

*Massachusetts Department of Elementary & Secondary Education*

Office for Career/Vocational Technical Education



*Vocational Technical Education Framework*



Manufacturing, Engineering & Technology Services  
Occupational Cluster

*Telecommunications and Fiber Optics (VTELE)*

CIP Code 150305

June 2014

**Massachusetts Department of Elementary and Secondary Education**

**Office for Career/Vocational Technical Education**

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# Acknowledgements

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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 Telecommunications and Fiber Optics Framework of the Manufacturing, Engineering & Technology Services Occupational Cluster.

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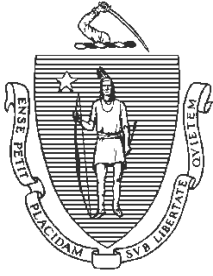
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## Commissioner's Letter

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# **Massachusetts Department of Elementary and Secondary Education**

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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

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## 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; Strand 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 Manufacturing, Engineering & Technology Services Occupational Cluster Telecommunications-Fiber Optics Framework Massachusetts Vocational Technical Education Framework

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<sup>1</sup>

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<sup>2</sup> 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.

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<sup>1</sup> *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.



# Manufacturing, Engineering & Technology Services Occupational Cluster

## Telecommunications and Fiber Optics Framework (VTELE)

### Strand 1: Safety and Health Knowledge and Skills

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#### 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](http://www.doe.mass.edu/bullying)
- Centers for Disease Control and Prevention: [www.cdc.gov](http://www.cdc.gov)
- Environmental Protection Agency : [www.epa.gov](http://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](http://www.doe.mass.edu/cte)
- Massachusetts Department of Elementary and Secondary Education: [www.doe.mass.edu](http://www.doe.mass.edu)
- Massachusetts Emergency Management Agency: [www.mass.gov/eopss/agencies/mema](http://www.mass.gov/eopss/agencies/mema)
- Massachusetts General Law: [www.malegislature.gov](http://www.malegislature.gov)
- Massachusetts Health and Human Services: [www.mass.gov/dph](http://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](http://www.sdsonline.com)
- National Fire Protection Association: [www.nfpa.org](http://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](http://www.osha.gov)
- Readiness and Emergency Management for Schools: [www.rems.ed.gov](http://www.rems.ed.gov)
- Safe and Healthy Learning Environments: [www.doe.mass.edu/ssce/safety.html](http://www.doe.mass.edu/ssce/safety.html)

## Strand 2: Technical Knowledge and Skills

### 2.A Health and Safety

- 2.A.01 Identify first aid, OSHA and safety code requirements.
- 2.A.01.01 List the tasks that may, or may not be performed by trained first aid workers.
  - 2.A.01.02 List the level of electricity (shock) considered lethal to humans.
  - 2.A.01.03 Describe OSHA body restraint rules and list the hazards associated with use of ladders and working at heights.
  - 2.A.01.04 Explain the purposes and reasons for technician adherence to the National Electrical Code (NEC) and the National Fire Protection Association (NFPA) codes.
  - 2.A.01.05 Explain the purpose and usage of the REMC (Residential Electrical Maintenance Code).

2.A.01 Performance Example:

- Demonstrate how to properly set up a 24 foot extension ladder using the 4:1 ratio to reach a height of 20 feet.

### 2.B Industry Standards

- 2.B.01 Develop working knowledge of Telecommunications Industry Association (TIA), Electronics Industries Alliance (EIA), and American National Standards Institute (ANSI) standards.
- 2.B.01.01 Describe the situations where an installer needs to refer to and abide by TIA 570-A.
  - 2.B.01.02 Describe the cabling components and methods addressed by TIA/EIA-568-A, TIA/EIA-568-B and ANSI/TIA-568-C.
  - 2.B.01.03 Describe the Telcordia standards related to cabling.
  - 2.B.01.04 Explain how to find correct cable pair colors and list the applicable TIA/EIA standard.

2.B.01 Performance Example:

- Create a detailed sketch illustrating the proper way to terminate a CAT 5e Unshielded Twisted Pair (UTP) patch cable with an RJ-45 connector in accordance with TIA/EIA 568-A.

### 2.C Low Voltage Wiring

- 2.C.01 Describe low voltage wiring requirements.
- 2.C.01.01 Demonstrate the use of blue prints and adherence to specifications.
  - 2.C.01.02 Define AWG and explain American Wire Gauge (AWG) wire size standards.
  - 2.C.01.03 List possible government permits required to install or service low voltage wiring.
  - 2.C.01.04 Describe low voltage lighting, its usage and precautions.
  - 2.C.01.05 Describe current audio signal and speaker cabling and wiring and the reasons for choice of wire.
  - 2.C.01.06 Describe CAT 5e and 6 UTP cables and preferred usages.
  - 2.C.01.07 Describe control and sensor wiring used for home automation and manual operation.

2.C.01 Performance Example:

- List the most important factors to consider when selecting the optimum audio speaker cable wire.

## 2.D Cabling and Connectors

- 2.D.01 Explain network cable installation.
  - 2.D.01.01 Compare copper coaxial cable and plastic fiber optic cable usage in residential applications.
  - 2.D.01.02 Explain how 66 and 110 block panels are used in distribution and interface center for telecom services.
  - 2.D.01.03 Define patch cable and list the maximum length allowed by standards.
  - 2.D.01.04 Define workstation cables and explain usage.
  - 2.D.01.05 Define backbone/distribution cabling and compare with link, workstation and patch cables.
  - 2.D.01.06 Explain the differences between composite and hybrid cables.
  - 2.D.01.07 Describe proper cable prepping tools; how ends of cable are prepared for connectors; and how connectors are properly installed.
  - 2.D.01.08 List the types of signal losses in cables, the purpose of impedance matching and converting dB levels to microvolt levels.
  - 2.D.01.09 Properly prep and install F coaxial cable fittings and explain impedance problems.
  - 2.D.01.10 Properly install UTP, Cat 5e and 6 connectors.
  - 2.D.01.11 Explain how and why ground loops occur in electrical circuits.
  - 2.D.01.12 Identify and describe various network topologies.

### 2.D.01 Performance Examples:

- Given a diagram: wire a network; demonstrate that the network meets specifications, and troubleshoot any faults.

## 2.E Pre-wiring

- 2.E.01 Define the design and rough-in layout process.
  - 2.E.01.01 Describe the task of roughing-in cabling in new structures, installing wall and distribution boxes, conduit, speaker-in-wall units, CCTV mounts etc.
  - 2.E.01.02 Explain the purpose and usage of biscuit jacks/surface mount boxes.
  - 2.E.01.03 Explain the use of wall plates and indicate proper locations.
  - 2.E.01.04 Describe purposes and locations for J-hooks and cable trays.
  - 2.E.01.05 Explain inductive signal interference, its effects and precautions and separation distances for cabling.
  - 2.E.01.06 List advantages of stranded vs. solid wiring and reasons for choosing either.
  - 2.E.01.07 Describe detriments in exceeding TIA/EIA tensile strength/bend radius.
  - 2.E.01.08 Outline the purposes of wire labeling and how it applies.
  - 2.E.01.09 Explain the methods used to closely estimate cable requirements for individual applications.
  - 2.E.01.10 Explain UTP untwist precautions and define NEXT/FEXT testing issues.
  - 2.E.01.11 List common problems encountered in coaxial cable installation or repair.
  - 2.E.01.12 Describe surface mount channeling and how it is used.

### 2.E.01 Performance Examples:

- Create a costed bill of materials necessary to pre-wire a new residence or building.

## 2.F Fundamentals of Electricity/ Electronics

- 2.F.01 Explain the basics of electricity.
  - 2.F.01.01 Perform calculations using Ohm's and Watt's Laws formulas.
  - 2.F.01.02 Explain electric power generation and services provided to residences.

- 2.F.01.03 Describe wire size choices and distribution for home electrical circuitry.
- 2.F.01.04 Compare fuse and circuit breaker boxes and describe the components and metering.
- 2.F.01.05 Compare AC and DC voltages and currents.
- 2.F.01.06 Explain the purpose of electric circuit grounding and NEC rules for residences.
- 2.F.01.07 Describe lightning hazards, lightning arrestors used in electronic applications, and how ground blocks are used.
- 2.F.01.08 Compare AC power frequency, and voice, TV and radio and data frequencies.
- 2.F.01.09 Describe causes and methods of reducing electrical interference.

2.F.01 Performance Examples:

- The student will create a breadboard prototype circuit and demonstrate how to properly use a Digital Multi-meter (DMM) to measure voltage, current and resistance in a basic DC resistive circuit.

- 2.F.02 Develop a working knowledge of electronic circuits.
  - 2.F.02.01 Identify and explain the function of various passive components found in DC and AC circuits.
  - 2.F.02.02 Analyze and calculate DC and AC passive circuit parameters using applicable formulas.
  - 2.F.02.03 Construct and demonstrate the testing of proper DC and AC passive circuit functionality.
  - 2.F.02.04 Identify and explain the function of discrete and integrated semiconductor devices and circuits.
  - 2.F.02.05 Analyze and calculate DC and AC circuit parameters of discrete and integrated semiconductor circuits using applicable formulas.
  - 2.F.02.06 Construct and demonstrate the testing of discrete and integrated semiconductor circuits for proper functionality.
  - 2.F.02.07 Identify and explain the function of logic gates, combinational and sequential logic circuits.
  - 2.F.02.08 Analyze and calculate DC and AC circuit parameters of logic gates, combinational and sequential logic circuits using applicable formulas.
  - 2.F.02.09 Construct and demonstrate the testing of logic gates, combinational and sequential logic circuits for proper functionality.
  - 2.F.02.10 Troubleshoot and repair defective components in electronic circuits.
  - 2.F.02.11 Read and interpret flow, block, and schematic diagrams.
  - 2.F.02.12 Determine the factors that affect thermal management of various electronic components and devices.
  - 2.F.02.13 Set up and use a variety of electronic/test equipment to test electronic equipment and systems.

2.F.02 Performance Example:

- Student will produce a complete documentation package for an electronic assembly project which they will then present and demonstrate to the class.

## 2.G Fundamentals of Telephony

- 2.G.01 Define the fundamentals of telephone systems.
  - 2.G.01.01 Diagram a basic telephone circuit.
  - 2.G.01.02 Define Tip & Ring and show wiring conventions of the POTS and list expected voltages on telephone plugs.

- 2.G.01.03 Name the conventional color of UTP wires used with 2/4/8 wire connections.
- 2.G.01.04 Compare analog and digital phone systems.
- 2.G.01.05 Explain where type 66/110 punchdown blocks are used and their purpose.
- 2.G.01.06 Differentiate between internet-cable TV-wireless systems and B-VoIP.
- 2.G.01.07 Describe the main blocks that make up a Private Branch Exchange (PBX) system.
- 2.G.01.08 Describe the concept of a cellular system and the makeup of a cell.
- 2.G.01.09 Explain how handoffs and roaming work.
- 2.G.01.10 Explain the meaning of the terms “drop out” and “dead zones”.

2.G.01 Performance Example:

- Summarize common troubles associated with telephone systems and suggest repair solutions.

## 2.H Fiber Optics Theory and Applications

- 2.H.01 Define theories and applications of fiber optic cabling.
  - 2.H.01.01 List fiber optic cable eye, skin, and inhalation safety precautions.
  - 2.H.01.02 Summarize basic light theory and list commonly used wavelengths.
  - 2.H.01.03 Demonstrate connector and splice methods and testing.
  - 2.H.01.04 Differentiate between plastic and glass fiber and list reasons for choices.
  - 2.H.01.05 Explain the phrase “total internal reflection” relative to fiber optic cable.
  - 2.H.01.06 Explain fiber optic system design, installation and testing.
  - 2.H.01.07 Discuss the basic steps in planning a fiber optic system installation.
  - 2.H.01.08 Explain the operation of an Optical Time-Domain Reflectometer (OTDR).
  - 2.H.01.09 Describe and perform an optical continuity test.
  - 2.H.01.10 Perform fiber cable loss testing using a calibrated light source and a power meter.

2.H.01 Performance Example:

- Discuss what a loss budget is and its importance in fiber optic system design.

## 2.I Principles of Electronic Communication

- 2.I.01 Explain the principles of electronic communication.
  - 2.I.01.01 Define the properties of signals in both acoustic and electrical form.
  - 2.I.01.02 Describe the dimension signal frequency, wavelength and phase.
  - 2.I.01.03 Calculate the relationship of time vs. frequency, phase vs. distance and phase vs. time.
  - 2.I.01.04 Calculate power gain and loss in dB units and convert to power.
  - 2.I.01.05 Calculate reference power levels in dBm and convert to power.
  - 2.I.01.06 State the S/N ratio required for communication with telephone/audio systems.
  - 2.I.01.07 Define fundamental and harmonic frequencies of electrical signals.
  - 2.I.01.08 Identify and define the harmonic structure of common signal waveforms.
  - 2.I.01.09 Specify the common forms of waveform distortion applied to signals in electronic circuits.
  - 2.I.01.10 Identify the acoustic and electrical properties of common input and output transducers.

2.I.01 Performance Examples:

- Given a diagram: wire and demonstrate the operation of a basic electronic communication system.

## 2.J Fundamentals of Wireless Communication

- 2.J.01 Describe the fundamentals of wireless communication.
- 2.J.01.01 Identify and explain various modulation schemes.
  - 2.J.01.02 State the functions of a transmitter, receiver and a channel in a basic wireless communication system.
  - 2.J.01.03 State the purpose and define the properties of transmission lines.
  - 2.J.01.04 Calculate the length of a  $\frac{1}{2}$  wave dipole antenna for a given frequency.
  - 2.J.01.05 Discuss ground waves, space waves, and sky waves.
  - 2.J.01.06 List the frequency components of AM, FM, and TV signals.
  - 2.J.01.07 Describe the major components of a communication satellite and ground stations.
  - 2.J.01.08 List the basic system requirements for digital data communications.
  - 2.J.01.09 Describe the nature and effects of transmission imperfections.
  - 2.J.01.10 Define the terms aspect ratio, resolution, pixels, and triads as they relate to HDTV.

- 2.J.01 Performance Example:
- Create the block diagrams of a tuned RF transmitter and super heterodyne receiver.

## 2.K Residential Management

- 2.K.01 Discuss residential management techniques.
- 2.K.01.01 Explain bar coding and modern inventory control methods for residences.
  - 2.K.01.02 Explain manual, automatic and programmable appliances control.

- 2.K.01 Performance Example:
- List the benefits of residential management.

## 2.L Premise Restoration

- 2.L.01 Discuss the necessity of premise restoration.
- 2.L.01.01 Describe the need for drywall and other penetrations of walls and ceilings in retrofit applications.
  - 2.L.01.02 Demonstrate restoration techniques and list materials used.

- 2.L.01 Performance Example:
- Restore a drywall surface to its original condition after installing a wall box outlet.

## 2.M Tools and Equipment

- 2.M.01 Explain the proper use of tools and equipment.
- 2.M.01.01 Explain usage of VOM meters in residential cabling and demonstrate use of each function.
  - 2.M.01.02 Demonstrate the ability to use wire strippers/crimps/punch-down tool and fish tapes.
  - 2.M.01.03 Explain the usage of gofer poles, drills/bits, scissors and face mask.
  - 2.M.01.04 Explain the use of a toner and light meter/source.
  - 2.M.01.05 Describe the proper installation of an F connector using compression tool and fittings.
  - 2.M.01.06 Explain why wire pull lubricant is needed.
  - 2.M.01.07 Describe the proper usage and safety concerns for hand and power tools.
  - 2.M.01.08 Identify cable using cable markers and discuss how to identify wires that have no markers.



- 2.M.01 Performance Examples:
  - Create a list of hand and power tools needed for a typical telecom tech's tool kit.

**2.N Customer Orientation and Documentation**

- 2.N.01 Explain the need for customer satisfaction.
  - 2.N.01.01 Compare excellent customer/owner relations, problem prevention and conflict resolution concepts.

- 2.N.01 Performance Example:
  - Create a flow chart showing the relationship between and factors that determine both internal and external customer satisfaction.

**2.0 Troubleshooting Skills**

- 2.0.01 Demonstrate the ability to troubleshoot electronic communication systems.
  - 2.0.01.01 Explain the divide and conquer troubleshooting method.
  - 2.0.01.02 List common problems and solutions in residential cabling.
  - 2.0.01.03 Identify sources of on-line and phone technical help from product manufacturers and suppliers.

- 2.0.01 Performance Example:
  - Demonstrate the ability to successfully troubleshoot a communication system.

## Strand 3: Embedded Academics

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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

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### 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](http://www.bpa.org)

### *Selected Websites*

- 5 Ways to Ace a Job Interview: [http://kidshealth.org/teen/school\\_jobs/jobs/tips\\_interview.html](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](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](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](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](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

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### 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](http://www.nfib.com)
- National Foundation for Teaching Entrepreneurship (NFTE): [www.nfte.com](http://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](http://www.sba.gov)

### *Glossary*

<b>Term</b>	<b>Definition</b>
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**

Chain of Command and Organizational Structure

**Definition**

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

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### 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

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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.F.01.02 2.F.01.03 2.F.01.06	WHST. Grades 6-10.2 b & d	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience’s knowledge of the topic d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.
Performance Example: <ul style="list-style-type: none"> <li>Students will produce a flip-book explaining the basics of electricity with clear, concise domain specific language appropriate to the grade level.</li> </ul>		
2.F,02.11 2.G.01.01 2.B.01.03 2.B.01.02	RST. Grades 6 – 12.4	4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6–12 texts and topics.
Performance Example: <ul style="list-style-type: none"> <li>Students will read and interpret in written form domain specific schematics using precise language explaining the processes clearly and demonstrating understanding in an organized, concise style.</li> </ul>		
2.G. .01	WHST. Grades 6-10.6	6-8 Use technology, including the Internet, to produce and publish writing and present the relationships between information and ideas clearly and efficiently. 9-10 Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology’s capacity to link to other information and to display information flexibly and dynamically
Performance Example: <ul style="list-style-type: none"> <li>In a multimedia presentation to the class, students will compare analog &amp; digital phone systems/internet cable wireless systems &amp; B-VOLP and/or other appropriate content specific topics using appropriate vocabulary and adapting speech to audience and purpose.</li> </ul>		
2.I.01	WHST. Grades 6-12.4 WHST. Grades 6-10.6	6-12.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience 6-8.6 Use technology, including the Internet, to produce and publish writing and present the relationships between information and ideas

		clearly and efficiently. 9-10.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically
Performance Example: <ul style="list-style-type: none"> <li>Students will create a dictionary with domain specific vocabulary and definitions demonstrating clear, concise, coherent writing, and an understanding of the principles of electronic communication.</li> </ul>		
2.J.01	WHST. Grades 6-12.2 a & d  RST. Grades 9-10.2	2.a&d Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers. 2. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text
Performance Example: <ul style="list-style-type: none"> <li>Students will write a paper summarizing the fundamentals of wireless communication accurately demonstrating command of standard English grammar and usage citing appropriate text.</li> </ul>		
2.K.01 2.L.01	SL. Grades 6-12.4	6-10 Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation 10-12 Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks
Performance Example: <ul style="list-style-type: none"> <li>Students will create a multimedia presentation demonstrating the restoration of a drywall surface after installing a wall box outlet. Students will articulate in a logical step-by-step procedure adapting the speech to the purpose and audience.</li> </ul>		
2.L.01	WHST. Grades 9-10.6 WHST. Grades 6-10.7	6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically 7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.



<p>Performance Example:</p> <ul style="list-style-type: none"> <li>Students will design an advertising pamphlet for customers explaining Premise Restoration. The product will accurately use domain specific vocabulary and phrases and demonstrate an understanding of the content. With the use of technology, the product will demonstrate command of conventions and standards of English grammar and usage.</li> </ul>		
2.M.01 2.N.01	<p>WHST. Grades 6-10.4 WHST. Grades 6-12.2</p> <p>SL.9-12.3</p>	<p>4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience</p> <p>2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.</p> <p>SL 9-10 Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, identifying any fallacious reasoning or exaggerated or distorted evidence.</p> <p>11-12 Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, assessing the stance, premises, links among ideas, word choice, points of emphasis, and tone used.</p>
<p>Performance Example:</p> <ul style="list-style-type: none"> <li>Students will generate a 3 column paper (tool-usage-concerns)describing the proper use and safety concerns for hand and power tools in appropriate terminology in clear, concise English citing appropriate text and codes.</li> <li>Students will write scripts and role-play scenarios of difficult customer situations. Students will adapt speech to appropriate purpose and audience.</li> <li>Students will compose a response to a customer billing complaint clearly articulating logical reasoning in a clear manner with supporting facts.</li> </ul>		
2.O.01	<p>SL.9-12.6 WHST.6-12.9</p> <p>L.9-12.6</p>	<p>6 Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate</p> <p>9 Draw evidence from informational texts to support analysis, reflection, and research. 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</p>
<p>Performance Examples:</p> <ul style="list-style-type: none"> <li>Individually or in a team, students will design and present a flip chart/guide book describing trouble-shooting skills demonstrating understanding of the topic using evidence from informational text.</li> <li>Individually or in a team, students will write and produce a podcast on trouble-shooting skills. Students will research instructional manuals, texts, journals, and web sites while paying attention to accuracy in laws and regulations.</li> </ul>		
2.A – 2.0	L. Grades 6-12.6	Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression
<p>Performance Example:</p> <ul style="list-style-type: none"> <li>Students will demonstrate to the teacher in writing and speaking a clear understanding of domain specific vocabulary and its appropriate usage in all assignments.</li> </ul>		
2.A	RST. Grades 9-10.1	Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or

		descriptions
<p>Performance Example:</p> <ul style="list-style-type: none"> <li>Students will read technical texts and supporting articles summarizing the precise details of safety and other technical procedures in 2 column notes.</li> </ul>		
2.A, 2.B, 2.C, 2.D, 2.E, 2.F, 2.G, 2.H, 2.I, 2.J, 2.K, 2.L, 2.M, 2.N, 2.O	SL. Grade 8.4 SL. Grades 9 – 12.4	8 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. 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 are appropriate to purpose, audience, and task. 11-12 Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.
<p>Performance Example:</p> <ul style="list-style-type: none"> <li>Students will present orally to the teacher/class demonstrations and/or role plays on content specific topics and/or techniques in a clear, organized, logical manner using appropriate command of the English language.</li> </ul>		
2.A, 2.B, 2.C, 2.D, 2.E, 2.F, 2.G, 2.H, 2.I, 2.J, 2.K, 2.L, 2.M, 2.N, 2.O	WHST. Grades 6-12.10 RST. Grades 9 – 10.1	10 Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences. 1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions
<p>Performance Example:</p> <ul style="list-style-type: none"> <li>Students will maintain daily/weekly logs describing and defining important fundamentals of telecommunications including domain specific vocabulary and phrases in clear, concise, coherent writing.</li> <li>Students will read technical texts and articles summarizing the precise details of technical procedures using 2 column notes.</li> </ul>		
2.D.01.01 2.D.01.06 2.F.01.04 2.F.01.05 2.G.01.06 2.N.01.01	RST. Grades 9-10.9	Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.
<p>Performance Example:</p> <ul style="list-style-type: none"> <li>Students will compare and contrast professional tools, techniques, and behaviors as well as various business plans using Venn diagrams and other graphic organizers to demonstrate understanding that different strategies produce different results.</li> </ul>		
2.B 2.B.01.03	RST. Grades 6-12.4 WHST. Grades 6-8.2d WHST. 9-10.2d	4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6–12 texts and topics 2. Write informative/explanatory texts, including the narration of

		historical events, scientific procedures/ experiments, or technical processes. 2d Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.
<p>Performance Example:</p> <ul style="list-style-type: none"> <li>Students will write a short paper providing specific textual evidence from the Telecordia standards to support its relations to cabling utilizing domain specific phrasing and demonstrating command of the standards of English grammar and usage.</li> <li>(2.B) Students will read technical texts and demonstrate understanding of the specific technical process by creating a top-down web or other graphic organizer reflecting key details.</li> </ul>		
2.C.01 2.F.02 2.H.01.02	WHST. Grades 6 – 12.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
<p>Performance Example:</p> <ul style="list-style-type: none"> <li>Students will write, for their customers, an information sheet on the selection factors of optimum audio speaker cable wires demonstrating understanding of the content and vocabulary using correct standard English grammar.</li> <li>Students will create a written documentation package for a content specific project demonstrating well-chosen, relevant facts in precise language and vocabulary indicating understanding of purpose and audience.</li> <li>Students will create a poster summarizing basic light theory with a list of commonly used wave lengths. Students will present it to the class demonstrating understanding of the topic.</li> </ul>		
2.D01 2.E.01	WHST. Grades 6-10.6 SL. Grades 6 – 12.6	6-10.6 Use technology, including the Internet, to produce and publish writing and present the relationships between information and ideas clearly and efficiently 6-12.6 Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate.
<p>Performance Example:</p> <ul style="list-style-type: none"> <li>Students will produce a multimedia presentation to the class on network cable installation demonstrating accurate information in a concise, organized manner adapting speech to the task.</li> <li>Students will produce, with the use of technology, a manual on the lay-out process using domain specific vocabulary and phrasing in an organized concise style following the rules of standard English conventions.</li> </ul>		

## Embedded Mathematics

CVTE Learning Standard Number	Math Content Conceptual Category and Domain Code Learning Standard Number	Text of Mathematics Learning Standard
2.A.01.02	A-CED.1, A-CED.4, A-REI.3	<b>Create equations that describe numbers or relationships</b> A-CED.1. Create equations and inequalities in one variable and use them to solve problems. <i>Include equations arising from linear and quadratic functions, and simple rational and exponential functions.</i> ( Note: This

		<p><i>standard is included because given voltage and resistance students can write and use OHM's Law to solve for current).</i></p> <p><b>A-CED.4.</b> Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. <i>For example, rearrange Ohm's law <math>V = IR</math> to highlight resistance <math>R</math>.</i></p> <p><b>Solve equations and inequalities in one variable</b>  A-REI.3. Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. (see note for A-CED-1 )</p>
<p>Performance example:</p> <ul style="list-style-type: none"> <li>Have students demonstrate the use of <math>I=E/R</math>.</li> </ul>		
2.A.01.03	8.G.7	<p>Understand and apply the Pythagorean Theorem.  8.G.7. Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.</p>
<p>Performance example:</p> <ul style="list-style-type: none"> <li>Given the height of the point where a ladder is leaning against a building and the length of a ladder determine how far the base of the ladder is from the building.</li> </ul>		
2.B.01.01	2.MD.1,2.MD.3, 3.MD.4	<p>Measure and estimate lengths in standard units.  2.MD.1. Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes.  2.MD.3. Estimate lengths using units of inches, feet, centimeters, and meters.  Represent and interpret data.  3.MD.4. Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch. Show the data by making a line plot, where the horizontal scale is marked off in appropriate units—whole numbers, halves, or quarters.</p>
<p>Performance example:</p> <ul style="list-style-type: none"> <li>Estimate the measurement of a drop cable from a telephone pole to the interface box and then verify using a tape measure.</li> </ul>		
2.C.01.02	8.F.3,7.G.4,6.EE.1, 6.EE.2.C	<p>Define, evaluate, and compare functions..  8.F.3. Interpret the equation <math>y = mx + b</math> as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. For example, the function <math>A = s^2</math> giving the area of a square as a function of its side length is not linear because its graph contains the points (1,1), (2,4) and (3,9), which are not on a straight line.  Solve real-life and mathematical problems involving angle measure, area, surface area, and volume.  7.G.4. Know the formulas for the area and circumference of a circle and use them to solve problems; give an informal derivation of the relationship between the circumference and area of a circle.  Apply and extend previous understandings of arithmetic to algebraic</p>

		<p>expressions.</p> <p>6.EE.1. Write and evaluate numerical expressions involving whole-number exponents.</p> <p>6.EE.2.c. Evaluate expressions at specific values of their variables. Include expressions that arise from formulas used in real-world problems. Perform arithmetic operations, including those involving whole number exponents, in the conventional order when there are no parentheses to specify a particular order (Order of Operations). For example, use the formulas <math>V = s^3</math> and <math>A = 6s^2</math> to find the volume and surface area of a cube with sides of length <math>s = 1/2</math>.</p>
<p>Performance example:</p> <ul style="list-style-type: none"> <li>Calculate the area of a number 14 gauge wire.</li> </ul>		
2.C.01.05	7.NS.2,7.NS.3	<p>7.NS.2. Apply and extend previous understandings of multiplication and division and of fractions to multiply and divide rational numbers.</p> <p>a. Understand that multiplication is extended from fractions to rational numbers by requiring that operations continue to satisfy the properties of operations, particularly the distributive property, leading to products such as <math>(-1)(-1) = 1</math> and the rules for multiplying signed numbers. Interpret products of rational numbers by describing real-world contexts.</p> <p>b. Understand that integers can be divided, provided that the divisor is not zero, and every quotient of integers (with non-zero divisor) is a rational number. If <math>p</math> and <math>q</math> are integers, then <math>-(p/q) = (-p)/q = p/(-q)</math>. Interpret quotients of rational numbers by describing real-world contexts.</p> <p>c. Apply properties of operations as strategies to multiply and divide rational numbers.</p> <p>d. Convert a rational number to a decimal using long division; know that the decimal form of a rational number terminates in 0s or eventually repeats.</p> <p>3. Solve real-world and mathematical problems involving the four operations with rational numbers.</p>
<p>Performance example:</p> <ul style="list-style-type: none"> <li>Calculate the resistance of a 100 foot length of copper wire with a cross sectional area of 810 cm.</li> </ul>		
2.D.01.08	F-BF.5, F-LE.4	<p>Build new functions from existing functions</p> <p>F-BF.5. (+) Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.</p> <p>Construct and compare linear, quadratic, and exponential models and solve problems</p> <p>F-LE.4. For exponential models, express as a logarithm the solution to <math>ab^{ct} = d</math> where <math>a</math>, <math>c</math>, and <math>d</math> are numbers and the base <math>b</math> is 2, 10, or <math>e</math>; evaluate the logarithm using technology.</p>
<p>Performance example:</p> <ul style="list-style-type: none"> <li>Determine the relative power in dBm of a 100mW signal.</li> </ul>		
2.E.01.09	2.MD.1, 2.MD.3, 3.MD.4	<p>Measure and estimate lengths in standard units.</p> <p>2.MD.1. Measure the length of an object by selecting and using appropriate</p>

		<p>tools such as rulers, yardsticks, meter sticks, and measuring tapes.</p> <p>2.MD.3. Estimate lengths using units of inches, feet, centimeters, and meters.</p> <p>Represent and interpret data.</p> <p>3.MD.4. Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch. Show the data by making a line plot, where the horizontal scale is marked off in appropriate units—whole numbers, halves, or quarters.</p>
<p>Performance example:</p> <ul style="list-style-type: none"> <li>Estimate cable requirements for a home computer network. Explain your reasoning.</li> </ul>		
2.E.01.10	F-BF.5, F-LE.4	<p>Build new functions from existing functions</p> <p>F-BF.5. (+) Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.</p> <p>Construct and compare linear, quadratic, and exponential models and solve problems</p> <p>F-LE.4. For exponential models, express as a logarithm the solution to <math>abct = d</math> where <math>a</math>, <math>c</math>, and <math>d</math> are numbers and the base <math>b</math> is 2, 10, or <math>e</math>; evaluate the logarithm using technology</p>
<p>Performance example:</p> <ul style="list-style-type: none"> <li>Calculate the interference where the interference power is 10mW and the signal power is 1W.</li> </ul>		
2.F.01.01	A-CED.1, A-CED.4, A-REI.3, 8.EE.4	<p>Create equations that describe numbers or relationships</p> <p>A-CED.1. Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions</p> <p>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 <math>V = IR</math> to highlight resistance <math>R</math>. (Note: This standard is included because given voltage and current students can write and use Watt's Law to solve for power).</p> <p>Solve equations and inequalities in one variable</p> <p>A-REI.3. Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.</p> <p>8.EE.4 Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology. (Note: Use of engineering notation.)</p>
<p>Performance example:</p> <ul style="list-style-type: none"> <li></li> </ul>		
2.F.01.05	F-TF.2, F-TF.5, F-TF.7, F-TF.3, F-TF.4	<p>Extend the domain of trigonometric functions using the unit circle</p> <p>F-TF.2. Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted</p>

		<p>as radian measures of angles traversed counterclockwise around the unit circle. Model periodic phenomena with trigonometric functions F-TF.5. Choose trigonometric functions to model periodic phenomena with Specified amplitude, frequency, and midline.★ F-TF.7. (+) Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology, and interpret them in terms of the context.★</p> <p>Extend the domain of trigonometric functions using the unit circle F-TF.3. (+) Use special triangles to determine geometrically the values of sine, cosine, tangent for <math>\frac{\pi}{3}, \frac{\pi}{4}</math> express the values of sine, cosine, and tangent for <math>\frac{\pi}{x}</math>, <math>\frac{\pi}{2x}</math> in terms of of their values for <math>x</math>, where <math>x</math> is any real number. F-TF.4. (+) Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions.</p>
<p>Performance example:</p> <ul style="list-style-type: none"> <li>Calculate the current in an electric circuit which has a 9 volt battery connected to 12 ohm resistor.</li> </ul>		
2.F.02.05	A-REI.4, F-IF.7.a	<p>Solve equations and inequalities in one variable A-REI.4. Solve quadratic equations in one variable. b. Solve quadratic equations by inspection (e.g., for <math>x^2 = 49</math>), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as <math>a \pm bi</math> for real numbers <math>a</math> and <math>b</math>. Analyze functions using different representations F-IF.7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.★ a. Graph linear and quadratic functions and show intercepts, maxima, and minima.</p>
<p>Performance example:</p> <ul style="list-style-type: none"> <li>Determine the resonant frequency of a filter with values of <math>L=1\text{mH}</math> and <math>C=10\mu\text{F}</math>.</li> </ul>		
2.H.01.10	F-BF.5, F-LE.4	<p>Build new functions from existing functions F-BF.5. (+) Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents. Construct and compare linear, quadratic, and exponential models and solve problems F-LE.4. For exponential models, express as a logarithm the solution to <math>abct = d</math> where <math>a</math>, <math>c</math>, and <math>d</math> are numbers and the base <math>b</math> is 2, 10, or <math>e</math>; evaluate the logarithm using technology</p>
<p>Performance Example:</p> <ul style="list-style-type: none"> <li>Calculate the loss of a fiber cable where the output power is 6mW and the input power is 12mW.</li> </ul>		
2.I.01.01	A-CED.1, A-CED.4, A-REI.3, 8.EE.4	<p>Create equations that describe numbers or relationships A-CED.1. Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and</p>

		<p>quadratic functions, and simple rational and exponential functions</p> <p>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 <math>V = IR</math> to highlight resistance R. (Note: This standard is included because given voltage and current students can write and use Watt's Law to solve for power).</p> <p>Solve equations and inequalities in one variable A-REI.3. Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.</p> <p>8.EE.4 Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology. (Note: Use of engineering notation.)</p>
<p>Performance Example:</p> <ul style="list-style-type: none"> <li>Calculate the wavelength of an electric signal for a frequency of 100MHz.</li> </ul>		
2.J.01.04	A-CED.1, A-CED.4, A-REI.3, 8.EE.4	<p>Create equations that describe numbers or relationships A-CED.1. Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions</p> <p>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 <math>V = IR</math> to highlight resistance R. (Note: This standard is included because given voltage and current students can write and use Watt's Law to solve for power).</p> <p>Solve equations and inequalities in one variable A-REI.3. Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.</p> <p>8.EE.4 Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology. (Note: Use of engineering notation.)</p>
<p>Performance Example:</p> <ul style="list-style-type: none"> <li>Calculate the length of a <math>\frac{1}{2}</math> wave dipole antenna at a frequency of 850kHz.</li> </ul>		
2.M.01.01	5.G.1,5.G.2,,5.G.3,,5.G.4,	Graph points on the coordinate plane to solve real-world and



	<p>6.NS.8, N-Q.1, A-REI.10, A-REI.11</p>	<p>mathematical problems.</p> <p>5.G.1. Use a pair of perpendicular number lines, called axes, to define a coordinate system, with the intersection of the lines (the origin) arranged to coincide with the 0 on each line and a given point in the plane located by using an ordered pair of numbers, called its coordinates. Understand that the first number indicates how far to travel from the origin in the direction of one axis, and the second number indicates how far to travel in the direction of the second axis, with the convention that the names of the two axes and the coordinates correspond (e.g., x-axis and x-coordinate, y-axis and y-coordinate).</p> <p>5.G.2. Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation.</p> <p>Classify two-dimensional figures into categories based on their properties.</p> <p>5.G.3. Understand that attributes belonging to a category of two dimensional figures also belong to all subcategories of that category. For example, all rectangles have four right angles and squares are rectangles, so all squares have four right angles.</p> <p>5.G.4. Classify two-dimensional figures in a hierarchy based on properties.</p> <p>Apply and extend previous understandings of numbers to the system of rational numbers.</p> <p>6.NS.8. Solve real-world and mathematical problems by graphing points in all four quadrants of the coordinate plane. Include use of coordinates and absolute value to find distances between points with the same first coordinate or the same second coordinate.</p> <p>Reason quantitatively and use units to solve problems.</p> <p>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.</p> <p>Represent and solve equations and inequalities graphically</p> <p>A-REI.10. Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).</p> <p>A-REI.11. Explain why the x-coordinates of the points where the graphs of the equations <math>y = f(x)</math> and <math>y = g(x)</math> intersect are the solutions of the equation <math>f(x) = g(x)</math>; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where <math>f(x)</math> and/or <math>g(x)</math></p>
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		<p>are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.★</p> <p>Interpret functions that arise in applications in terms of the context F-IF.4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.★</p>
<p>Performance Example:</p> <ul style="list-style-type: none"> <li>Graph a sine wave every 15 degrees with a maximum of 10.</li> </ul>		

## Embedded Science and Technology/Engineering

### *Earth and Space Science*

CVTE Learning Standard Number	Subject Area, Topic Heading and Learning Standard Number	Text of Earth and Space Science Learning Standard
2.F.02.12	Heat Transfer in the Earth System	3. Differentiate among radiation, conduction, and convection, the three mechanisms by which heat is transferred through the earth's system.
<p>Performance Example:</p> <ul style="list-style-type: none"> <li>Students will identify the similarities between the temperature management of electronic systems and the climate mechanisms that manage temperature on earth.</li> </ul>		
2.J.01.06	1. Matter and Energy in the Earth System	1.2 Describe the characteristics of electromagnetic radiation and give examples of its impact on life and Earth's systems.
<p>Performance Example:</p> <ul style="list-style-type: none"> <li>Students will recognize that the electromagnetic spectrum includes both visible light energy, as well as the frequencies used in telecommunications and cellular phones.</li> </ul>		
2.F.02.12	1. Matter and Energy in the Earth System	1.3 Explain how the transfer of energy through radiation, conduction, and convection contributes to global atmospheric processes, such as storms, winds, and currents.
<p>Performance Example:</p> <ul style="list-style-type: none"> <li>Students will identify the similarities between the temperature management of electronic systems and the climate mechanisms that manage temperature on earth.</li> </ul>		

### *Physical Science (Physics)*

CVTE Learning Standard Number	Subject Area, Topic Heading and Learning Standard Number	Text of Physics Learning Standard
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2.C.01.04 2.F.01.01	5. Electromagnetism	5.2 Develop qualitative and quantitative understandings of current, voltage, resistance, and the connections among them (Ohm's law).
Performance Example: <ul style="list-style-type: none"> <li>Students will understand and apply knowledge of ohms law to solve problems in low voltage applications.</li> </ul>		
2.F.01.02 2.F.01.05 2.F.01.09	5. Electromagnetism	5.5 Explain how electric current is a flow of charge caused by a potential difference (voltage), and how power is equal to current multiplied by voltage. 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.
Performance Example: <ul style="list-style-type: none"> <li>Students will understand the relationship between moving electrical charges and magnetism and how these relate to the generation of electricity and electrical interference.</li> </ul>		
2.F.02.01 2.F.02.02 2.F.02.03	5. 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.
Performance Example: <ul style="list-style-type: none"> <li>Students create a simple light bulb circuit using a power supply. The student will operate the same light bulb with AC and DC current and be able to measure the properties of the circuit and give an explanation of the difference in illumination.</li> </ul>		
2.F.02.12	3. Heat and Heat Transfer	3.1 Explain how heat energy is transferred by convection, conduction, and radiation. 3.2 Explain how heat energy will move from a higher temperature to a lower temperature until equilibrium is reached. 3.4 Explain the relationships among temperature changes in a substance, the amount of heat transferred, the amount (mass) of the substance, and the specific heat of the substance.
Performance Example: <ul style="list-style-type: none"> <li>Students will understand why electrical components generate heat and how to properly select and apply devices (i.e. heat sinks and fans) to transfer heat energy away from sensitive electronics.</li> </ul>		
2.H.01.02 2.I.01.02 2.I.01.07 2.I.01.08 2.J.01.04	4. Waves	4.1 Describe the measurable properties of waves (velocity, frequency, wavelength, amplitude, period) and explain the relationships among them. Recognize examples of simple harmonic motion.
Performance Example: <ul style="list-style-type: none"> <li>Students will be able to make basic calculations of wave characteristics and apply them to determine wavelengths for various frequencies used in telecommunications.</li> </ul>		
2.I.01.01 2.J.01.05	4. Waves	4.2 Distinguish between mechanical and electromagnetic waves.
Performance Example: <ul style="list-style-type: none"> <li>Students will understand the difference between waves caused by mechanical motion of a material and waves which are transmitted along the electromagnetic spectrum.</li> </ul>		
2.H.01.02 2.H.01.05	4. Waves	4.4 Describe qualitatively the basic principles of reflection and refraction of waves.
Performance Example: <ul style="list-style-type: none"> <li>Students will understand how wave reflection and total internal reflection changes with different materials</li> </ul>		

and how this effects the selection of fiber optic cabling.		
2.J.01.05 2.J.01.06	6. 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.
Performance Example:		
<ul style="list-style-type: none"> <li>Students will understand the electromagnetic spectrum and the small portion which is occupied by communications technologies.</li> </ul>		

### *Technology/Engineering*

<b>CVTE Learning Standard Number</b>	<b>Subject Area, Topic Heading and Learning Standard Number</b>	<b>Text of Technology/Engineering Learning Standard</b>
2.D.01.01 2.D.01.07 2.E.01.05 2.E.01.06 2.F.01.03 2.H.01.04 2.L.01.01	1. Materials, Tools, and Machines	1.1 Given a design task, identify appropriate materials (e.g., wood, paper, plastic, aggregates, ceramics, metals, solvents, adhesives) based on specific properties and characteristics (e.g., strength, hardness, and flexibility).
Performance Example:		
<ul style="list-style-type: none"> <li>Given a task, students will be able to identify the best materials and tools for the situation.</li> </ul>		
2.H.01 2.J.01.02 2.J.01.07 2.J.01.08	3. Communication Technologies	3.1 Identify and explain the components of a communication system, i.e., source, encoder, transmitter, receiver, decoder, storage, retrieval, and destination.  3.3 Identify and compare communication technologies and systems, i.e., audio, visual, printed, and mass communication.
Performance Example:		
<ul style="list-style-type: none"> <li>Students will be able to explain the components necessary for a basic fiber optic system and identify the benefits and drawbacks between fiber optics and coax technologies</li> </ul>		
2.M.01.07	1. Materials, Tools, and Machines	1.3 Identify and explain the safe and proper use of measuring tools, hand tools, and machines (e.g., band saw, drill press, sander, hammer, screwdriver, pliers, tape measure, screws, nails, and other mechanical fasteners) needed to construct a prototype of an engineering design.
Performance Example:		
<ul style="list-style-type: none"> <li>Students will be able to identify and safely operate the tools commonly used in residential service and installation of telecom equipment.</li> </ul>		
2.C.01.01	1. Engineering Design	1.4 Interpret and apply scale and proportion to orthographic projections and pictorial drawings (e.g., ¼" = 1'0", 1 cm = 1 m). 1.5 Interpret plans, diagrams, and working drawings in the construction of prototypes or models.
Performance Example:		
<ul style="list-style-type: none"> <li>When given a set of blueprints, students will be able to interpret the specifications of the drawings.</li> </ul>		
2.C.01.03	2. Construction Technologies	2.6 Recognize the purposes of zoning laws and building codes in the design and use of structures.
Performance Example:		
<ul style="list-style-type: none"> <li>Students will be able to understand and recognize the need for building codes in safely installing or</li> </ul>		

servicing electrical wiring.		
2.C.01.04 2.F.01.01 2.F.01.09	5. Energy and Power Technologies—Electrical Systems	5.3 Explain the relationships among voltage, current, and resistance in a simple circuit, using Ohm’s law.
Performance Example: <ul style="list-style-type: none"> <li>Students will understand how current and voltage relate in applications involving low voltage lighting. Students will understand how resistance can affect electrical interference.</li> </ul>		
2.F.01.09 2.E.01.11	5. Energy and Power Technologies—Electrical Systems	5.4 Recognize that resistance is affected by external factors (e.g., temperature).
Performance Example: <ul style="list-style-type: none"> <li>Students will understand the external factors that can be controlled through proper installation that affect clear signal transmission in copper cabling.</li> </ul>		
2.F.01.5	5. Energy and Power Technologies—Electrical Systems	5.5 Compare and contrast alternating current (AC) and direct current (DC), and give examples of each.
Performance Example: <ul style="list-style-type: none"> <li>Students will understand how AC rather than DC current is required for communications technologies and the importance of AC frequency to different applications.</li> </ul>		
2.F.02.01 2.F.02.03 2.F.02.05 2.F.02.08 2.M.01.01	5. Energy and Power Technologies—Electrical Systems	5.1 Explain how to measure and calculate voltage, current, resistance, and power consumption in a series circuit and in a parallel circuit. Identify the instruments used to measure voltage, current, power consumption, and resistance. 5.2 Identify and explain the components of a circuit, including sources, conductors, circuit breakers, fuses, controllers, and loads. Examples of some controllers are switches, relays, diodes, and variable resistors. 5.3 Explain the relationships among voltage, current, and resistance in a simple circuit, using Ohm’s law. 5.5 Compare and contrast alternating current (AC) and direct current (DC), and give examples of each.
Performance Example: <ul style="list-style-type: none"> <li>Students will be able to identify and understand the function of common circuit components in AC and DC circuits, make voltage and current calculations, and test their predictions using appropriate measurement tools.</li> </ul>		
2.F.02.12	4. Energy and Power Technologies—Thermal Systems	4.1 Differentiate among conduction, convection, and radiation in a thermal system (e.g., heating and cooling a house, cooking). 4.2 Give examples of how conduction, convection, and radiation are considered in the selection of materials for buildings and in the design of a heating system.
Performance Example: <ul style="list-style-type: none"> <li>Students will understand the type of heating caused by electrical components and be able to develop solutions for temperature control.</li> </ul>		
2.H.01.02,05-07	6. Communication Technologies	6.4 Identify and explain the applications of laser and fiber optic technologies (e.g., telephone systems, cable television, photography). 6.5 Explain the application of electromagnetic signals in fiber optic technologies, including critical angle and total internal reflection.
Performance Example: <ul style="list-style-type: none"> <li>Students will be able to explain the basic technology behind fiber optic communications as well as the benefits and limitations to fiber optics in the home.</li> </ul>		
2.G.01.04 2.I.01.01	6. Communication Technologies	6.2 Differentiate between digital and analog signals. Describe how communication devices employ digital and analog technologies (e.g.,

2.J.01.08		computers, cell phones).
Performance Example: <ul style="list-style-type: none"> <li>Students will understand the benefits and drawbacks to switching from analog to digital communications. Students will apply this to understanding the 2008 regulatory decision by the FCC to switch from analog to digital cellular signals in the US.</li> </ul>		
2.M.01.07	2. Construction Technologies	2.5 Identify and demonstrate the safe and proper use of common hand tools, power tools, and measurement devices used in construction.
Performance Example: <ul style="list-style-type: none"> <li>Students will be able to identify and safely operate the tools commonly used in residential service and installation of telecom equipment.</li> </ul>		

## DESE Statewide Articulation Agreements

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No Statewide Articulation Agreements at this time.

## Industry Recognized Credentials (Licenses and Certifications/Specialty Programs)

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ETA Residential Electronics System Integrator Basic Skills & Knowledge Certification Program



## Other

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### Reference Materials

- Telephone Systems, Heathkit, ISBN 0-87119-300-0
- Principles of Electronic Communication, Heathkit, ISBN 0-87119-296-9
- Principles of Electric Circuits, Floyd, ISBN 0-13-098576-7
- Practical Fiber Optics, Bailey, Wright, ISBN 0-7506-5800-2
- Electronic System Technician, NCCER, ISBN 0-13-109195-6
- Digital Electronics, Tokheim, ISBN 0-02-804161-5
- Tools for Problem Solving, Pearson, ISBN 0-13-028695-8

### Related National, Regional, and State Professional Organizations

- IBEW
- ETA International

### Student Organizations

- Skills USA      [www.maskillsusa.org](http://www.maskillsusa.org)

### Selected Websites

- [www.eta-i.org](http://www.eta-i.org)