sheet/individualized-learning-plan
- ILP Policy Brief: http://www.ncwd-youth.info/ilp/produce-college-and-career-ready-high-school-graduates
- ILP Resources Home Page: http://www.ncwd-youth.info/ilp
- Interview Skills Lesson Plans: http://www.amphi.com/media/1220281/interview%20skills%20lesson%20plan.doc
- Labor and Workforce Development: http://www.mass.gov/lwd/employment-services/preparing-for-your-job-search/
- Maine Community College System – Center for Career Development: http://www.ccd.me.edu/careerprep/CareerPrepCurriculum_LP-6.pdf
- Massachusetts Work-Based Learning: http://skillspages.com/masswbl
- North Dakota Association of Agriculture Educators: http://www.ndaae.org/attachments/File/Preparing_students_for_a_Job_Interview.pptx
- NY CTE Learning Standards—Career Development and Occupational Studies (CDOS) Resource Guide with Core Curriculum : http://www.p12.nysed.gov/cte/cdlearn/cdosresourceguide.html
- Occupational Outlook Handbook: http://www.bls.gov/ooh/
- Purdue OWL Job Search Resources (for writing resumes, applications, and letters): https://owl.english.purdue.edu/engagement/34/
- Soft Skills to Pay the Bills — Mastering Soft Skills for Workplace Success: http://www.dol.gov/odep/topics/youth/softskills/
- US Department of Labor: http://www.dol.gov/dol/audience/aud-unemployed.htm
- Workplace Communication: http://www.regionalskillstraining.com/sites/default/files/content/WC%20Book%201.pdf
- Your Plan For the Future: http://www.yourplanforthefuture.org

Strand 5: Management and Entrepreneurship Knowledge and Skills

5.A Starting a Business

5.A.01 Demonstrate an understanding of the practices required to start a business.

- 5.A.01.01 Define entrepreneurship and be able to recognize and describe the characteristics of an entrepreneur.
- 5.A.01.02 Compare and contrast types of business ownership (i.e., sole proprietorships, franchises, partnerships, corporations).
- 5.A.01.03 Identify and explain the purpose and contents of a business plan.
- 5.A.01.04 Demonstrate an understanding of the principles and concepts of a business's supply chain (i.e., suppliers, producers and consumers.

5. A Performance Examples:

- Develop a presentation pertaining to an entrepreneur and their business.
- Communicate with a business owner and discuss the pros and cons of starting and owning a business. Summarize the main points of the discussion.
- Choose a product or service and describe the process leading to distribution.
- Write a business plan for a business in your community.

5.B Managing a Business

5.B.01 Demonstrate an understanding of managing a business.

- 5.B.01.01 Formulate short- and long-term business goals.
- 5.B.01.02 Demonstrate effective verbal, written and visual communication skills.
- 5.B.01.03 Utilize a decision-making process to make effective business decisions.
- 5.B.01.04 Identify a business's chain of command and define its organizational structure.
- 5.B.01.05 Identify and apply effective customer service skills and practices.
- 5.B.01.06 Identify, interpret and develop written operating procedures and policies.
- 5.B.01.07 Track inventory, productivity and labor cost.
- 5.B.01.08 Demonstrate business meeting skills.
- 5.B.01.09 Identify professional organizations and explore their benefits.

5. B Performance Examples:

- Working as a team, role-play situations that an entrepreneur might face in dealing with customers or employees.
- Contact a relevant professional organization and request information about its benefits, membership requirements and costs.
- Plan and conduct a business meeting.
- Identify companies that are known for customer service and list the practices that help differentiate themselves from all others in their industry.

5.C Marketing a Business

5.C.01 Demonstrate an understanding of marketing and promoting a business.

- 5.C.01.01 Explain the role of business in the economy.
- 5.C.01.02 Describe the relationship between business and community.
- 5.C.01.03 Describe methods of market research and identifying target markets.

5.C.01.04 Describe and apply the concepts of a marketing mix (the 4Ps of marketing: product, price, place and promotion).
5.C.01.05 Compare and contrast the promotional tools and techniques used to sell products, services, images and ideas.
5.C.01.06 Describe the impact of supply and demand on a product or business.
5.C.01.07 Identify direct and indirect competition on a business.
5.C.01.08 Identify and use sales techniques to meet client needs and wants.
5.C.01.09 Discuss strategies to acquire and retain a customer base.

5. C Performance Examples:
- Research reliable sources to identify marketing and industry data related to a business.
- Conduct market research by developing a survey and presenting the results.
- Create a promotional campaign using a variety of media.
- Write a marketing plan for a product.

5.D Financial Concepts and Applications in Business

5.D.01 Demonstrate an understanding of financial concepts and applications.

5.D.01.01 Identify essential financial reports and understand their purpose (i.e., budget, balance sheet and income statement).
5.D.01.02 Describe payroll practices (i.e., deductions – federal, FICA and state taxes and insurances).
5.D.01.03 Identify the importance of maintaining accurate records.
5.D.01.04 Apply practices related to pricing, purchasing and billing.
5.D.01.05 Maintain and reconcile a checking account.
5.D.01.06 Identify the options for funding a business.

5. D Performance Examples:
- Given an employee time card and rate of pay, calculate gross pay, taxes, deductions and net pay.
- Develop a budget for a simulated business or project.
- Analyze and discuss financial documents from a company.
- Research various methods of funding a business.

5.E Legal/Ethical/Social Responsibilities

5.E.01 Demonstrate an understanding of legal, ethical and social responsibility for businesses.

5.E.01.01 Identify state and federal laws and regulations related to managing a business.
5.E.01.02 Describe and identify ethical business practices.
5.E.01.03 Demonstrate an understanding of business contracts.
5.E.01.04 Explain the role of diversity in the workplace.
5.E.01.05 Explain the role of labor organizations.
5.E.01.06 Identify practices that support clean energy technologies and encourage environmental sustainability.
5.E.01.07 Demonstrate an understanding of how technology advancements impact business practices.

5.E Performance Example:
- Read and interpret a contract.
- Complete an application for a license, permit or certificate.
- Research federal, state and local regulations and laws required for a business.
- Participate in and summarize a discussion with a member of a labor or civil rights organization.

Selected Websites

- CVTE Strand 1, 4, and 5 Resources: https://sites.google.com/a/mccanntech.org/cvte-strands-1-4-and-5-resources/
- Entrepreneur: http://www.entrepreneur.com
- Inc. Magazine: http://www.inc.com/
- Junior Achievement "Be Entrepreneurial Program": https://www.juniorachievement.org/web/ja-usa/home
- Kahn Academy Interviews with Entrepreneurs: https://www.khanacademy.org/economics-finance-domain/entrepreneurship2/interviews-entrepreneurs
- Kauffman Founders School: http://www.entrepreneurship.org/en/founders-school.aspx
- National Federation of Independent Business: www.nfib.com
- National Foundation for Teaching Entrepreneurship (NFTE): www.nfte.com
- SBA Loans: http://www.sba.gov
- SkillsUSA Professional Development Program Competency List: http://www.skillsusa.org/downloads/PDF/lessons/professional/PDPPreview.pdf
- Small Business Administration: www.sba.gov

Glossary

Term	**Definition**
Balance sheet	A statement of the assets, liabilities and capital of a business at a particular point in time.
Budget	An estimate of income and expenditure for a set period of time.
Business Ownership	Types of business ownership refer to the legal structure of an organization. Legal structures include: Sole Proprietorship, Partnerships, Corporations and Limited Liability Companies.
Business Plan	A written document that describes in detail your business goals and how you are going to achieve them from a marketing, operational and financial point of view.

Term	Definition
Chain of Command and Organizational Structure 	Refers to the management structure of an organization. It identifies lines of authority, lines of communication, and reporting relationships. Organizational structure determines how the roles, power and responsibilities are assigned and coordinated and how information flows between the different levels of management. (A visual representation of this structure is called an org chart).
FICA	Federal Insurance Contributions Act requires taxes deducted from pay for supporting Social Security.
Income Statement	A financial statement providing operating results for a specific time period showing a business's revenues, expenses and profit or loss.
Market Research	• Primary: Surveys, Focus Groups, Observation • Secondary: Websites, Internet
Marketing Mix	A set of controlled variables that formulate the strategic position of a product or service in the marketplace. These variables are known as the 4 P's of marketing and include product, place, price and promotion.
Methods to Track Inventory, Productivity and Labor Cost	Refers to the processes a business uses to account for: 1) the inflows and outflows of inventory and materials related to inventory; 2) the efficiency of operations and 3) the cost of labor including salary and benefits.
Promotional Tools and Techniques	The six elements of a promotional mix are: advertising, visual merchandising, public relations, publicity, personal selling and sales promotion.
Supply Chain	The supply chain, or channel of distribution, describes how the product is handled and/or distributed from suppliers with materials, to the manufacturer, wholesaler or retailer and finally to the consumer.
Target Market	Those who are most likely to buy your product or service.

Strand 6: Technology Literacy Knowledge and Skills

6.A Technology Literacy Knowledge and Skills (Grades 9 through 12)

6.A.01 Demonstrate proficiency in the use of computers and applications, as well as an understanding of the concepts underlying hardware, software, and connectivity.

- 6.A.01.01 Use online help and other support to learn about features of hardware and software, as well as to assess and resolve problems.
- 6.A.01.02 Install and uninstall software; compress and expand files (if the district allows it).
- 6.A.01.03 Explain effective backup and recovery strategies.
- 6.A.01.04 Apply advanced formatting and page layout features when appropriate (e.g., columns, templates, and styles) to improve the appearance of documents and materials.
- 6.A.01.05 Use editing features appropriately (e.g., track changes, insert comments).
- 6.A.01.06 Identify the use of word processing and desktop publishing skills in various careers.
- 6.A.01.07 Identify the use of database skills in various careers.
- 6.A.01.08 Define and use functions of a spreadsheet application (e.g., sort, filter, find).
- 6.A.01.09 Explain how various formatting options are used to convey information in charts or graphs.
- 6.A.01.10 Identify the use of spreadsheet skills in various careers.
- 6.A.01.11 Use search engines and online directories.
- 6.A.01.12 Explain the differences among various search engines and how they rank results.
- 6.A.01.13 Explain and demonstrate effective search strategies for locating and retrieving electronic information (e.g., using syntax and Boolean logic operators).
- 6.A.01.14 Describe good practices for password protection and authentication.

6.A.02 Demonstrate the responsible use of technology and an understanding of ethics and safety issues in using electronic media at home, in school, and in society.

- 6.A.02.01 Demonstrate compliance with the school's Acceptable Use Policy.
- 6.A.02.02 Explain issues related to the responsible use of technology (e.g., privacy, security).
- 6.A.02.03 Explain laws restricting the use of copyrighted materials.
- 6.A.02.04 Identify examples of plagiarism, and discuss the possible consequences of plagiarizing the work of others.

6.A.03 Design and implement a personal learning plan that includes the use of technology to support lifelong learning goals.

- 6.A.03.01 Evaluate the authenticity, accuracy, appropriateness, and bias of electronic resources, including Web sites.
- 6.A.03.02 Analyze the values and points of view that are presented in media messages.
- 6.A.03.03 Describe devices, applications, and operating system features that offer accessibility for people with disabilities.

6.A.03.04 Evaluate school and work environments in terms of ergonomic practices.

6.A.03.05 Describe and use safe and appropriate practices when participating in online communities (e.g., discussion groups, blogs, social networking sites).

6.A.03.06 Explain and use practices to protect one's personal safety online (e.g., not sharing personal information with strangers, being alert for online predators, reporting suspicious activities).

6.A.03.07 Explain ways individuals can protect their technology systems and information from unethical users.

6.A.04 Demonstrate the ability to use technology for research, critical thinking, problem solving, decision making, communication, collaboration, creativity, and innovation.

6.A.04.01 Devise and demonstrate strategies for efficiently collecting and organizing information from electronic sources.

6.A.04.02 Compare, evaluate, and select appropriate electronic resources to locate specific information.

6.A.04.03 Select the most appropriate search engines and directories for specific research tasks.

6.A.04.04 Use a variety of media to present information for specific purposes (e.g., reports, research papers, presentations, newsletters, Web sites, podcasts, blogs), citing sources.

6.A.04.05 Demonstrate how the use of various techniques and effects (e.g., editing, music, color, rhetorical devices) can be used to convey meaning in media.

6.A.04.06 Use online communication tools to collaborate with peers, community members, and field experts as appropriate (e.g., bulletin boards, discussion forums, listservs, Web conferencing).

6.A.04.07 Plan and implement a collaborative project with students in other classrooms and schools using telecommunications tools (e.g., e-mail, discussion forums, groupware, interactive Web sites, video conferencing).

Appendices

The framework teams created an "Appendix" listing potential industry recognized credentials attainable by secondary students; lists of professional, student, and relevant government organizations; and useful resources and websites. **** It is important to note that although most Framework Teams provided information for the "Appendix", not all teams did. Therefore, sub-headings within the "Appendix" without information have been deleted.***

Disclaimer: Reference in the Appendices Section to any specific commercial products, processes, or services, or the use of any trade, firm or corporation name is for the information and convenience of the public, and does not constitute endorsement or recommendation by the Massachusetts Department of Elementary and Secondary Education.

Embedded Academic Crosswalks

Embedded English Language Arts and Literacy

CVTE Learning Standard Number	Strand Coding Designation Grades ELAs Learning Standard Number	Text of English Language Arts Learning Standard
2.A.01, 2.B.01 -05 2D, 2G, 2H,2.I.02, 2.I.03,2.J.02 , 2.K.01.05-06, 2.N.01, 2.O.01, 2.P.02, 2.Q.01, 2.R.03, 2.T.02, 2U, 2V, 2.Z.01, 2.Z.02,2AA	RST 3. Grades 9-10	Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
Performance Example: • Students will read technical manuals, texts, and manufacturer's recommendations then accurately perform complex technical tasks in the career area setting, taking into account special situations and recommendations.		
2.A.02, 2.B.06-08, 2C, 2.I.01, 2.J.03, 2.N.02, 2.O.02, 2.P.01,2.Q.2 2.R.03, 2S, 2.T.03,2V, 2W, 2X, 2.Z.03, 2BB	RST 3. Grades 11 - 12	Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results on explanations in the text.
Performance Example: • Students will read technical texts such as, but not limited to, a service manual and manufacturer's recommendations, then follow a variety of more complex multistep procedures, taking into special consideration the use of more high tech tools, procedures and vehicle specifications.		
2A - 2BB	L 6. Grades 9 -10 and Grades 11 - 12	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.
Performance Example: • Students will use domain specific words and phrases accurately when performing technical tasks/procedures in the career area and related setting, whether working with classmates, instructors or clients.		
2.A.02, 2C, 2.D.01, 2.D.02, 2E,	SL 4 Grades 9 - 10	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

2H		are appropriate to purpose, audience, and task.
Performance Example: • Students will present orally to the instructor/class demonstrations and role plays on content specific technical techniques using domain specific words and phrases. Students will accurately and concisely describe those technical processes, techniques, and/or tools		
2.A.03	WHST 9 Grades 9 – 10 and 11 - 12	Draw evidence from informational texts to support analysis, reflection, and research.
Performance Example: • Students will complete a written assessment on safety procedures to demonstrate an understanding of the value of safe practices in the career setting at all times		
2B, 2C, 2.E.01, 2H, 2I, 2.J.01, 2.J.02, 2.N.01, 2.O.01 2X, 2.BB.01.05	RST 4 Grades 9-10	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.
Performance Example: • Students will read and interpret technical charts and symbols, as related to more complex technical procedures, and apply those specifications to diagnose and repair the vehicle		
2C, 2Q, 2.Y.01, 2.Z.02.10, 2.Z.03	WHST 4 Grades 9 – 10 and Grades 11 and 12	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
Performance Example: • Considering audience, task, and purpose students will write clearly and effectively when answering technical writing open response questions and/or assessments, as well as producing technical work order forms. Students will utilize domain specific vocabulary and phrases appropriate to the technical writing tasks.		

Embedded Mathematics

CVTE Learning Standard Number	Math Content Conceptual Category and Domain Code Learning Standard Number	Text of Mathematics Learning Standard
2.C.01, 2.D, 2.E.01, 2.J.02, 2.P.02	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.*
Performance Example: • Students will use correct unit measurements, SAE or metric, to match drill bit size to diameter of hole to be drilled, converting within and between fractions of an inch and mm-cm as necessary.		
2.D.02, 2.P.02	8.NS.1	Understand informally that every number has a decimal expansion; the rational numbers are those with decimal expansions that terminate in 0s or eventually repeat. Know that other numbers are called irrational.
Performance Example: • Students will order measures from least to greatest in inspecting brake rotors.		
2.G.02, 2.S.02,	N-Q.3.a, S.IC.6	Describe the effects of approximate error in measurement and rounding on measurements and on computed values from measurements. Identify significant figures in recorded measures and computed values based on the context given and the precision of the

		tools used to measure.* Evaluate reports based on data.*
Performance Example: • Students explain manufacture's specifications for an anti-lock brake system and the "tolerance" as measurement of error, and explain its range based on the tools used.		
2.G.01, 2.J.02, 2.N.01, 2.P.02	7.G.2	Draw (freehand, with ruler and protractor, and with technology) geometric shapes with given conditions. Focus on constructing triangles from three measures of angles or sides, noticing when the conditions determine a unique triangle, more than one triangle, or no triangle.
Performance Example: • Students will draw a diagram of a wheel, tire, axle and hub, or a vehicle riding height, or a brake pedal height, labeling their measurements of each in appropriate units, and determine action to be taken.		
2.C.01, 2.C.03 2.S.02, 2.Z.02	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.
Performance Example: • Students calculate the power an electrical tool can produce using the formula P= IV, or the recommended pressure specified by manufacturer using Pascal's Principle		
2.G.01, 2.I.02, 2.X.01	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.
Performance Example: • Student will diagram and label a mechanical steering wheel system, labeling angles as specified or measured in the shop, and use the information in corrective action.		
2.G.04	7.EE.4, G.MG.2	Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).*
Performance Example: • Students will translate from the real world description of a system that monitors tire pressure to an equation with variables to indicate variables such as wheel diameter, tire width, tire profile height, and "load" or weight on tire. They will make estimates of the results of the of the monitoring system based on their calculations.		

Embedded Science and Technology/Engineering

Life Science (Biology)

CVTE Learning Standard Number	Subject Area, Topic Heading and Learning Standard Number	Text of Biology Learning Standard
2.A.01- 2.L.06	Biology Grades 9-12 Anatomy and Physiology	*Central Concepts:* There is a relationship between the organization of cells into tissues and the organization of tissues into organs. The structures and functions of organs determine their relationships within body systems of an organism. Homeostasis allows the body to perform its normal functions.

Performance Example: • Students recognize that toxic compounds can interfere with healthy physiological functions. For example, students examine SDS's to identify toxic substances that they may encounter on the job and demonstrate methods to minimize exposure

Physical Science (Chemistry)

CVTE Learning Standard Number	Subject Area, Topic Heading and Learning Standard Number	Text of Chemistry Learning Standard
2.A.01- 2.BB.02	Chemistry Grades 9-12 Periodicity 3.2	Use the periodic table to identify the three classes of elements: metals, nonmetals, and metalloids.
	Chemistry Grades 9-12 Properties of Matter 1.1	Identify and explain physical properties (e.g., density, melting point, boiling point, conductivity, malleability) and chemical properties (e.g., the ability to form new substances). Distinguish between chemical and physical changes.
	Chemistry Grades 9-12 Properties of Matter 1.2	Explain the difference between pure substances (elements and compounds) and mixtures. Differentiate between heterogeneous and homogeneous mixtures.
	Chemistry Grades 9-12 Properties of Matter 1.3	Describe the three normal states of matter (solid, liquid, gas) in terms of energy, particle motion, and phase transitions.
	Chemistry Grades 9-12 Chemical Reactions and States of Matter, Kinetic Molecular Theory, and Thermochemistry 6.5	Recognize that there is a natural tendency for systems to move in a direction of disorder or randomness (entropy).
Performance Examples: • Students use the periodic table to classify elements. For example, students identify elements from each of the three classes that are found in automobiles. • Students distinguish between physical and chemical properties and changes. For example, students identify substances that are found in automobiles, list physical and chemical properties of each and explain those properties in terms of periodic table position • Students classify matter as either pure substances or mixtures. For example, students create a graphic organizer including the classification terms identified in the standard and add an example found in automobiles to each sub-category of matter. • Students recognize that there are three normal states of matter and can describe phase changes in thermodynamic terms. For example, students identify pure substances found in automobiles that are usually found in either the solid, liquid or gas phase and describe the motion of the atoms or molecules that make up the substance. Students use a table to identify the temperatures at which phase changes occur for each pure substance at one atmosphere pressure (melting/freezing and boiling /condensation temperatures) and describe thermodynamic changes associated with each phase transition. • Students recognize that all thermodynamic processes irreversibly dissipate energy which cannot be retrieved for work. For example, students list reasons why an automobile engine's efficiency in the transformation of thermal energy to mechanical energy is much less than 100%.		
2.G.01-04	Chemistry Grades 9-12 States of Matter, Kinetic Molecular Theory, and Thermochemistry 6.1	Using the kinetic molecular theory, explain the behavior of gases and the relationship between pressure and volume (Boyle's law), volume and temperature (Charles's law), pressure and temperature (Gay-Lussac's law), and the number of particles in a gas sample

		(Avogadro's hypothesis). Use the combined gas law to determine changes in pressure, volume, and temperature.
2.K.01	Chemistry Grades 9-12 Chemical Reactions and Stoichiometry 5.2	Classify chemical reactions as synthesis (combination), decomposition, single displacement (replacement), double displacement, and combustion.
2.N.02	Chemistry Grades 9-12 Chemical Reactions and Chemical Bonding 4.6	Name and write the chemical formulas for simple ionic and molecular compounds, including those that contain the polyatomic ions: ammonium, carbonate, hydroxide, nitrate, phosphate, and sulfate.
2.R.01	Chemistry Grades 9-12 Acids and Bases and Oxidation-Reduction Reactions 8.4	Describe oxidation and reduction reactions and give some everyday examples, such as fuel burning and corrosion. Assign oxidation numbers in a reaction
Performance Examples: • Performance Example: Students use kinetic molecular theory to explain relationships between the pressure, volume, temperature and particle number of an ideal gas. For example, students qualitatively explain the relationships between these four parameters in a tire. • Students classify chemical reactions by type. For example, students research older and newer refrigerants used in automobiles and describe the chemistry of refrigerant mediated ozone depletion, including classification of one of the chemical reaction steps. Students explain the reasons for special handling of refrigerants, and state a claim regarding the safety of currently used refrigerants. • Students name and write chemical formulas for simple compounds. For example, students relate brake hydraulic fluid component names to their chemical formulas. • Students recognize that many common chemical reactions may be classified as redox reactions. For example, students compare and contrast chemical equations for the combustion of octenol with chemical equations for metal rusting.		
2.U.01 2.Y.01	Chemistry Grades 9-12 Acids and Bases and Oxidation-Reduction Reactions 8.2	Relate hydrogen ion concentrations to the pH scale and to acidic, basic, and neutral solutions. Compare and contrast the strengths of various common acids and bases (e.g., vinegar, baking soda, soap, citrus juice).
Performance Example: • Students recognize that a pH scale indicates hydronium ion concentration and use the scale to categorize the relative strengths of acids and bases. For example, students use a pH table to compare the relative strength of battery acid to other common acidic solutions and explain why PPE is required when working with battery acid.		
2.BB.02	Chemistry Grades 9-12 Solutions, Rates of Reaction, and Equilibrium 7.5	Identify the factors that affect the rate of a chemical reaction (temperature, mixing, concentration, particle size, surface area, catalyst).
Performance Example: • Students recognize that a catalyst can increase chemical reaction rates. For example, students research and diagram 3-way catalytic converter construction and list chemical reactions that are facilitated by 3-way catalytic converters. Students qualitatively compare reaction rates with and without catalysis.		
2.G.01- 2.BB.02	Chemistry Grades 9-12 SIS1: Make observations, raise questions, and formulate hypotheses.	Observe the world from a scientific perspective. Pose questions and form hypotheses based on personal observations, scientific articles, experiments, and knowledge. Read, interpret, and examine the credibility and validity of scientific claims in different sources of information, such as scientific articles, advertisements, or media stories.
	Chemistry Grades 9-12 SIS2: Design and conduct	• Articulate and explain the major concepts being investigated and the purpose of an investigation.

	scientific investigations.	• Select required materials, equipment, and conditions for conducting an experiment. • Identify independent and dependent variables. • Write procedures that are clear and replicable. • Employ appropriate methods for accurately and consistently o making observations o making and recording measurements at appropriate levels of precision o collecting data or evidence in an organized way • Properly use instruments, equipment, and materials (e.g., scales, probeware, meter sticks, microscopes, computers) including set-up, calibration (if required), technique, maintenance, and storage. • Follow safety guidelines.
	Chemistry Grades 9-12 SIS3: Analyze and interpret results of scientific investigations	Present relationships between and among variables in appropriate forms. o Represent data and relationships between and among variables in charts and graphs. o Use appropriate technology (e.g., graphing software) and other tools. Use mathematical operations to analyze and interpret data results. Assess the reliability of data and identify reasons for inconsistent results, such as sources of error or uncontrolled conditions. Use results of an experiment to develop a conclusion to an investigation that addresses the initial questions and supports or refutes the stated hypothesis. State questions raised by an experiment that may require further investigation.
	Chemistry Grades 9-12 SIS4: Communicate and apply the results of scientific investigations	Develop descriptions of and explanations for scientific concepts that were a focus of one or more investigations. Review information, explain statistical analysis, and summarize data collected and analyzed as the result of an investigation. Explain diagrams and charts that represent relationships of variables. Construct a reasoned argument and respond appropriately to critical comments and questions. Use language and vocabulary appropriately, speak clearly and logically, and use appropriate technology (e.g., presentation software) and other tools to present findings. Use and refine scientific models that simulate physical processes or phenomena.

Performance Examples:

- Students observe the world from a scientific perspective. They pose questions and form hypotheses based on personal observations. For example, students observe an automotive problem, pose questions relating to the problem and hypothesize likely solutions to the problem.
- Students explain the purpose of their automotive inspection, maintenance or repair action, and select appropriate and safe methods for accomplishing their tasks.
- Students decide on a course of action based on the data they have obtained. They evaluate their actions and determine if further investigations are needed to address problems.
- Students rigorously evaluate, communicate and respond to challenges of the findings of their investigations. They present the process by which they came to their solutions in a logical way and use critical thinking in their response to constructive challenges of their method and solution.

Physical Science (Physics)

CVTE Learning Standard Number	Subject Area, Topic Heading and Learning Standard Number	Text of Physics Learning Standard
2.A.01- 2.BB.02	Physics Grades 9-12 Motions and Forces 1.4	Interpret and apply Newton's three laws of motion.
	Physics Grades 9-12 Motions and Forces 1.4	Interpret and apply Newton's three laws of motion.
	Physics Grades 9-12 Motions and Forces 1.2	Distinguish between displacement, distance, velocity, speed, and acceleration. Solve problems involving displacement, distance, velocity, speed, and constant acceleration.
2.A.01 2.E.02	Physics Grades 9-12 Motions and Forces 1.5	Use a free-body force diagram to show forces acting on a system consisting of a pair of interacting objects. For a diagram with only co-linear forces, determine the net force acting on a system and between the objects.
Performance Examples: • Students recognize that net forces result in changes in motion (Newton's second law). For example, students determine and compare the net forces acting cars moving at constant and non-constant velocity using a 4-force diagram. • Students recognize forces are interactions between objects (Newton's third law). For example, students interpret Newton's third law by comparing the force of the pliers on the cotter pin with the force of the cotter pin on the pliers. • Students distinguish between constant velocity and acceleration. For example, students describe turning the wheel, pressing the brake or accelerator pedals as means of changing velocity (as means of acceleration). • Students use collinear force diagrams to determine the net force acting on an object. For example, students draw a scaled force diagram to show the normal and gravitational forces acting between the automotive lift and automobile lift points.		
2.A.02 2.N.01 2.N.02 2.Q.01 2.S.02	Physics Grades 9-12 Conservation of Energy and Momentum 2.3	Describe both qualitatively and quantitatively how work can be expressed as a change in mechanical energy.
2.A.03 2.I.03	Physics Grades 9-12 Conservation of Energy and Momentum 2.5	Describe both qualitatively and quantitatively how work can be expressed as a change in mechanical energy.
2.A.03 2.I.03	Physics Grades 9-12 Conservation of Energy and Momentum 2.5	Provide and interpret examples showing that linear momentum is the product of mass and velocity, and is always conserved (law of conservation of momentum). Calculate the momentum of an object.
2.B.01 2.B.03 2.B.04 2.C.01 2.E.03	Physics Grades 9-12 Motions and Forces 1.8	Describe conceptually the forces involved in circular motion. Explain how electric current is a flow of charge caused by a potential

2.C.01-03 2.S.01- 2.AA.02 2.D.01 2.D.02 2.P.02	Physics Grades 9-12 Electromagnetism 5.5 Physics Grades 9-12 Mathematical Skills	difference (voltage), and how power is equal to current multiplied by voltage. Measure with accuracy and precision (e.g., length, volume, mass, temperature, time)
Performance Examples: • Students describe how work done is equivalent to a change in mechanical energy. For example, students use Pascal's Law to determine the distance that a small piston will travel resulting from hydraulic pressure caused by a larger piston, and explain the greater distance traveled by the small piston using the work-energy theorem. • Students describe how work done is equivalent to a change in mechanical energy. For example, students use Pascal's Law to determine the distance that a small piston will travel resulting from hydraulic pressure caused by a larger piston, and explain the greater distance traveled by the small piston using the work-energy theorem. • Students provide and interpret examples of the conservation of momentum. For example, students compare the linear momentum of slow and fast moving cars and defend the use of SRS (air bags) in preventing injury using the impulse-momentum theory. • Students describe forces involved in circular motion. For example, students calculate the magnitude of torque necessary to tighten a bolt given average force applied and the lever arm length. Students explain why a 90° angle between the applied force and the radius of the turning object maximizes torque. • Students explain voltage as a potential difference, and electrical power as the rate at which charge moves through a potential difference. For example, students use Ohm's Law to calculate the internal resistance of a power tool using electrical parameters indicated on the tool. Students determine the amount of power the tool can produce using P=IV and relate this formula to the definition of power, which is the rate at which work is done. • Students measure with accuracy and precision. For example, students compare the use of high and low precision measuring tools and describe situations in which either high precision or low precision measuring tools are more appropriate.		
2.E.01	Physics Grades 9-12 Mathematical Skills	Convert within a unit (e.g., centimeters to meters).
2.F.01 2.G.01 2.J.01 2.M.01	Physics Grades 9-12 SIS2: Design and conduct scientific investigations.	Employ appropriate methods for accurately and consistently making observations, making and recording measurements at appropriate levels of precision, collecting data or evidence in an organized way.
2.G.02 2.G.03 2.G.04 2.H.01 2.I.01-03 2.J.01-03 2.O.01 2.Q.02	Physics Grades 9-12 SIS2: Design and conduct scientific investigations.	Properly use instruments, equipment, and materials (e.g., scales, probeware, meter sticks, microscopes, computers) including set-up, calibration (if required), technique, maintenance, and storage.
2.H.02 2.H.03 2.O.02 2.P.01 2.R.01 2.R.02	Physics Grades 9-12 Motions and Forces 1.6	Distinguish qualitatively between static and kinetic friction, and describe their effects on the motion of objects.

2.K.01	Physics Grades 9-12 SIS1: Make observations, raise questions, and formulate hypotheses.	Observe the world from a scientific perspective.
2.L.01	Physics Grades 9-12 Heat and Heat Transfer 3.3	Describe the relationship between average molecular kinetic energy and temperature. Recognize that energy is absorbed when a substance changes from a solid to a liquid to a gas, and that energy is released when a substance changes from a gas to a liquid to a solid. Explain the relationships among evaporation, condensation, cooling, and warming.
Performance Examples: • Students perform unit conversions. For example, students measure the length of a car part in feet and convert to inches and yards. Students measure the same part in decimeters and convert to millimeters, centimeters and meters. Students state a claim for the relative ease of use of either the metric or English systems of measurement. • Students use appropriate methods for collecting and organizing data. For example, students research applicable vehicle and service information, such as brake system operation, vehicle service history, service precautions and technical service bulletins. • Students properly use, calibrate and maintain investigative materials, equipment and instruments. For example, students set up and use TPMS diagnostic and repair equipment to diagnose a TPMS warning lamp concern. • Students describe the effects of friction on an object's motion. For example, students demonstrate how lubricants reduce frictional force and explain why frictional force reduction may be required for an object's motion. • Students observe the world from a scientific perspective. While performing a basic maintenance inspection, students identify a potential problem area (make observations, identify a problem) and propose a possible solution to the problem (hypothesize). • Students recognize that energy is absorbed or released during phase changes and can explain the relationships between phase changes. For example, students use a graphic organizer to show refrigeration steps and explain why heat is absorbed from surroundings when refrigerant vaporizes, and released to surroundings when refrigerant condenses in terms of kinetic molecular theory.		
2.R.03 2.X.01	Physics Grades 9-12 Electromagnetic Radiation 6.2	Describe the electromagnetic spectrum in terms of frequency and wavelength, and identify the locations of radio waves, microwaves, infrared radiation, visible light (red, orange, yellow, green, blue, indigo, and violet), ultraviolet rays, x-rays, and gamma rays on the spectrum.
2.S.01 2.T.01- 2.Y.02	Physics Grades 9-12 Electromagnetism 5.3	Analyze simple arrangements of electrical components in both series and parallel circuits. Recognize symbols and understand the functions of common circuit elements (battery, connecting wire, switch, fuse, resistance) in a schematic diagram.
2.T.03	Physics Grades 9-12 Heat and Heat Transfer 3.1	Explain how heat energy is transferred by convection, conduction, and radiation.
2.C.01-03 2.X.03	Physics Grades 9-12 Electromagnetism 5.6	Recognize that moving electric charges produce magnetic forces and moving magnets produce electric forces. Recognize that the interplay of electric and magnetic forces is the basis for electric motors, generators, and other technologies.
2.Y.01	Physics Grades 9-12 Electromagnetism 5.1	Recognize that an electric charge tends to be static on insulators and can move on and in conductors. Explain that energy can produce a separation of charges.

Performance Examples: • Students describe the frequency range of visible light as part of the electromagnetic radiation spectrum. • Students analyze electrical circuits with components in series or in parallel. For example, students use schematic diagrams to analyze electrical circuits. • Students explain three methods of heat transfer and analyze heat energy transfer due to welding. • Students recognize that the interplay between electric and magnetic forces is the basis for the electric motor. For example, students analyze a simple electric motor using a battery, magnets, and a coil of copper wire. Students qualitatively explain coil motion. • Students explain that energy can produce a separation of charges. For example, students explain the method by which a hybrid vehicle's rechargeable battery is recharged and describe energy transformations that enable this process.		
2.G.01- 2.BB.02	Physics Grades 9-12 SIS1: Make observations, raise questions, and formulate hypotheses	Observe the world from a scientific perspective. Pose questions and form hypotheses based on personal observations, scientific articles, experiments, and knowledge. Read, interpret, and examine the credibility and validity of scientific claims in different sources of information, such as scientific articles, advertisements, or media stories.
	Physics Grades 9-12 SIS2: Design and conduct scientific investigations.	Articulate and explain the major concepts being investigated and the purpose of an investigation. Select required materials, equipment, and conditions for conducting an experiment. Identify independent and dependent variables. Write procedures that are clear and replicable. Employ appropriate methods for accurately and consistently • making observations • making and recording measurements at appropriate levels of precision • collecting data or evidence in an organized way Properly use instruments, equipment, and materials (e.g., scales, probeware, meter sticks, microscopes, computers) including set-up, calibration (if required), technique, maintenance, and storage. Follow safety guidelines.
	Physics Grades 9-12 SIS3: Analyze and interpret results of scientific investigations.	Present relationships between and among variables in appropriate forms. • Represent data and relationships between and among variables in charts and graphs. • Use appropriate technology (e.g., graphing software) and other tools. Use mathematical operations to analyze and interpret data results. Assess the reliability of data and identify reasons for inconsistent results, such as sources of error or uncontrolled conditions. Use results of an experiment to develop a conclusion to an investigation that addresses the initial questions and supports or refutes the stated hypothesis. State questions raised by an experiment that may require further investigation.
	Physics Grades 9-12 SIS4: Communicate and apply the results of scientific investigations.	Develop descriptions of and explanations for scientific concepts that were a focus of one or more investigations. Review information, explain statistical analysis, and summarize data collected and analyzed as the result of an investigation. Explain diagrams and charts that represent relationships of

		variables. Construct a reasoned argument and respond appropriately to critical comments and questions. Use language and vocabulary appropriately, speak clearly and logically, and use appropriate technology (e.g., presentation software) and other tools to present findings. Use and refine scientific models that simulate physical processes or phenomena.

Performance Examples:

- Students observe the world from a scientific perspective. They pose questions and form hypotheses based on personal observations. For example, students observe an automotive problem, pose questions relating to the problem and hypothesize likely solutions to the problem.
- Students explain the purpose of their automotive inspection, maintenance or repair action, and select appropriate and safe methods for accomplishing their tasks.
- Students decide on a course of action based on the data they have obtained. They evaluate the success of their course of action and determine if further work is needed to address problems.
- Students rigorously evaluate, communicate and respond to challenges of the findings of their investigations. They present the process by which they came to their solutions in a logical way and use critical thinking in their response to constructive challenges of their method and solution.

DESE Statewide Articulation Agreements

ARTICULATION AGREEMENT

Between

Massachusetts Community Colleges

And

Massachusetts Chapter 74-Approved Secondary
Career/Vocational Technical Automotive Technology Programs

Effective Date: December 5, 2012

for more information, click

http://www.masscc.org/partnerships-initiatives/voc-schools-articulation-agreements

Industry Recognized Credentials (Licenses and Certifications/Specialty Programs)

- ***National Institute for Automotive Service Excellence (ASE)***
  101 Blue Seal Drive, S.E.
  Leesburg, VA 20175
  www.ase.com/

- ***OSHA*** 10 Hour general safety card

- Section 609 Certification for Refrigerant handling, recovery, and recycling

- Safety and Pollution Prevention (SP/2) Certification - Provider: 1 (877) 463-6287

Other

Reference Materials

Modern Automotive Technology
Author: James E. Duffy
Publisher: The Goodheart-Willcox Company, Inc.
Copyright 2009

Automotive Technology (A Systems Approach) 5th Edition
Jack Erjavec-Professor Emeritus, Columbia State Community College
Published 2010 Delmar Cenguage Learning

CDX Online Automotive Training
Jones and Bartlett Learning
www.cdxauto.com

Modern Automotive Technology
Author: James E. Duffy
Publisher: The Goodheart-Willcox Company, Inc.
Copyright 2009

Automotive Technology (A Systems Approach) 5th Edition
Jack Erjavec-Professor Emeritus, Columbia State Community College
Published 2010 Delmar Cenguage Learning

Related National, Regional, and State Professional Organizations

The National Automotive Technicians Education Foundation (NATEF)
www.natef.org
The National Institute for Automotive Service Excellence (ASE)
www.ase.com/

Student Organizations

- SkillsUSA www.maskillsusa.org

Selected Websites

ALLDATA www.alldata.com