BRISTOL TECHNICAL EDUCATION CENTER

PART OF THE CONNECTICUT TECHNICAL EDUCATION AND CAREER SYSTEM

2026

CTECS-Bristol TEC Two-Year HVAC Curriculum ©

BRISTOL-TEC TWO-YEAR HVAC CURRICULUM

CTECS: CIARLEGLIO, PASQUALE (CO)

Bristol TEC 2-Year HVAC Curriculum

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CTECS Instructional Model

CTECS uses the Marzano Compendium to guide research-based instructional strategies that differentiate learning and promote access, engagement, and success for all students. Teachers apply these strategies to support diverse learners (including multilingual learners, students with disabilities, and students with varied academic or technical backgrounds) through scaffolds, modeling, guided practice, and multiple ways to participate and show understanding. This approach ensures every student can work toward proficiency in the Priority Standards and the competencies outlined in the CTECS Vision of a Graduate.

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Feedback	Content	Context
Providing and Communicating Clear Learning Goals 1. Providing scales and rubrics 2. Tracking student progress 3. Celebrating success **Using Assessments** 4. Using informal assessments of the whole class 5. Using formal assessments of individual students	**Conducting Direct Instruction Lessons** 6. Chunking content 7. Processing content 8. Recording and representing content **Conducting Practicing and Deepening Lessons** 9. Using structured practice sessions 10. Examining similarities and differences 11. Examining errors in reasoning **Conducting Knowledge Application Lessons** 12. Engaging students in cognitively complex tasks 13. Providing resources and guidance 14. Generating and defending claims **Using Strategies That Appear in All Types of Lessons** 15. Previewing strategies 16. Highlighting critical information 17. Reviewing content 18. Revising knowledge 19. Reflecting on learning 20. Assigning purposeful homework 21. Elaborating on information 22. Organizing students to interact	**Using Engagement Strategies** 23. Noticing and reacting when students are not engaged 24. Increasing response rates 25. Using physical movement 26. Maintaining a lively pace 27. Demonstrating intensity and enthusiasm 28. Presenting unusual information 29. Using friendly controversy 30. Using academic games 31. Providing opportunities for students to talk about themselves 32. Motivating and inspiring students **Implementing Rules and Procedures** 33. Establishing rules and procedures 34. Organizing the physical layout of the classroom 35. Demonstrating withitness 36. Acknowledging adherence to rules and procedures 37. Acknowledging lack of adherence to rules and procedures **Building Relationships** 38. Using verbal and nonverbal behaviors that indicate affection for students 39. Understanding students' backgrounds and interests 40. Displaying objectivity and control **Communicating High Expectations** 41. Demonstrating value and respect for reluctant learners 42. Asking in-depth questions of reluctant learners 43. Probing incorrect answers with reluctant learners

Curriculum Introduction

This curriculum document outlines the essential learning for this trade program and provides a clear structure for planning, instruction, and assessment. It includes the components required by NEASC Standard 2.2a, along with elements that reflect the unique nature of CTECS technical programs. The curriculum is organized to show what students learn in each course, how learning progresses across grade levels, and how instruction supports both technical skill

development and the CTECS Vision of a Graduate.

Teachers should use this document to:

- Understand the overall structure and expectations of the course sequence
- Reference the Course Map to see the scope and sequence of Priority Standards and the alignment to District Summative Assessments (DSAs)
- Use the Priority Standards and Units of Study to guide daily, weekly, and cycle-based planning
- Integrate Big Ideas, Essential Questions, Skills/Learning Outcomes, vocabulary, and resources during lesson design
- Identify required safety, industry, and technical content expectations
- Plan and implement formative assessments to monitor progress and guide instruction
- Prepare students for the District Summative Assessments, ensuring alignment with the Course Map
- Maintain consistency of technical and professional practice instruction across campuses while adapting to student needs and industry-based opportunities

Curriculum Components

Course Map

A Course Map serves as the scope and sequence for this course by outlining the progression of instructional units and the standards that guide teaching and assessment. While each campus will have individual student needs, cycle schedules, and industry-based opportunities, all instructors are expected to teach the standards outlined in the Course Map. Using the Course Map below, teachers will intentionally plan learning experiences that prepare students to meet the identified standards within the designated assessment windows.

Priority Standards (Units of Study)

Priority Standards identify the most essential learning in the trade program. They reflect the core technical competencies, safety practices, and industry-aligned skills that require the greatest instructional focus and appear on program assessments. In CTE programs, each Priority Standard also functions as a Unit of Study, because it includes the required components such as big ideas, essential questions, content topics, and skills/learning outcomes aligned to assessments.

Vertical Alignment

Vertical alignment shows how Priority Standards and instructional expectations progress from

grade to grade within the trade program. It provides a clear pathway of skill development, increasing complexity, and technical proficiency across the four-year sequence.

Learning Outcomes

Learning outcomes are what students will know (Concepts) and be able to do (Skills). Concepts identify the major content topics within the Priority Standard (Unit of Study). They appear in the left column of the Learning Outcomes table and follow a similar coding structure as the Priority Standard.

Skills are learning objectives that describe the measurable actions students must be able to perform to demonstrate proficiency. They appear in the right column of the Learning Outcomes table and show the progression of learning evidence in the Priority Standard.

Vocabulary

Essential vocabulary includes the technical and academic terms students must understand and use accurately to engage in trade-specific learning and demonstrate proficiency on assessments. Vocabulary is foundational to safety, technical precision, and industry communication, and should be a primary initial focus within each unit and taught explicitly through modeling, demonstration, and repeated application.

Resources

Resources include the tools, equipment, texts, materials, and digital tools that support learning within each unit and reflect industry standards.

Assessment Practices

Teachers use ongoing formative assessments—such as questioning, checks for understanding, performance demonstrations, reflections, and teacher observation—to monitor progress, guide instruction, and support all learners in mastering the Priority Standards.
Each program also includes District Summative Assessments (DSAs), which measure proficiency on the Priority Standards identified in the Course Map. DSAs provide consistent evidence of student learning across campuses and ensure alignment to industry expectations, safety requirements, and program outcomes. Teachers should reference the Course Map and Units of Study when planning instruction to ensure students have opportunities to practice and demonstrate the skills and knowledge assessed on the DSA.

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Proficiency Scale Alignment

Mastery by Design: Aligning to Marzano Proficiency Scales

To ensure every student reaches high-level learning, our curriculum utilizes **Marzano-aligned Proficiency Scales** directly embedded within each **Priority Standard**. Rather than a simple "pass/fail" metric, these scales provide a clear, consistent roadmap for growth, moving from foundational knowledge to complex application.

By placing these scales at the point of use within the curriculum, we bridge the gap between planning and instruction.

Why This Alignment Matters

- **Clarity of Expectation:** Teachers and students share a common language for what "Level 3.0" (Target Mastery) looks like versus "Level 4.0" (Exceeding the Standard).
- **Instructional Precision:** With scales linked to specific Priority Standards, you can instantly identify prerequisite skills (Level 2.0) to support struggling learners or provide enrichment for those ready to go beyond.
- **Scaffolded Success at Level 2:** To support foundational understanding, Level 2.0 includes explicitly aligned and tiered vocabulary required for each priority standard, ensuring students have the linguistic building blocks needed for mastery.
- **Data-Driven Feedback:** Grading becomes more objective and transparent, focusing on the evidence of learning rather than points earned.

The 4-Point Structure at a Glance

- 4.0: Exceeding: In-depth inferences and applications that go beyond what was taught.
- 3.0: The Target: Mastery of the specific Priority Standard as defined by the curriculum.
- 2.0: Foundational: Understanding of tiered vocabulary and basic processes related to the standard.
- 1.0: Emerging: Success with help or partial understanding of the 2.0 and 3.0 content.

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Integrated for Ease of Access: When you open a Priority Standard in your curriculum docs, the specific success criteria and required vocabulary are right there, ready for your daily lesson plan or assessment design.

A link to the CTECS Proficiency Scales aligned to this curriculum is located below:

CTECS HVAC Proficiency Scales

A more comprehensive guide to implementation can be found by clicking on the link below:

VANGUARD Trades PS Implementation Guide

CTECS HVAC Math Integration & Competency Crosswalks

To fully illustrate the rigorous mathematical foundations embedded within the ***Bristol TEC HVAC curriculum***, we have developed a comprehensive integration guide. While the priority standards within this document include specific embedded examples of math applications, a

more exhaustive resource is available for instructional use. This guide features detailed mathematics competency crosswalks designed to bridge technical skills with academic standards. You can access the complete ***CTECS HVAC Math Integration Guide*** on the Licensed Trades website or by clicking the link below:

Embedded Math

- **Point-of-Use Integration**: Each Priority Standard contains specific ***"Trade Math Crossover"*** sections that align mathematical concepts; such as: Gas Pipe Sizing, ladder ratios, and BTU Heat Load and Heat Loss Calculations; directly to the technical task at hand.
- **Marzano-Aligned Scales**: Every standard is linked to a Marzano-aligned Proficiency Scale, providing a clear 4-point roadmap from foundational vocabulary (Level 2.0) to target mastery (Level 3.0) and advanced application (Level 4.0).
- **Cross-Over Tables**: Detailed tables in the curriculum and ***appendix*** sections provide a crosswalk between technical skills and apprenticeship standards, ensuring students meet the requirements for CT-DOL related instruction.

Additional Resources

For those seeking more in-depth information, a more comprehensive guide to implementation and the full ***Math Integration Guide*** can be found on the **Licensed Trades website**

Access the HVAC Math Integration Guide

CTECS HVAC Philosophy

The ***Bristol TEC HVAC course*** of studies is designed to create an appreciation of the industry and to develop entry-level skills within the ***HVAC*** construction trade. Opportunities to develop skills for personal use and to make a successful transition from school to the workplace or post-secondary institutions will be presented to students enrolled in this course.

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The ***HVAC*** course is designed to provide Level I apprenticeship theory content within the trade. Practical experience will be gained within the school, through outside production experience, and through optional Work Based Learning, employed by a licensed ***HVAC*** contractor or wholesale company.

Program Description

Students enrolled in the ***Bristol TEC Heating, Ventilation and Air Conditioning (HVAC)*** program will obtain instruction and demonstrate skills and knowledge in construction safety, measuring and blueprint reading, calculations of ductwork & heating systems with an emphasis on both heat loss and heat gain heating and cooling calculations. Students are also instructed on Domestic and Commercial Refrigeration systems, Gas, Oil Heating. Students in the HVAC program receive both on-site and off-campus jobsite learning opportunities simulating real-world applications. Students are trained in the installation and repair of refrigeration, heating, and cooling mechanical systems in both residential homes and commercial buildings. The systems that control indoor climate are constantly evolving to reflect technological advancements and environmental concerns.

In addition, students enrolled in the HVAC program will also obtain instruction in energy efficiency, environmental, renewable energy, as well as energy conservation practices.
A field that anticipates a high demand for skilled mechanics and technicians, the HVAC program ensures that students are skilled in the operation, design, installation, troubleshooting and repair of air conditioning, refrigeration, heating and ventilation equipment.

CTECS HVAC Goals

The ***HVAC*** Program will create an awareness of opportunities within the vast trade areas that comprise the HVAC Construction Industry. The program incorporates new developments and practices related to HVAC installation in residential, commercial and industrial construction.

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Program Goals

As a result of education in the **Bristol TEC HVAC** Program, students will:

- Identify, describe and apply health and safety regulations that apply to specific tasks and Jobsite Safety. Students must complete a safety credential program. Practice Shop and Jobsite Safety;
- 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;
- Understand career opportunities in the HVAC industry;
- Study blueprints, design specifications, or manufacturers' recommendations to ascertain the configuration of heating or cooling equipment components and to ensure the proper installation of components;
- Understand and apply joining methods for piping and sheet metal materials;
- Demonstrate safety in refrigerant handling following Environment Protection Agency (EPA) regulations;
- Describe, demonstrate and troubleshoot wiring of HVAC&R controls, motors, and circuits;
- Design, install and troubleshoot refrigeration components and systems;
- Design, install and service of Heating & Cooling Equipment and Systems (Oil, Gas, & Heat pump);
- Describe and demonstrate ventilation applications and forced-air duct systems;
- Perform blueprint reading, sketching and estimating according to code;
- Lay out full scale drawings of pipe systems, supports, or related equipment, according to blueprints;
- Demonstrate hand/power tool uses and operations;
- Install pipe systems to support alternative energy-fueled systems, such as geothermal

and hybrid systems;

- Prepare cost estimates for clients

Program Standards

- Building Science Principles Certificate
- CT-DOL – Apprenticeship Related Instruction 720 Hours
- EPA Certification – Refrigerant Recovery/Recycling
- Fall Protection Certification
- Lockout Tagout Certification
- OSHA – 10, 30 Certification – CFR – 1926
- Roth Oil Tank Certification
- Ladder Safety Certification
- CSST Gas Piping Certification
- Fluke Meter Certification
- Zoom Lock Certification

Program Locations in CT

CTECS HVAC:

Bristol TEC 2-Year HVAC Curriculum

1. Bristol Technical Education Center, **Bristol**

CT-DOL Program Approval

The Bristol TEC HVAC Curriculum is fully approved by the CT-DOL Office of Apprenticeship Training.

A CTECS HVAC graduate who *successfully completes* the program is entitled to 720 hours of related instruction training* towards a S-2 apprenticeship and all limited-licenses under the scope of the S-2.

(*Contingent upon student receiving OSHA 30 certification)

Curriculum Legend	
Bold	**Powered-Need to know**
Non-Bold	Nice to Know
Green Font	**Green Technology Alignment**
Red Font	**Common Core Technical Standards Alignment**
Blue Font	**Alignment to the CTECS Vision of a Graduate Standards**

CTECS Vision of a Graduate

The Bristol TEC Vision of the Graduate: A Roadmap for Instructional Excellence

The ***Bristol TEC Vision of the Graduate (VOG)*** represents the collective voice of our stakeholders, capturing the essential traits, attitudes, and skills our students need to excel both in our classrooms and in their future careers. More than just a list of aspirations, the VOG serves as a framework to help you deliver purposeful, high-quality instruction that prepares every student for the demands of the modern workforce.

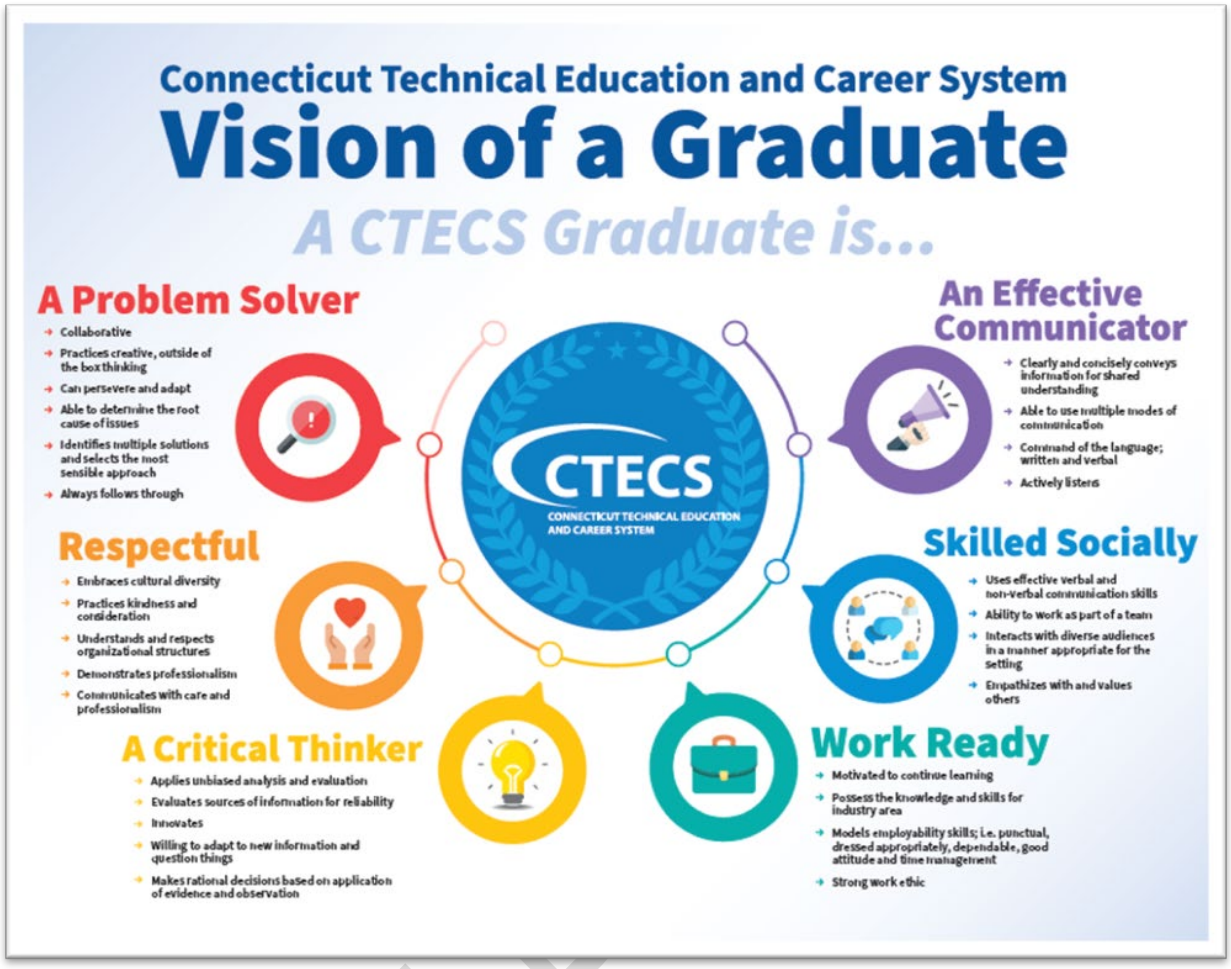
How to Use This Document: To help you bridge the gap between curriculum standards and real-world application, we have integrated the VOG directly into your teaching tools:

- **Integrated Standards:** Each Priority Standard within this curriculum has been intentionally aligned with the CTECS VOG. To make these connections easy to identify at a glance, all VOG-aligned standards are denoted in ***blue font*** throughout this document.

- **Teacher Support Tools:** We have developed a comprehensive resource site to support your daily instruction. This hub provides the materials and strategies needed to bring these VOG traits to life in your shop or classroom.

Access your teaching resources here: CTECS Licensed Trades VOG Resource Site

The following page has a pictograph that depicts the six CTECS VOG traits we strive to adhere to:



CTECS VOG 1

Bristol TEC 2-Year HVAC Curriculum

Bristol TEC HVAC Course Map

Year 1, Quarter 1

- 1-1: To have a general understanding of shop and work site safety
- 1-2: To have knowledge about the history of Heating, Air-conditioning and Refrigeration
- 1-3: To be able to use hand/power tools correctly
- 1-4: To have an awareness of the job opportunities available within the HVAC industry
- 1-5: Identify tools commonly used when working with copper tubing and their fastening\ sealing materials.

Year 1, Quarter 2

- 1-1: To have a general understanding of shop and work site safety
- 1-6: Introduction of the effects of heat energy and pressure on the properties of matter
- 1-7: Sheet metal basics
- 1-8: To have a basic understanding of electrical values and circuits including ohms law and rules for different electrical circuits.
- 1-9: To have a basic understanding of how electrical diagrams are use in HVAC
- 1-10: Comprehend how codes and their regulations affect the HVAC trade.
- End of Term DSA: (Please refer to DSA Study Guide for in-depth topics listed on the exam)

Bristol TEC 2-Year HVAC Curriculum

Year 1, Quarter 3

- 2-1: An understanding of the expected conduct at school, work site and how it relates to safety. (OSHA training)
- 2-2: Understand the application of and be able to interpret trade drawings
- 2-3: Knowledge of using the right fastener for the job, while using proper tool interaction for each fastener.
- 2-4: Advanced sheet metal.
- 2-5: To comprehend and to describe watts, ohms, volts, and amps using Ohms law
- 2-6: Knowledge and application of basic electricity, electrical circuits and AC electric motors
- 2-7: Know the use or function of typical electrical components found in HVAC systems.
- End of Term DSA: (Please refer to DSA Study Guide for in-depth topics listed on the exam)

Year 1, Quarter 4

- 2-8: Know the accepted types of pipe and piping practices.
- 2-9: To have a clear understanding of the effects of heat energy and pressure on the properties of matter
- 2-10: Understand the relationship of pressures and fluids at saturation temperatures.
- 2-11: To have a strong understanding the vapor compression refrigeration cycle.
- 2-12: Industry EPA standards for safety and environmental issues regarding refrigerant.
- End of Term DSA: (Please refer to DSA Study Guide for in-depth topics listed on the exam)

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Year 2, Quarter 1

- 3-1: Comprehension of the conduct and safety expectations at the school/work site.
- 3-2: Application of knowledge of basic electricity, electrical circuits and AC electric motors
- 3-3: Have an understanding the use of building codes and manufacturers' installation instructions on current production jobs
- 3-4: Understand how to calculate total heat gain/loss for the proper sizing of heating\cooling equipment.
- 3-5: Understanding of airflow principles and design of air handling equipment.
- End of Term DSA: (Please refer to DSA Study Guide for in-depth topics listed on the exam)

Year 2, Quarter 2

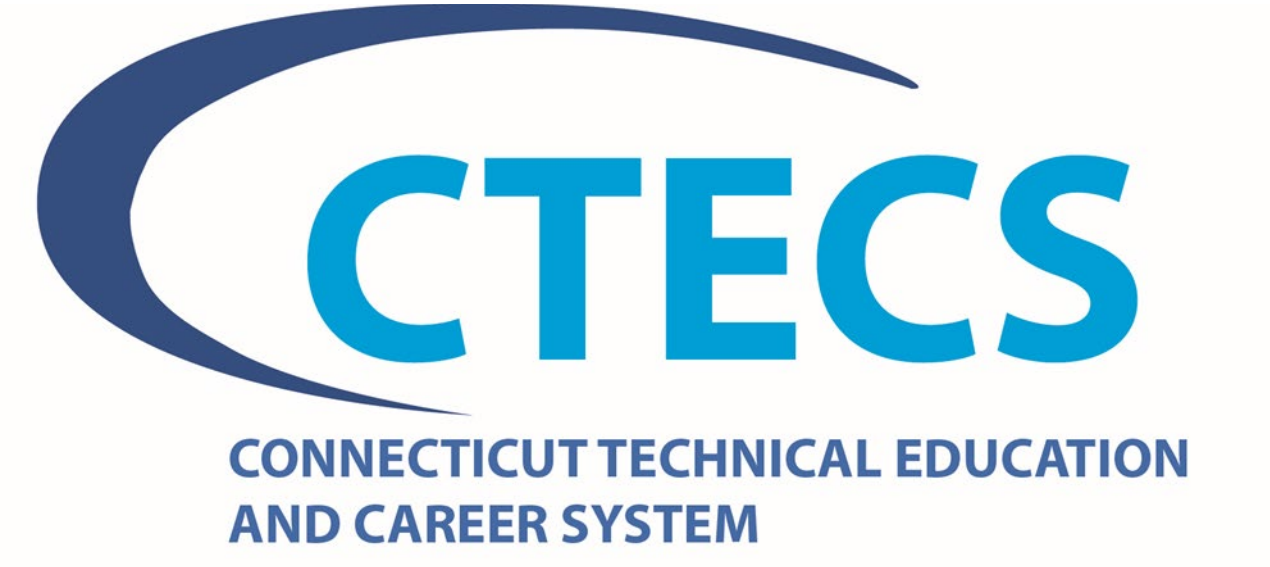
- 3-6: Have the understanding of how to safely work with fuel gases while comprehending industry environmental issues regarding storage
- 3-7: Have the knowledge and the ability to conduct a start-up on gas heating systems and combustion
- 3-8 Have the knowledge how to systematically troubleshoot and to service a Gas system
- 3-9: Have the understanding of how to safely handle refrigerants, while comprehending industry environmental issues regarding refrigerant.
- 3-10: Have a comprehensible understanding of the refrigeration cycle and superheat, sub-cooling, and coil temperature differences.
- End of Term DSA: (Please refer to DSA Study Guide for in-depth topics listed on the exam)

Year 2, Quarter 3

- 4-1: Have the understanding of how to safely work with fuel oil while comprehending industry environmental issues regarding storage and combustion.
- 4-2: Become acquainted with various contemporary oil heating appliances.
- 4-3: Have the knowledge and the ability to conduct a start-up on oil heating systems.
- 4-4: Have the knowledge how to systematically troubleshoot and service an Oil system.
- 4-5: Industry EPA standards for safety and environmental issues regarding refrigerant.
- End of Term DSA: (Please refer to DSA Study Guide for in-depth topics listed on the exam)

Year 2, Quarter 4

- 4-6: Know the mechanical refrigeration cycle and be able to troubleshoot problems.
- 4.7: Have an understanding of startup and testing procedures of an air-conditioning system
- 4-8: Have an understanding of the theory of a heat pump systems operation and its functioning ability
- 4-9: Have the knowledge how to systematically troubleshoot so to service an air conditioning
- 4-10: Become acquainted with Hydronic heating systems
- 4-11: Have an understanding of startup and testing procedures of a Hydronic system
- End of Term DSA: (Please refer to DSA Study Guide for in-depth topics listed on the exam)



B-TEC HVAC

Year 1; Semester 1

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Year 1, Semester 1 Curriculum

Priority Standard 1-1: Shop and work site safety.	
Big Idea(s): **1. Safety practices build the foundation of a successful HVAC career by protecting workers and promoting efficiency through awareness, responsibility, and routine.**	
Essential Question(s): **1. How do safety protocols in a workshop or worksite help prevent accidents, and what role do individuals play in maintaining a safe environment?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
1-1.A Personal Protective Equipment • **Work Boots/Safety Shoe** • **Proper fit** • **Ear protection** • **Safety Glasses** • **Gloves** • **Hard hat** • **OSHA**	**1. Provide reasons with examples for use of each as written assessment.** **2. Daily assessment of personal safety during lab work.** **3. Students are wearing appropriate proper fitting clothing. including Uniform hard hat, safety glasses, hearing protection, safety shoes, gloves, etc.** **4. Remove jewelry.** **5. Score 100% on the written Safety Test.** **6. Explain OSHA.**
1-1.B Hazards in the Workplace • **Using torches** • **Cutting wood and metal with saws** • **Cutting sheet metal** • **Drilling holes** • **Throwing instead of carrying tool** • **Carrying heavy objects**	**1. Recognize situations that are unsafe in the shop for a given situation/scenario.** **2. Identify work areas that have potential safety risks.** **3. Explain possible consequences of talking to someone while using tools or throwing an object.** **4. Identify the cause of injuries.** **5. Identify fire alarms, extinguishers, blankets, eye wash stations, and power shut-off locations.** **6. Explain the dangers of coming in contact with blood pathogens.**
1-1.C Substance Abuse • **Alcohol** • **Over the counter and prescribed medications** • **Illegal drugs**	**1. Analyze how impaired thought and coordination can cause serious injury or death of self or others around them.**

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1-1.D Hardware and Materials • Screws • Nails • Hinges	1. Demonstrate proper use of hardware items. 2. Demonstrate proper disposal and recycling of items such as sharp materials.
1-1.E Fire safety • Protecting against fire • Fire classifications • Fire extinguisher use	1. Identify different classifications of fire extinguishers. 2. Explain proper use of a fire extinguisher.
1-1.F Work habits • Neatness • Thoroughness • Systematic procedures • Working patiently	1. Explain and demonstrate work habits including, neatness, thoroughness, systematic procedures and patience.
1-1.G Environmental Safety • Greenhouse gases • Ozone layer • Chemical disposal	1. Explain the need to protect the environment when working with and disposing of HVAC equipment.
1-1.H Live Work Precautions. • Electrocution • Moving parts	1. Demonstrate safe meter use. 2. Demonstrate keeping a safe distance when working near moving components. 3. Performing Lock out/Tag out procedure.
1-1.I Storage and Handling of cylinders • Danger of tanks falling • Oil use around oxygen • Pressure regulators • Storage	1. Demonstrate proper handling of pressurized vessels. 2. Demonstrate proper storage of pressurized vessels.
1-1.J Sheet Metal hop Safety. • How to work safely in the sheet metal shop with others	1. Demonstrate fabricating sheet metal projects safely. 2. Explain shop safety procedures and concerns with peers and others about safety when working with sheet metal. 3. Identify safety hazards in the sheet metal shop.

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words

Work Boots Proper fit Ear protection Safety Glasses Gloves Personal Protective Equipment (PPE) Signal Word Lockout/Tagout Air-Purifying Respirator Confined Space Hazard Occupational Safety and Health Act (OSHA)	Fire extinguisher Neatness Electrocution Hazard Communication Standard (HCS) Pictogram Hazard Safety Data Sheet (SDS) Stationary Refrigerant Detector Supplied-Air Respirator	OSHA PPE MSD Ozone Layer Globally Harmonized System (GHS) ASHRAE Standard 34
Trade Math Crossover: Ladder Safety 4:1 ratio		

Suggested Resources

Heating & Cooling Essentials: ISBN 13: 1781631260599
Chapter 3. Safety

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545
Section 1, Chapter 2.

Basic Principles for Construction, 4th Edition (Residential Construction Academy) 4th Edition
ISBN-13: 978-1-3050-8862-7
Chapter 3. Job Safety

OSHA.Gov:
https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Apprenticeship Correlation

OSHA 30: A0099

VOG Portfolio Collection Examples

Students will have the ability to develop a Fire Evacuation plan with proper egress and exits **(VOG - A Critical Thinker**)

Project: Shop Safety Audit & Evacuation Map: Description: Students work in teams to identify potential hazards in the HVAC shop (e.g., improper cylinder storage or blocked egress). They must create a professional fire evacuation plan and a safety checklist for personal protective equipment (PPE). **VOG Alignment: Critical Thinker & Problem Solver.**

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Priority Standard 1-2: History of Heating, Air-conditioning, and Refrigeration	
Big Idea(s): **1. Understanding the evolution of HVAC systems helps students appreciate the technological progress that improves health, comfort, and energy use in modern life.**	
Essential Question(s): **1. How have advancements in heating, air conditioning, and refrigeration technologies shaped modern life, and what were the key innovations that made these systems possible?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
1-2.A History of heating systems. • **Fire/Fireplace** • **Wood/coal stoves** • **Wood/coal boilers/furnace** • **Oil/gas boilers/furnace** • **Electric resistance heaters** • **High efficiency boiler and furnaces** • **Passive solar** • **Active solar** • **Combination systems hydro air boiler with blower**	**1. Explain the history of heating systems "from fireplaces to hydro air".** **2. Identify heating systems, water, air, oil, gas, electric resistance, heat pumps, solar.**
1-2.B Air-conditioning and Refrigeration History • **Air circulation for building cooling** • **Underground food storage** • **Ice used to absorb heat** • **Mechanical cooling system**	**1. Compare and contrast historical events of air-conditioning and refrigeration** **2. Construct a timeline of key historical events of refrigeration** **3. Giving examples of the effects on society since the development of air conditioning.**
1-2.C Air-conditioning and refrigeration and define their differences.	**1. Explain the 6 elements of a complete air conditioning system, heat, cool, humidify, dehumidify, clean air, move air** **2. Explain refrigeration as used for retarding bacterial growth.**
1-2.D Types of AC Systems.	**1. Identify package and split air conditioning systems**
1-2.E Air-conditioning Human Comfort	**1. Explain the history of air conditioning including needs beyond human requirements such as temperature and humidity standards for human comfort**

1-2.F Trade Associations in the HVAC Trades	1. **Identify different trade associations within Connecticut and United States, i.e., RSES, ACCA, ARI, CHCCA, ASHRAE** 2. **Provide education, keeping workers up to date on industry and work standards**

Tiered Vocab:		
Tier One Words	Tier Two Words	Tier Three Words
HVAC/R Ladder Diagram Pictorial Diagram Mechanical Skill Mental Skill Physical Skill	Technician Service Technician Installer Parts Clerk	Building Engineer Technical Training Instructor Building Engineer Energy Auditor Business Owner

Trade Math Crossover: A technician is checking the operation of a residential central air conditioner. One of the tasks is to measure the difference from the outside temperature in comparison to the inside temperature. The outside temperature is 89 degrees, and the inside temperature is 70 degrees. What is the temperature difference?

Suggested Resources

Heating & Cooling Essentials: ISBN 13: 9781631260599
Chapter 1. Careers in HVAC

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5
Introduction

Basic Principles for Construction, 4th Edition (Residential Construction Academy) 4th Edition
ISBN-13: 978-1-3050-8862-7
Section 1 Chapter 1 working in industry

OSHA.Gov:
https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Apprenticeship Correlation

Refrigeration Fundamentals A0781

VOG Portfolio Collection Examples

Students will be able to take a Delta-t measurement across an evaporator coil and record the information accurately. **(VOG- A Problem Solver)**

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Project: The Evolution of Comfort Timeline: Description: Students research and present a timeline of heating and cooling, from open fireplaces to modern high-efficiency heat pumps, explaining how these advancements impacted human health and society. **VOG Alignment: Effective Communicator.**

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Priority Standard 1-3: Hand/power tools	
Big Idea(s): **1. Using the right tool for the job improves quality, efficiency, and safety, and demonstrates the professionalism expected in the HVAC trade.**	
Essential Question(s): **1. Why is it that skilled craftspeople get paid more?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
1-3.A Hand and Power tools • **Hand Drill** • **Drill press** • **Band saw** • **Reciprocating saw** • **Circular saw** • **all sizes of standard screwdriver** • **all sizes of Phillip screwdriver** • **combination wrenches** • **Adjustable wrench** • **Needle nose Pliers** • **Lineman pliers** • **Diagonal pliers** • **Pipe pliers** • **Crimper/stripers**	**1. Label hand/power tools.** **2. Verbally identify the correct application.**
1-3.B Power Tool Safety • **Hand Drill** • **Drill press** • **Band saw** • **Reciprocating saw** • **Circular saw**	**1. Demonstrate the proper and safe use of listed power tools.** **2. Select the proper tool for given projects.** **3. Pass a written exam on safety of power tools.**
1-3.C Proper Power Tool Selection • **All sizes of standard screwdriver** • **All sizes of Phillip screwdriver** • **Combination wrenches** • **Adjustable wrench** • **Needle nose Pliers** • **Lineman pliers** • **Diagonal pliers** • **Pipe pliers** • **Crimper/stripers**	**1. Demonstrate the proper and safe use of listed hand tools.** **2. Select the proper tool for given projects.** **3. Pass a written exam on safety of hand tools** **4. Demonstrate safe and proper use of required tools and equipment used in the solar trades, (Reference NABCEP 1.2)**

Bristol TEC 2-Year HVAC Curriculum

1-3.D Stationary HVAC Equipment. • **Pittsburg** • **Foot operated shear** • **Bending break** • **Box, pan, finger break** • **Roller**	1. **Demonstrate the proper and safe use of listed manufacturing equipment** 2. **Select the proper tool for given projects** 3. **Pass a written exam on safety of large manufacturing equipment**
1-3.E Maintenance of Equipment • **Hand oiler** • **Grease gun** • **Spray lubricants**	1. **Demonstrate the use of lubricating tools commonly used in HVAC such as grease gun and spray lubricants.**
1-3.F Fasteners • **Nails** • **Screws** • **Bolts** • **Nuts** • **Lags**	1. **Identify fasteners commonly used in HVAC**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
Adjustable wrench	Open End Wrench	Flare Nut Wrench
Box end wrench	Box End Wrench	Allen Wrench
Combination pliers (slip-joint)	Combination Wrench	Socket Wrench
	Adjustable Wrench	Lineman's Pliers
Diagonal pliers	Pump Pliers	Locking Pliers
Double-cut file	Diagonal Cutting Pliers	Torx Bit Driver
File	Adjustable Pliers	Ball Pein Hammer
Hacksaw	Nut Drivers	Setting Hammer
Hammer	Straight Blade Screwdriver	Hole Saw
Hex key	Fearson Screwdriver	Aviation Snips
Lineman's pliers	Nail Hammer	Masonry Drill Bit
Screwdriver	Hacksaw	Chisel
Cordless drill	Drill Bit	Punches
	Snips	Cold Chisels
	Struck Tools	Abrasives
	level(orientation)level(tool)	Cleaning solvent
	Center punch	Manometer
	Cold chisel	Refrigeration service valve wrench
	Flare nut wrench	
	Mallet	Thermometer

	Socket wrench Twist drill bit Vise Sawzall Circular saw	Temperature analyzer Right angle drill Hammer drill

Trade Math Crossover: Hammers come in different weights for different types of nailing. A 16oz. hammer is used for general use. A 28 oz. hammer is used for heavy duty nailing. What is the difference in weight are they?

Suggested Resources

Heating & Cooling Essentials: ISBN 13: 9781631260599
Chapter 2. Hand tools

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545
Section 3 Chapter 7 Tools and supplies

Basic Principles for Construction, 4th Edition (Residential Construction Academy) 4th Edition
ISBN-13: 978-1-3050-8862-7
Section 4 Chapter 14 Hand tools
Section 4 Chapter 15 Power tools
Section 4 Chapter 16 Fasteners

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5
Unit 5 Tools & equipment
Unit 6 Fasteners

OSHA.Gov:
https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Apprenticeship Correlation

A0781 Refrigeration Fundamentals –B- Tools

VOG Portfolio Collection Examples

Students will be able to identify the correct snips for cutting sheet metal for a customer's project. (VOG-Work Ready)

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 1-4: Job opportunities available within the HVAC industry	
Big Idea(s): **1. The HVAC field offers a wide range of career paths, and exploring these options helps students align their interests with industry demand and emerging technologies.**	
Essential Question(s): **1. What types of jobs are available in the HVAC industry, and how do these careers contribute to our daily lives and the environment?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
1-4.A Job opportunities in the HVAC industry. • **Electrical** • **Plumbing** • **Heating** • **Air Conditioning** • **Refrigeration** • **Sheet Metal** • **Residential** • **Commercial** • **Industrial** • **Service** • **Installation** • **Maintenance**	**1. Explain careers that are included in the HVAC trade.** **2. Discuss opportunities for graduates of HVAC.** **3. Develop a list of job opportunities within the field.** **4. Prepare a report on career opportunities in the total comfort industry.** **5. Explain differences between Industrial, Commercial, and residential** **6. Develop an understanding of apprenticeship and how it differs between trades and the purpose of its existence.** **7. Identify installation, service, maintenance jobs.** **8. Identify upcoming changes in the industry.** **9. Demonstrated Knowledge of *GREEN TECHNOLOGIES* and their impact on jobs in HVAC.**
1-4.B Job Selection Methods • **Most enjoyable tasks** • **Easiest task to learn** • **Greatest need** • **Highest earning potential**	**1. Create a personal skill portfolio and predict/forecast job opportunities.**
1-4.C HVAC licensing in Connecticut • **S2** • **D2** • **B2** • **SM 2** • **S10**	**1. List different licenses.** **2. Explain differences in licenses.**

1-4.D Customer Expectations as it pertains to Solar Thermal Installations. (Reference NABCEP 11.7-11.13)	**1. Demonstrate to the owner operation and functionality of system** **2. Demonstrate to the owner start-up and shut-down procedures for system** **3. Demonstrate to owner simple maintenance and diagnostic procedures** **4. Identify for owner all markings and labels for system service and owner interaction** **5. Identify for owner safety issues associated with operation and maintenance of system** **6. Complete and transfer documentation package to system owner/operators** **7. Review system/component warranties and requirements with owner**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
Installer	Mechanical Skill	Service Technician

Trade Math Crossover: On a residential repair the technician charges $16 per hour for labor. How much should be charged for a 17-hour job?

Suggested Resources

Heating & Cooling Essentials: ISBN 13: 9781631260599
Chapter 1 Careers In HVAC

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545
Chapter 1 Careers & certifications

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5
Introduction section

Basic Principles for Construction, 4th Edition (Residential Construction Academy) 4thEdition
ISBN-13: 978-1-3050-8862-7
Chapter 3 Introduction to Green Building

OSHA.Gov:
https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Apprenticeship Correlation

A0729 International mechanical Code

Bristol TEC 2-Year HVAC Curriculum

VOG Portfolio Collection Examples

Students that take part in our HVAC/R program recognize that there are many career paths to choose from in the HVAC/R field. (VOG – Work Ready)

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 1-5: Identify tools commonly used when working with copper tubing and their fastening/sealing materials.	
Big Idea(s): **1. Mastering copper tubing tools and joining techniques is essential for producing durable, leak-free connections in both traditional and green HVAC systems.**	
Essential Question (s): **1. What tools and materials are commonly used to work with copper tubing, and how do they help create secure, leak-proof connections in plumbing or HVAC systems?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
1-5.A Tubing and piping used in the HVAC/R industry	**1. Identify ACR size verse nominal size.** **2. Identify K,L,M, and DW pipe.** **3. Identify purpose and application of each type of pipe.**
1-5.B Tubing tools that are associated with copper tubing.	**1. Demonstrate safe practices using tools commonly used when working with copper tubing.** **2. Take a written test on tools used with working piping.** **3. Demonstrate proper use of acetylene and oxygen/acetylene torch.**
1-5.C Soldering and brazing alloys used in HVAC/R industry and describe their purpose.	**1. Distinguish differences between soldering filler metals i.e., 50/50, 95/5 etc.** **2. Discuss percent of silver content importance.** **3. Reviewing percentage of silver content and its importance.** **4. Identify brazing filler metals and melting temperatures.**
1-5.D Several types of fittings and describe and analyze their purpose.	**1. Identify long radius verse short radius elbows** **2. Shown tee sizing i.e., ¾ x ¾ x ¾ or ¾ x ¾ x ½ tee with reducing branch**
1-5.E Types of torches used in the HVAC/R industry.	**1. Explain the appropriate use of each method in a written assessment.**
1-5.F Applications of soldering and brazing alloy that will be used with copper joints.	**1. Demonstrate safe practices using tools commonly used when working with copper tubing**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
Tubing	Type K Tubing	ACR Tubing
Pipe	Type L Tubing	Union Fitting
Hard Drawn Copper	Type M Tubing	Mechanical Fittings
Annealed	Tubing Reamer	Soldering
Tubing Cutter	Tubing Bender	Brazing
Outside Diameter (OD)	Swaging	Carburizing
Inside Diameter (ID)	ABS	Flame
Wrought Fittings	(acrylonitrile- butadiene-styrene)	Purging
Flare Fitting	annealing	
Bending spring	CPVC (chlorinated polyvinyl chloride)	
Tubing bender	Double-flare	
Capillary action	PVC (polyvinyl chloride)	
`Flux	Street fitting	
Neutral flame		
Oxidizing flame		
Oxyacetylene torch		
Single flare		
Soldering		
Solvent		
Welding		

Trade Math Crossover: When measuring ACR copper tubing the technician measurers 7/16ths inside diameter (ID). What should the outside measurement (OD) be?

Suggested Resources

Heating & Cooling Essentials: ISBN 13: 9781631260599
Chapter 4,5,6,7 Piping Practices

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545
Chapter 8 Tubing

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5
Unit 7 Tubing & piping

OSHA.Gov:
https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Apprenticeship Correlation

A2113 Brazing, cutting metals – A- Brazing, welding, and soldering

Bristol TEC 2-Year HVAC Curriculum

VOG Portfolio Collection Examples
Students will be able to identify and use mechanical skills to properly connect various pipe and tubing concepts. (VOG- Work Ready)

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 1-6: Effects of heat energy and pressure on the properties of matter.	
Big Idea(s): **1. Heat and pressure drive changes in matter, and understanding these principles helps HVAC technicians manage systems that regulate indoor environments.**	
Essential Question(s): **1. Why does water boil at a different temperature at sea level compared to a higher elevation?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
1-6.A Properties of matter and define. • **Solid** • **Liquid** • **Vapor**	**1. Classify matter according to its different states.**
1-6.B Properties of matter.	**1. Explain how the atmospheric pressure at sea level is higher than that at higher elevations.**
1-6.C Heat and Temperature.	**1. Identify the different scales of temperature measurements.** **2. Explain how heat is energy that is measured in British Thermal Units.** **3. Compare and contrast heat and temperature.**
1-6.D Heat flow rates	**1. Identify heat flow from hot to cold.**
1-6.E Heat transfer types.	**1. Identify radiant, conduction and convection heat transfer methods.**
1-6.F Specific heat value of a substance.	**1. Identify temperature scales.** **2. Identify and demonstrate how the boiling, freezing and absolute zero points are used as reference for these scales.**
1-6.G Change of state of matter based on temperature change.	**1. Identify temperature scales.** **2. Identify and demonstrate how the boiling, freezing and absolute zero points are used as reference for these scales.**
1-6.H Sensible heat effect.	**1. Identify how sensible heat causes temperature changes**
1-6. I Specific heat effect.	**1. Identify how specific heat is different for amounts of sensible heat required to change the temperature of substances.**

Bristol TEC 2-Year HVAC Curriculum

1-6.J Latent heat effect.	**1. Identify how latent heat cannot be measured as states of matter changes.** **2. Discuss how a fluid can be at temperature that when heat is added or removed the fluid will change state.**
1-6.K Latent and Sensible heat	**1. Describe how latent and sensible heat effect substances as they change between states.** **2. Compare and Contrast Latent and Sensible heat and explain their differences.**
1-6.L Heat/cool storage.	**1. Identify how heat energy or the ability to remove heat energy can be stored.**
1-6.M Latent heat of fusion	**1. Describe the removal of latent heat causing a substance to change from a liquid to solid.** **2.** Explain the process of Latent Heat of Fusion
1-6.N Latent heat of vaporization	**1. Describe the addition of latent heat causing a substance to change from a liquid to vapor.** **2. Explain the process of Latent heat of vaporization**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
British Thermal Unit (Btu)	Latent Heat	Sensible Heat
Boiling Point	Change of State	Specific Heat
Cold	Conduction	Subcooled
Absolute Zero	Convection	Superheated Vapor
Thermodynamics	Radiation	Statured Condition
Fist Law of Thermodynamics	Ton of Refrigeration	Saturation Point
Second Law of	Sublimate	Ambient temperature
Thermodynamics	Heat insulator	Enthalpy
Physical States	Latent heat	Latent heat of fusion
Solid	Density	Latent heat of evaporation
Liquid	Law of conservation of energy	Sensible heat
Vapor/Gas	Newton	Ton of refrigeration
Absolute temperature scale	Potential energy	Therm
Celsius scale	Kinetic energy	
Cold	Horsepower(hp)	
Energy	Foot-pound(ft-lb)	

Fahrenheit scale Force(f) Gas Heat Joule(J) Kelvin scale Liquid Mass Matter Power Rankine scale Solid Temperature Weight Work	Specific gravity Specific heat Specific volume Watt (W)	

Trade Math Crossover: How many tons of refrigeration effect can be obtained from a window air conditioner rated at 18,000 Btu/hr.?

Suggested Resources

Heating & Cooling Essentials: ISBN 13: 9781631260599
Chapter 9 Thermal dynamic principles
Chapter 10 Temp/Pressure

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545
Chapter 4,5. Energy and matter, gasses

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5
Unit 1 Heat/Temperature Pressure
Unit 2 Matter & energy

OSHA.Gov:
https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Apprenticeship Correlation

A0006 HVAC Math (complete course)

VOG Portfolio Collection Examples

A student in the HVAC/R trade will be an effective communicator and be able to explain the three physical states of matter and how superheat and subcooling affect a substance. (VOG – An Effective Communicator)

Bristol TEC 2-Year HVAC Curriculum

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 1-7: Sheet Metal Basics	
Big Idea(s): **1. Developing precision and craftsmanship in sheet metal work equips students to fabricate essential components for air distribution in HVAC systems.**	
Essential Question(s): **1. What are some HVAC projects a technician would encounter acquire the use of their sheet metal skills?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
1-7.A Sheet metal bending with machines, Sheet metal hand tools	**1. Listing and describing the use of at least 10 sheet metal hand tools.** **2. Identify by name all the sheet metal working machines shown and describe their basic purpose.** **3. Construction of assigned projects.**
1-7.B Sheet metal Cutting Tools and sheet metal hand tools from sheet metal blueprint(s)/drawing(s)	**1. Formulate and construct assigned projects.** **2. Identify by name sheet metal hand tools.**
1-7.C Basic sheet metal duct fittings	**1. Identify different fittings by formulating and classifying duct fitting from blueprint(s)/ drawing(s)**
1-7.D Characteristics of sheet metals.	**1. Explain the type of gauge measuring system used on any of the common sheet metals.** **2. Read the thickness of sheet metal by using a micrometer.** **3. Read the thickness of a piece of sheet metal from a gauge table.**
1-7.E Commonly used types of fasteners,	**1. Describe tinners' rivets and explain how they are designated for size.** **2. Describe sheet metal screws and lag bolts.** **3. Describe the following welding process:** **a. Oxyacetylene** **d. Arc** **b. Mig** **e. TIG** **c. Spot**
1-7.F Sheet metal cutting patterns	**1. Draw a smooth curve through these points with the use of a flexible rule.** **2. Draw the circumference of the circle to the nearest 1/16 of an inch.**

	3. **Figure the circumference to the nearest 1/16 of an inch using mathematics.** 4. **Use sheet metal snips to cut out any pattern or any kind of inside hole while observing the seven rules for the proper use and care of snips.** 5. **Identify the following tools and machines:** a. **Compound shears** b. **Bench level shears** c. **Pipe crimper** d. **Nibbler** e. **Double-cutting shears** f. **Squaring shears**
1-7.G Hole forming in sheet metal	1. **Make a riveted sheet metal seam.** 2. **Remove rivets without damaging the sheet metal.**
1-7.H Sketches, and sectional view and allowances • **Grooved seam** • **Standing seam** • **Pittsburgh seam** • **Double seam** • **Dovetail seam**	1. **Use of the bar folder, making all normal adjustments** 2. **Use of the bending brake safely, making all the ordinary adjustments for bending sheet metal** 3. **Describe sketches how forming molds are used on a bending brake.** 4. **Use of sketches, show how the drive-clip and the S-clip are used to loin sections of duct**
1-7. I Sheet Metal Machines: • **Turning machine** • **Burring machine** • **Combination machine** • **Raising**	1. **Turned edge, make a burred edge, make a wired edge, Raise a circular piece of metal**
1-7.J Sheet Metal: • **Forming** • **Crimping** • **Beading**	1. **Explain the difference between the plain forming machine and the slip roll forming machine.** 2. **Identify the correct machine for each of the following tasks and explain how it is used for Forming**

	3. Identify the correct machine for each of the following tasks and explain how it is used for Crimping **4. Identify the correct machine for each of the following tasks and explain how it is used for Beading**
1-7.K Metal Joining Techniques	**1. Define the following terms:** **1. Soft solder** **2. Hard solder** **3. Flux** **4. 50-50 solder** **5. Raw acid** **6. Cut acid** **7. Tinning** **8. Sweating** **9. Skimming** **10. Tacking** **11. Soldering** **2. List at least seven items that will make a poor soldering job** **3. Sweat solder, tack, or skim solders a flat seam of sheet metal.** **4. Tin a soldering copper**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
Furnace	Boot	Vapor Barrier
Horizontal Furnace	Bonnet	A-Coil
Up Flow Furnace	Drive Cleat	Mastic
Multi Position Furnace	Branch Line	Perimeter System
Duct board	Take off	Diffuser
Sheet Metal	Trunk Line	Insulated Flexible Duct
Supply Air	Starting Collar	Insulation
Return Air	Register	Grilles
CFM	Plenum	Pittsburg seam
Pattern	Bonnet	Crimping
Template	Round Duct	Hand seamers
Layout	Rectangular Duct	Plenum
Notching	Aviation snips	Sheet metal gauge
Hand brake	Elevation view	
Ductwork	Pictorial drawing	

Blind rivets Self-piercing screws Galvanized	Plan view Shears S-slips Drives	

Trade Math Crossover: How much CFM is required for a one-ton refrigeration system to have proper air flow?

Suggested Resources

Heating & Cooling Essentials: ISBN 13: 9781631260599
Chapter 29 Ductwork

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545
Chapter 29 Air Distribution

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5
Unit 38 Installation

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Apprenticeship Correlation

A2902 HVAC Sheet metal Theory 2

VOG Portfolio Collection Examples

Students will be able to construct a sheet metal fitting by using duct layout and using various sheet metal machinery to produce a product. **(VOG – A Problem Solver)**

Project: Precision Duct Component Fabrication: Description: Using sheet metal hand tools and machines, students must layout and fabricate a specific duct fitting from a blueprint. They are assessed on their ability to follow systematic procedures and maintain a clean workspace. **VOG Alignment: Work Ready.**

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 1-8: Electrical values and circuits including ohm's law and rules for different electrical circuits.	
Big Idea(s): **1. Electricity is the heartbeat of HVAC systems, and understanding electrical values and relationships empowers technicians to diagnose and build systems safely and accurately.**	
Essential Question (s): **1. What happens if the voltage applied to a circuit changes and how does this effect other electrical values?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
1-8.A Electrical values with Ohms law: ● **Watts** ● **Ohms** ● **Volts** ● **Amps**	**1. Define watts, ohms, volts, and amps.** **2. Calculate the equivalent resistance in a parallel & series circuit** **3. Utilize algebra and math skills with Ohm's Law to solve for unknown values**
1-8.B Electrical meters to measure circuit values in different types of circuits: ● **Ohms, Volts, Amps** ● **Series, Parallel** ● **Series – parallel**	**1. Practice measuring voltage, resistance and current with digital and analog voltmeters and clamp-on ammeter** **2. Perform a continuity tester to determine whether an open circuit or dead short exists** **3. Construct and analyze a series, parallel, and series-parallel circuit**
1-8.D Single- and three-phase voltage.	**1. Identify different types of electrical loads, resistive, capacitive and inductive** **2. Perform a capacitance test on run and start capacitors**
1-8.E Magnetism in electricity.	**1. Identify single and three-phase circuits.**
1-8.F Magnetic Theory	**1. Describe magnetic theory and applying magnetic principles to electrical theory.** **2. Explain the law of charges.**
1-8.F Conductors and insulators.	**1. Differentiate between conductors and insulators.**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
Atom, Electrons, Nucleus, Protons Electricity Potential Difference	Continuity Open Circuit Short Circuit Watts Multimeter	Switches, (SPST,SPDT,DPST,DPDT) Disconnects Direct Current (DC) Alternating Current (AC)

EMF(Electromotive Force)(Volts) Amperage Resistance Ohm's Law Alternating current(ac) ampere atom circuit conductor coulomb Current Direct current(dc) Electrical load Electrical power electricity Electromotive force (emf) Electron Fuse Insulator Ohms Ohm's law Voltage Watt Watt meter Wire Proton	Conductors Ampacity Electrical Loads Ammeter Busbar Back-electromotive force(back-emf) Continuity Conduit Disconnects Grounded Potential difference Lock out/Tag out Line voltage Stranded Poles Switch Schematic Ground fault Multi-meter	Hertz Polyphase Generation (Three Phase) L-1, L-2, Neural, Ground Contacts conductance Open circuit Closed circuit Parallel circuit Series circuit Three phase Single phase Voltage drop Short circuit

Trade Math Crossover: A home heating system requires 120 vac of electricity and has a 14/2-gauge romex wire rated for 15 amps. How many watts are required for this heating system to operate?

Suggested Resources

Heating & Cooling Essentials: ISBN 13: 9781631260599
Chapter 23 What is Electricity

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545
Chapter 13 Electrical Power

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5
Unit 12 basic Electricity and Magnetism

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Bristol TEC 2-Year HVAC Curriculum

Apprenticeship Correlation
A0782 Electrical Fundamentals
VOG Portfolio Collection Examples
Students can wire a basic heating or cooling system using parallel and series wiring (VOG – Work Ready)

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 1-9: Electrical diagrams used in HVAC		
Big Idea (s): **1. Electrical diagrams are essential blueprints that guide technicians in understanding, assembling, and troubleshooting HVAC equipment correctly and safely.**		
Essential Question(s): **1. HVAC technicians must have a thorough knowledge of electrical theory to support different types of equipment. Why do manufacturers have different wiring schematics?**		
Learning Outcomes		
Students will know:		*As evidenced by:*
1-9.A Electrical diagrams ● **Ladder** ● **Pictorial**		**1. Using basic electrical diagrams to identify loads and their controls.** ***2.*** **Identifying examples of basic electrical symbols used in diagrams.**
1-9.B Electrical measurements ● **Voltage** ● **Amperage** ● **Resistance** ● **Wattage**		**1. Explaining voltage as electrical pressure.** **2. Explaining ohms as a way to measure resistance to electron flow.** **3. Explaining amps as electron flow.** **4. Explaining watts/power a way to measure electrical energy consumed.**
1-9.C Electrical circuits types: ● **Series** ● **Parallel** ● **Series/Parallel**		**1. Calculating electrical values in a series, a parallel, and series-parallel circuit.**
1-9.D Electrical circuits switching		**1. Drawing basic electrical circuits that demonstrate an understanding of switches controlling electrical loads.**
1-9.E Electrical circuits types such as: ● **Voltage** ● **AC current** ● **Resistance**		**1. Measuring voltage with digital and analog voltmeters.** **2. Measuring AC current with a clamp-on ammeter.** **3. Measuring resistance with an ohmmeter.**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
Voltage, Amps, Resistance	Series	VOM (volt-ohm meter)
Schematic	Parallel	Open Circuit
Pictorial Diagram	Series/Parallel	Short Circuit
Ladder Diagram	Continuity	Clamp Meter
Ohms Law	Intensity/Amps	Multimeter
	Watts	Switches

Trade Math Crossover: There are two electrical baseboards installed in a room. One baseboard has a resistance of 291 ohms and the second baseboard has 97 ohms. What is the total resistance of the baseboard for that room?

Suggested Resources

Heating & Cooling Essentials: ISBN 13: 9781631260599
Chapter 23 What is Electricity

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545
Chapter 13 Electrical Power

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5
Unit 12 basic Electricity and Magnetism

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https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Apprenticeship Correlation

A0782 Electrical Fundamentals

VOG Portfolio Collection Examples

Students can identify parallel and series circuits within a ladder diagram and trouble shoot equipment malfunction. (VOG – A Problem Solver)

Bristol TEC 2-Year HVAC Curriculum

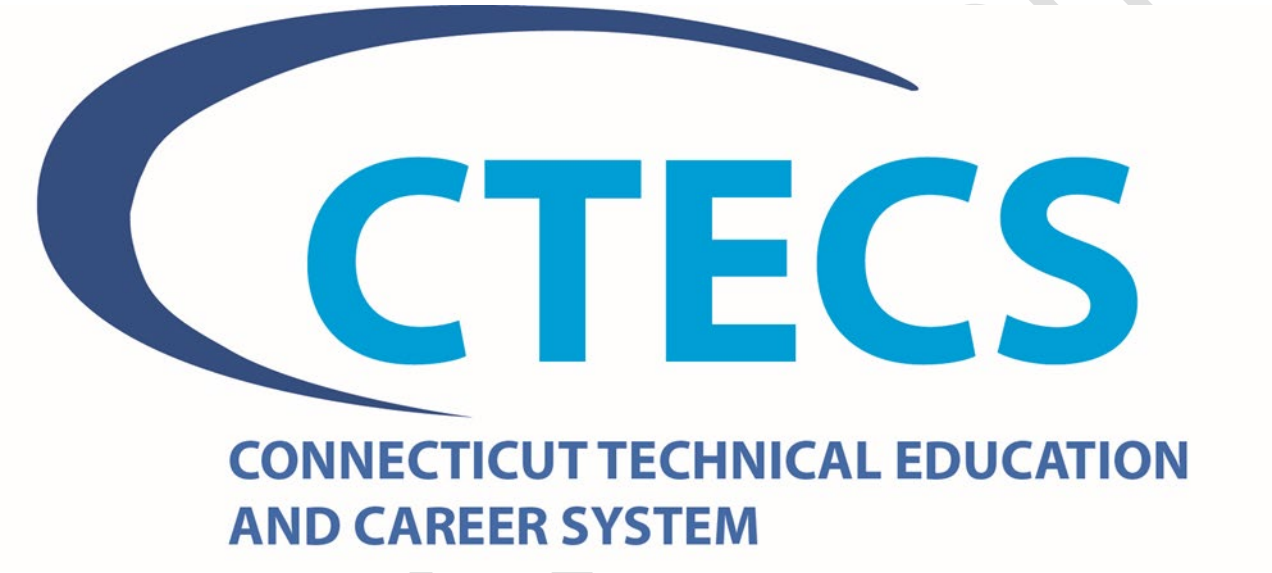
Priority Standard 1-10: How codes and their regulations affect the HVAC trade.	
Big Idea(s): **1. HVAC professionals must follow industry codes and manufacturer guidelines to ensure safety, efficiency, and legal compliance in all installations and repairs.**	
Essential Question(s): **1. How do the code books work in conjunction with the manufacture's installation instructions?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
1-10.A Codes relating to safety.	**1. Identifying codes as regulations for safe installations and repairs that which also insure proper system operation**
1-10.B Codes resource books.	**1. *Recognizing the difference between BOCA, SBCCI and ICBO, IMC, NFPA.***
1-10.C Codes and standards for the applicable area, locally and state.	**1. *Given examples of enforcement of codes by building inspectors*** **2. Providing examples of what IRC IMC, NFPA codes as standards used in CT**
1-10.D Relationship between codes and manufacturers' installation instructions.	**1. Identifying how local codes and manufacture instructions will supersede the code due to pertinent standards.**
1-10.E Pertinent standards published and established by AGA, AMCA, ANSI, ARI, ASHRAE, IED, ISO, SMACNA, IMC, NFPA and UL.	**1. Named pertinent standards published by AGA, AMCA, ANSI, ARI, ASHRAE, IED, ISO, SMACNA, IMC, NFPA, and UL.**
1-10.F Code Identification as it relates to the solar trades. (Reference NABCEP 1.6)	**1. Identify and implement appropriate codes and standards concerning installation, operation and maintenance of solar thermal systems and equipment. (Reference NABCEP 1.6)**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
CODES (What is it?)	Definitions	Annex
IMC	General Info	BOCA
IRC	Chapters	SBCCI
NFPA 51	Local codes	CABO
NFPA 54	State codes	ICBO
Regulations	National codes	SMACNA
Manufactures	Underwriters Laboratories (UL)	ASHRAE
Standards		ANSI
Installation		
OSHA		

Trade Math Crossover: How much cubic ft of air do you need for every 1,000 btu's for proper combustion of an oil-fired appliance?

Suggested Resources
International Mechanical Code book NFPA Books WWW.ICCSAFE WWW.SMACNA.ORG OSHA.Gov: https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593
Apprenticeship Correlation
A0730 Related Codes and Standards A2906 SMACNA A0729 Relating Codes and Standards
VOG Portfolio Collection Examples
Students will be able to calculate the cubic ft of air needed for an installation of 100,000 btu oil fired appliances installed in a customer's basement. (VOG – A Critical Thinker)



HVAC

Year 1; Semester 2

Bristol TEC 2-Year HVAC Curriculum

Year 1, Semester 2 Curriculum

Priority Standard 2-1: School and Jobsite Safety	
Big Idea(s): **1. Safe behavior, responsibility, and professionalism are essential habits that protect lives and build trust in the HVAC workplace.**	
Essential Question(s): **1. How does the way we behave at school and on a work, site affect safety, and why is it important to follow safety rules and guidelines?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
2-1.A OSHA standards for job site safety.	**1. Wear safety eye protection and hearing protection.** **2. Explain OSHA and how requiring safety standards and implementation helps everyone.** **3. Explain proper procedures when using safety equipment (e.g., footwear, hearing protection, hardhat, goggles, and gloves).** **4. Exhibit proper ladder safety.** **5. Demonstrate safe/proper lifting procedures.**
2-1.B Substance abuse effects.	**1. Describe examples of the reasons why technicians cannot work safely while under the influence of any substance that interferes with coordination and decision making and how it negatively can impact safety in the working field.**
2-1.C Positive work habits	**1. Demonstrate good housekeeping practices.** **2. Explain why practicing excellent work habits in school will make using them at work a secondary concern.**

2-1.D Types of safe clothing and safety equipment.	**3. Describe reasons for proper clothing and safety equipment.**
2-1.E The proper procedures when working with hands-on live equipment: • **Electrocution** • **Personal injury**	**1. Identify why the grounding conductor makes an electric tool and equipment safer.** **2. Explain how a small amount of amperage can cause electrical burns and cardiac defibrillation.** **3. Identify how it is safest to work on non-live circuits relating**
2-1.F Ground fault circuit interrupters.	**1. Explain how ground fault interrupter since a small amount of stray amperage tripping to protect from electrocution.**
2-1.G Proper storage and handling of: • **Oxygen** • **Nitrogen** • **Acetylene bottles**	**1. Demonstrate safe use of high-pressure regulators.** **2. Demonstrate how to safely store and handle high-pressure gases and the importance of keeping the cap in place and strapping and storing cylinders in their upright position.**
2-1.H Handle, use and dispose of hardware material.	**1. Describe ways to handle and dispose of hardware, especially sharp materials(s)/item(s).**
2-1.I Environmental safety and review practices.	**1. Identify proper handling of hazardous materials** **2. Explain proper disposal of hazardous materials**
2-1.J Safe driving practices.	**1. Research why the insurance companies of employers will require driving records.**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
Hazard	Fire Extinguishers (Type A, B,C,D)	Hazzard Assessment

PPE	Temperature Hazards	OSHA
OSHA	Pressure Hazards	Lockout/Tag Out
Eye Hazard	Refrigerant Hazards	Ladder Safety
Head Hazard	Chemical Hazards	Fall Prevention Training
Electrical Hard	Eye Protection	Safety Certifications
Fire Hazard	Electrical Protection	
Breathing Hazard	Confined Space	
Fall Protection	Head Protection	
First Aid	Hearing Protection	
	Protective Clothing	
	Respirator	

Trade Math Crossover: A ladder being used to access a roof top unit should extend at least 3 feet above the step off surface.

Suggested Resources

Heating & Cooling Essentials: ISBN 13: 9781631260599

Chapter 3. Safety

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545

Section 1, Chapter 2. Safety

Basic Principles for Construction, 4th Edition (Residential Construction Academy) 4th Edition

ISBN-13: 978-1-3050-8862-7

Chapter 3. Job Safety

Chapter 5. Safety with Scaffolds

OSHA.Gov:

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id= 593
Apprenticeship Correlation OSHA 30: A0099
VOG Portfolio Collection Examples Students working on equipment will use a procedure called "Lockout/Tagout" from training they received from their OSHA training. (VOG – Work Ready)

Bristol TEC 2-Year HVAC Curriculum

Priority Standard: 2-2 Application of trade drawings	
Big Idea(s): **1. Blueprints are visual tools that translate design into action, helping HVAC technicians plan and build accurate, functional systems.**	
Essential Question(s): **1. How do you describe what fittings are needed to install duct work? When building sheet metal fittings how would you determine size and shape?** **2. How can you determine whether a site is a suitable location for solar installations or where on a site to install solar collectors?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
2-2.A HVAC symbols and scaling blueprints.	**1. Identify HVAC symbols and components on a blueprint.**
2-2.B Sheet metal fitting from a given print.	**1. Demonstrate the ability to transpose from a drawing a sheet metal fitting.**
2-2.C Solar Thermal Site Assessment. (Reference NABCEP 4.1-4.9)	**1. Conduct a Solar Thermal Site Assessment. (Reference NABCEP 4.1-4.9)** **2. Determine the required installation area, orientation, and tilt for proposed collector installation.** **3. Establish whether there is suitable installation area with unobstructed solar access for installing collector** **4. Determine the extent of current and future shading for any proposed collector location using typical sun path calculators or similar methods** **5. Assure structural integrity and suitability of collector site. Determine soil conditions and integrity for footing design and pipe path.**

	(Local codes or site conditions might then require involving an engineer). **6. Determine suitable location for installing all subsystem components (This includes piping, water heater, valves, and ancillary equipment required for complete system installation.)** **7. Practice all personnel safety requirements** **8. Identify any other constraints and options for the installation related to local and state code requirements** **9. Verify that a system to be installed is appropriate for the building and climate** **10. Verify with the homeowner the proposed location of the collector and other major components**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
Furnace	Boot	Vapor Barrier
Horizontal Furnace	Bonnet	A-Coil
Up Flow Furnace	Drive Cleat	Mastic
Multi Position Furnace	Branch Line	Perimeter System
Duct board	Take off	Diffuser
Sheet Metal	Trunk Line	Insulated Flexible Duct
Supply Air	Starting Collar	Insulation
Return Air	Register	Grilles
CFM	Plenum	
	Bonnet	
	Round Duct	

	Rectangular Duct	

Trade Math Crossover: A length of trunk measuring 8”x20”x 4’ can deliver how much cfm?

Suggested Resources

Heating & Cooling Essentials: ISBN 13: 9781631260599

Chapter 29 Ductwork

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545

Section 1, Chapter 2.

Basic Principles for Construction, 4th Edition (Residential Construction Academy) 4thEdition

ISBN-13: 978-1111307189

Section 5 Chapter 18,19,20,21,22,23,24

Print Reading For Construction 6th Edition

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5

Unit 37 Air Distribution & Balance

OSHA.Gov:

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Apprenticeship Correlation

A0031 BPR

VOG Portfolio Collection Examples

Students will be able to produce different sheet metal fittings. **(VOG- Work Ready)**

Project: Solar Thermal Site Assessment: Description: Students analyze a building site to determine the best location for solar collectors, accounting for shading and structural integrity. They must use sun path calculators to make evidence-based decisions. **VOG Alignment: Critical Thinker.**

Bristol TEC 2-Year HVAC Curriculum

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 2-3: Fasteners	
Big Idea(s): 1. **Choosing the correct fastener and tool ensures a secure, lasting installation and demonstrates a technician's skill and attention to detail.**	
Essential Question(s): 1. **When building something how would you decide what to use as fasteners?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
2-3.A Basic hand tools when using fasteners ● **Slotted Screwdrivers** ● **Philips Screwdrivers** ● **Combination wrenches** ● **Socket wrenches** ● **Hex drivers** ● **Torx Drives**	1. **Select the proper tool for the proper application of fasteners.** 2. **Show proper safety techniques and procedures in using hand tools with the fastener selected.**
2-3.B Power tools and their accessories ● **Drill drivers** ● **Hammer drills** ● **Drill bit sizing**	1. **Demonstrate the proper safety techniques and in the use of power tools with a fastener selected.** 2. **Use eye protection and hearing protection during tool use** 3. **Select correct drill for fasteners**
2-3.C Fasteners and proper job application. ● **Self-tapping screws** ● **Lag bolts** ● **Machine bolts** ● **Set screws** ● **Treaded rod**	1. **Identify fasteners** 2. **Apply the use of the proper fastener for the job.**

- **Wood Screws**
- **Sheetrock screws**
- **Shielded anchors**
- **Toggle bolts**
- **Concrete anchors**
- **Staples**
- **Cotter pins**
- **Perforated straps**
- **Pipe hook**
- **Pipe Strap**
- **Nylon straps**
- **Electrical connectors**
- **Electrical terminals**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
American National Acme Thread	Blind rivet	Brown and Sharpe Worm thread
American National	Mandrel	Crest
Standard Thread	Masonry anchor	Die
Bolt	Minor diameter	Flexible duct straps
Bolt extractor	Molly	Flutes Thread angle
Cap screw	Root screw	Self-piercing screw
International Thread	Screw thread	Self-tapping screw
Machine screw	setscrew	Tap
Major diameter	Shank	Wire ties
Nut	Sheet metal screw	
Threads per inch	Speed chuck	

Washer	Threaded rod Toggle bolt	

Trade Math Crossover: When drilling into cement to install a 2" molly anchor what should the minimum drill depth be?

Suggested Resources

Heating & Cooling Essentials: ISBN 13: 9781631260599

Chapter 3. Fasteners

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545

Chapter 8 Reference 7.4 standards and supplies

Basic Principles for Construction, 4th Edition (Residential Construction Academy) 4th Edition

ISBN-13: 978-1111307189

Chapter 16 Fasteners

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5

Unit 6 Fasteners

OSHA.Gov:

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Apprenticeship Correlation

A2902 HVAC Sheet Metal Theory 2

VOG Portfolio Collection Examples

Students will be able to use the depth drill gauge when hammer drilling into a concrete installation. (VOG – Work Ready)

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 2-4: Advanced Sheet Metal	
Big Idea(s): 1. **Advanced sheet metal skills allow HVAC professionals to build complex ductwork systems that control airflow efficiently and meet customer needs.**	
Essential Question(s): 1. **Why do you need a clean and organized work area before starting the layout and fabrication procedures?**	
Leaning Outcomes	
Students will know:	*As evidenced by:*
2-4. A Six types of patterns and drawings and the information contained in each. • **Straight Duct** • **Reducer fitting** • **90 Degree radius Elbow** • **Offset fitting** • **Plenum** • **Starting tap fitting**	1. **Identify application of patterns to metal** 2. **Describe how to take measurements for pattern development** 3. **Describe the various hand tools and machines to cut metal and pipe.**
2-4.B Basic Duct Construction.	1. **Evaluate fitting construction including elbows, vane requirements & supports, offsets & transitions, and branch connections and rate the construction with a 1-10 scale with 10 the best.** 2. **Assemble round and oval duct and meet proper construction standards, pressure gauges for round duct and tees and laterals.**
2-4.C Flexible duct including grill and register connections, canvas connectors, and flexible duct supports.	1. **Prepare and install a flexible duct run starting with the tap and ending at the register.** 2. **Calculate what the CFM will be for the above flexible duct run. Performance test what is the actual CFM performance**

	3. Assemble a canvas connector and explain the reason for its use.
2-4. F Sheet metal types and installation standards: ● **NFPA 31 Standard for the Installation of Oil Burning Equipment** ● **NFPA 54 National Fuel Gas Code** ● **NFPA 85 Boiler and Combustion Systems Hazards Code** ● **NFPA 90A Standard for the Installation of Air Conditioning and Ventilation Systems** ● **NFPA 90B Standard for the Installation of Warm Air heating and Air Conditioning Systems** ● **NFPA 96 Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations** ● **SMACNA**	**1. Explain where the different standards will be applied.** **2. Formulate what standards will override mechanical codes** **3. Create a blueprint, showing the areas where NFPA standards will be applied. Then calculate the total of overriding standards with mechanical codes and manufacture installation manuals.**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
Damper	Axial flow fan	Air curtain
Diffuser	Butterfly damper	Airflow friction chart
Drive	Gable fan	Aspect ratio
Duct	Induced draft	Effective length
Duct board	Multiple-blade damper	Friction loss
Elbow	Primary air	Friction rate
Flexible pipe	Radial flow fan	Manual D

Grille	Return air Duct	Static Pressure
Hanger stock	Split damper	Pressure Losses
Offset	Supply air duct	Total Pressure drop
Plenum	Unvented attic	
Register	Vented attic	
Round pipe	Whole House fan	
Sheet Metal		
Starting tap/collar		
S-Slip		
Transition		

Trade Math Crossover: When sizing a return air duct, 80% of air needs to be returned back to the 24,000 btu air handler. How much return air CFM is required for proper operation?

Suggested Resources

Heating & Cooling Essentials: ISBN 13: 9781631260599

Chapter 29 Ductwork

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545

Chapter 29 Air Distribution

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-

Unit 37 Air Distribution & Balance Sheet Metal 2nd edition

OSHA.Gov:

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Apprenticeship Correlation

A2905 HVAC Layout 2
VOG Portfolio Collection Examples Students can take a static pressure test on a central air conditioner air handler using the manufacturing data information tag for proper static pressure and equipment operation. (VOG – A Problem Solver)

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 2-5: Electrical Calculation including: watts, ohms, volts, and amps using Ohms law	
Big Idea(s): 1. **Understanding Ohm's Law enables technicians to analyze electrical circuits and ensure safe and efficient system performance.**	
Essential Question(s): 1. **What happens if the voltage applied to a circuit changes?** 2. **How do magnetic theories apply to electricity?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
2-5.A Electrical values with ohms law and formulate: ● **Watts** ● **Ohms** ● **Volts** ● **Amps**	1. **Define watts, ohms, volts, and amps.** 2. **Calculate the equivalent resistance in a parallel & series circuit** 3. **Utilize algebra and math skills with Ohm's Law to solve for unknown values**
2-5.B The use and operation of an electrical meter(s) ● **Ohms** ● **Volts** ● **Amps** ● **Series** ● **Parallel** ● **Series – parallel**	1. **Demonstrate measuring voltage, resistance current with digital and analog voltmeters and clamp-on ammeter** 2. **Demonstrate using a multi meter to test continuity to determine whether an open circuit or dead short exists** 3. **Construct and analyze a series, parallel, and series-parallel circuit** 4. **Measure and analyze circuit values in different types of circuits.**
2-5.C Electrical loads and analyze such loads: ● **Resistive** ● **Capacitive**	1. **Identify different types of electrical loads, resistive, capacitive and inductive**

• **Inductive**	2. **Demonstrate using capacitance meter to measure capacitance of run and start capacitors**
2-5.D Single and three-phase voltage	1. **Identify and compare single and three-phase circuits.**
2-5.E Applications of magnetism in electricity circuitry.	1. **Defining magnetic theory and applying magnetic principles to electrical theory.** 2. **Defining the law of charges**
2-5.F Conductors and insulators.	1. **Explain the difference between conductors and insulators**
2-5.G Basic generator principle.	1. **Explain how magnetic fields induce current flow when a changing magnetic field is applied to a conductor.**
2-5.H Electrical distribution within an electrical distribution service panel.	**1. Explain electrical distribution from breaker panel to electrical components such as switches and receptacles and other electrical loads.**
2-5. I Electrical power sources by identifying and comparison of: • **Single-phase** • **Three-phase**	**Identify single and three-phase circuit by:** 1. **Number of conductors** 2. **Measuring voltages between legs** 3. **Measuring voltages to ground**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
Alternating current(ac)	AWG	Bonding
ampere	Closed	Brushes
atom	Circuit	Capacitance
brushes	Circuit breaker	Capacitor
conductor	Dielectric	Electromagnet
coulomb	Electrical circuit	Electromagnetism
current	Electrical load	Farad(F)

electricity	Fuse	Induced magnetism
Direct current(dc)	Grounding	Induction
Electricity	Open circuit	Volt-amps
Electromotive force(emf)	Closed circuit	Voltage drop
Electron	Ground fault interrupter	
Ohm's law	Load	
Switch	Resistance	
	Short circuit	
	Single phase	
	Three-phase	
	Watt's law	

Trade Math Crossover: A service technician is called out for a no cooling service call. When checking the power supply at the outdoor disconnect, the technician checks the L-1 terminal to ground and the electrical meter reads 120 vac, then checks the L-2 terminal to ground and 120 vac. What is the circuit's total voltage?

Suggested Resources

Heating & Cooling Essentials: ISBN 13: 9781631260599

Chapter 23 What is Electricity

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545

Chapter 13 electrical Power

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5

Unit 18 Application of motors

Unit 19 Motor Controls

OSHA.Gov:

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Bristol TEC 2-Year HVAC Curriculum

Apprenticeship Correlation
A0782 Electric Fundamentals
VOG Portfolio Collection Examples
Students will be able to check for electrical power at a disconnect using their prior knowledge and use of an electrical meter. (VOG – A Problem Solver)

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 2-6: Basic electricity, electrical circuits and AC electric motors	
Big Idea(s): 1. **A solid grasp of electrical systems and motor function empowers HVAC technicians to design, install, and troubleshoot modern equipment.**	
Essential Question(s): **1.How do electrical circuits work, and what role do AC electric motors play in powering everyday devices?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
2-6.A Applications of magnetism in electricity in relation to electrical theory.	**1.Define magnetic theory** **2. Exhibit the use, the appropriate meter to check basic electrical components.**
2-6.B Low voltage wiring and controls required for heating and cooling equipment operation.	**1. Exhibit the wiring of a complete low voltage heating and air conditioning control circuit to accommodate a heating furnace with a split cooling system.** **2. Show how to program a programmable thermostat for heating/cooling including set-up and setback modes.** **3. Detect and comparing single- and three-phase voltage and current**
2-6.C Different electric motor types: ● **Shaded pole** ● **Split-phase motor (RSIR)** ● **Multi-speed motor** ● **Permanent split capacitor (PSC)** ● **Capacitor start induction run motor** ● **Capacitor start capacitor run motor**	**1. Define the significance of power factor.** **2. Explain starting components associated with single-phase and three-phase motor.** **3. Explain the operation and application of motors and supporting what problems could happen** **4. Explain electric motor theory (i.e., magnetism, electromotive force, etc.).**

• **Electronically controlled motor** • **Variable-speed motor**	**5. Explain operation and application of different motors.**
2-6.D Types of electrical loads identification: • **Capacitive** • **Inductive** • **Resistive**	**1. Identify types of electrical loads** **2. Identify the relationships of voltage and amperage in different loads.**
2-6.E Starting components associated with single-phase and three-phase motors and examine: • **centrifugal switch** • **current coil relay** • **potential relay** • **PTC relay**	**1. Identify single phase starting components and examine and identify contactors and motor starters**
2-6.F Interpret detailed instructions for wiring circuits.	**1. Identify electrical switch and load symbols used in diagrams.** **2. Draw basic electrical circuits that demonstrate an understanding of switches controlling loads**
2-6.G Basic principles of solid-state switching devices.	**1. Explain how solid-state devices control flow of electrons without mechanical switches that failed due to friction sparks.** **2. Identify principles of solid-state switching devices.**
2-6.H How electricity is produced and distributed, including basic generator principle.	**1. Explain how magnetically produced electricity is transformed and distributed from plants to users through the electrical grid.** **2. Explain how a wire passed through a magnetic field will have a voltage created in it.**

2-6.I The operation and application of motors.	**1. Identify different motor types and uses, small axial fans, squirrel blowers, compressors etc.** **2. Explain proper horsepower of replacement motors.**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
Ac motor Built-up terminal Centrifugal switch Common terminal Continuous duty End bell Nameplate Rotor Squirrel cage rotor Stator Terminal box Torque	Full-load amperage (FLA) Locked rotor amperage (LRA) Rated full-load (RLA) Run Capacitor Run windings Slip Start capacitor Start winding Synchronous speed	Capacitor-start, capacitor-run(CSCR) motor Capacitor-start, induction-run(CSIR)motor Dual-voltage motor Electronically commutated motor (ECM) Induction motor Intermittent duty motor Permanent Split capacitor (PSC) motor Shaded-pole motor Single-phase motor Split-phase motor Three-phase motor Variable frequency Drive (VFD)

Trade Math Crossover: Three leads of a compressor are connected. What is the total resistance between (Start) 8 ohms and (Run) 2 Ohms when (Common) is disconnected?

Suggested Resources

Heating & Cooling Essentials: ISBN 13: 9781631260599

Chapter 25 Induction Motors

Chapter 26 Control Devices

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545

Chapter 14 Basic Electronics

Chapter 15 Electric Motors

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5

Unit 25 Special Refrigeration System components

OSHA.Gov:

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Apprenticeship Correlation

A0782 Electric Fundamentals

A0784 Heating Fundamentals

A0791 Oil Burner Controls

VOG Portfolio Collection Examples

A student will be able to test an electrical capacitors MFD to determine if the component has failed. (VOG – A Problem Solver)

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 2-7: Typical electrical components found in HVAC systems	
Big Idea(s): **1. Recognizing and understanding HVAC electrical components is essential for accurate system wiring and successful system operation.**	
Essential Question(s): **1. Why are electrical components not required for operation often used in HVAC systems?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
2-7.A The operation and role that basic electrical components play in different applications in the HVAC industry listed below: ● **Capacitors** ● **Contactor** ● **Fan/Limit Controls** ● **Overloads** ● **Relays** ● **Thermostats**	**1. Explain the functions of Capacitors, Contactor, Fan/Limit Controls, Overloads, Relays, Thermostats both low and line voltage**
2-7.B Electrical components troubleshooting.	**1. Demonstrate the sequence of troubleshooting techniques needed for problem solving with electrical components.** **2. Demonstrate proper techniques in changing out failed electrical components.**
2-7.C The operation and role of special electrical components: ● **Starters** ● **Defrost Timers** ● **Oil pressure safety**	**1. Explain the functions of Starters, Defrost Timers, Oil pressure safety, Pressure Controls, Solenoids, Solid state time delays, both low and line voltage (Critical Thinker)**

• **Pressure Controls** • **Solenoids** • **Solid state time delays**	
2-7.D Installing Electrical Control Systems as it pertains to Solar Thermal Systems (Reference NABCEP 9.1, 9.2, 9.4-9.8)	**(Reference NABCEP 9.1, 9.2, 9.4-9.8)** 1. **Determining the location of the controller** 2. **Explain a differential controller and sensors** 3. **Install a timer controller** 4. **Install control wiring** 5. **Select ultraviolet radiation protective method for external wiring** 6. **Explain protecting external wiring from ultraviolet degradation** 7. **Explain test operation of controller**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
Bimetal coil Bimetal device Bimetal disc Bimetal strip Contactor Control system Current relay Current limiting Ladder diagram Motor starter Pictorial diagram	Cut-in Cut-out differential Differential adjustment High-pressure Motor control Lockout Low-pressure motor control Low-pressure safety control Multipurpose fuse Pressure Motor Control range Range adjustment Remote temperature- sensing element Time-delay fuse	Actuator Below-atmospheric- pressure element Direct Digital Control (DDC) Primary control Positive Temperature coefficient (PTC) Solid-state Relay (SSR) Temperature Motor control Zone control panel

Potential relay Relay Set point Sensing bulb Thermostat	Transformer	

Trade Math Crossover: A run capacitor has a microfarad reading of 35mfd on the data nameplate. To be considered "good" it has to be tested using an electrical meter capable of testing microfarads or mfd. Also, on the data plate to be considered "good" it has to be +/- 5% of the 35 mfd. When tested it reads 25 mfd. Is this run capacitor "good"?

Suggested Resources

Heating & Cooling Essentials: ISBN 13: 9781631260599

Chapter 26 Electromagnetic Devices

Chapter 27 Motor Controls

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545

Chapter 24 Systems & Components of domestic and commercial refrigerators

Chapter 16 Electrical Control Systems

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5

Unit 43 Air Source Heat Pumps Unit 45 Domestic Refrigerators & Freezers

OSHA.Gov:

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Apprenticeship Correlation

A 0721 Refrigeration Commercial Domestic Special Systems

A0785 A/C

A0791 Oil Burner Controls & Servicing
VOG Portfolio Collection Examples When wiring a control transformer, students will be able to install and troubleshoot step-down transformers primary and secondary side connections. **(VOG – A Critical Thinker)** **Project: The "Troubleshooting Gauntlet" Description:** Instructors introduce faults into a control system (e.g., a bad capacitor or relay). Students must use meters and ladder diagrams to identify the root cause and perform a professional repair. **(VOG Alignment: Problem Solver.)**

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 2-8: Types of pipe and piping practices	
Big Idea(s): **1. Proper pipe selection and installation techniques ensure the safe and effective transport of fluids and gases throughout HVAC systems.**	
Essential Question(s): **1. What are the different types of pipes used in HVAC, and how do the materials and techniques for installing pipes help keep our systems safe and efficient?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
2-8.A Different types of piping and tubing used in HVAC systems ● **ACR** ● **Nominal,** ● **K, L, M**	**1. Explain differences between ACR verse standard pipe.** **2. Explain wall thickness K, L, M, and DW pipe**
2-8.B Types of fittings ● **Elbows** ● **Tees.**	**1. Explain differences between long way versus short way elbows.** **2. Explain differences between Normal and street elbows.** **3. Explain tee and sizing i.e: ¾ x ¾ x ¾ or ¾ x ¾ x ½ tee with reducing branch.**
2-8.C Hangers used in HVAC systems ● **"U" clamps** ● **Bell Hangers** ● **Hanger strap** ● **Uni-strut** ● **Beam Clamps** ● **Closed Cell insulation**	**1. Explain closed cell pipe insulation** **2. Explain insulating tapes** **3. Explain reasons for insulation such as maintaining superheat** **4. Demonstrate proper insulating techniques** **5. Identify different hangers** **6. Explain Steel to copper electrolysis**

2-8.D Soldering and brazing alloys and compare their placement and purpose used in the HVAC/R industry such as: ● **95/5, Silver content** ● **Silver brazing rod**	**1. Explain the use of different soldering filler metals i.e. 50/50, 95/5 and silver solder etc.** **2. Explain the use of different brazing filler metals and melting temperatures**
2-8.E Soldering and brazing alloys	**1. Explain percent of silver content importance** **2. Explain concerns associated with flux** **3. Demonstrate proper soldering and brazing techniques**
2-8.F Effects of pressure drop in the refrigeration system	**1. Explain how pressure drops reduce system efficiency by causing energy to be used to move refrigerant** **2. Explain how pressure drops change refrigerant volatility**
2-8.G Refrigerant lines capacities and sizing for proper flow.	**1. Explain how refrigerant line size affects the amount of refrigerant moved** **2. Calculate capacities of refrigerant lines and determine sizing for proper flow.** **3. Explain how vapor refrigerant take more space than liquid** **4. Calculate total effective length of pipe runs for a given refrigeration system.** **5. Calculate amount of refrigerant in lines to arrive at the allowances for refrigerant charge.** **6. Calculate pressure drop in liquid line risers to arrive at the correct liquid line size for a given system.** **7. Size liquid and vapor lines for an installation of an air**

2-8.H Types of torches used in HVAC industry.	**1. Explain and demonstrating proper acetylene torch use** **2. Explain and demonstrating proper oxygen/acetylene torch use** **3. Explain parts of flame**
2-8.I Heat sink methods.	**1. Demonstrate how heat sinks are used to protect heat sensitive materials.**
2-8.J Various heat exchanger techniques.	**1. Demonstrate method of soldering cap tube to suction line for heat exchange.** **2. Explain and identify commercially produced heat exchangers.**
2-8.K Vibration eliminators and components.	**1. Explain needs for vibration eliminators.** **2. Demonstrate how to make a vibration eliminator that can be made with making loops of tubing.** **3. Explain and identify manufactured vibration eliminators.**
2-8.L Effects of refrigerant velocity in refrigeration lines.	**1. Explain how refrigeration oil travels through the refrigerant system.** **2. Explain how the velocity of the refrigerant keeps the heavier oil moving conditioning/refrigeration system.**
2-8.M Piping, Pipe Insulation and Connecting System Piping as it pertains to Solar Thermal installations. (Reference NABCEP 7.1-7.15) • **Copper Tube Installation** • **Plastic Piping Installation** • **Insulation Techniques** • **CSST Installation**	**(Reference NABCEP 7.1-7.15)** **1. Determine the extent of, and make allowances for expansion of pipe and its effect on hangers and the integrity of the pipe** **2. Determine type, length, and diameter of copper piping required** **3. Cut copper pipe to desired length**

	4. Demonstrate solder copper piping connections 5. Demonstrate test soldering fittings for leaks 6. Determine type, length, and diameter of plastic piping required 7. Cut plastic pipe to desired length 8. Glue plastic piping connections 9. Test glued fittings for leaks 10. Determine type, diameter, and length of insulation required 11. Demonstrate cutting insulation and install over piping and plumbing fittings 12. Miter insulation ends, where appropriate 13. Glue and sealing insulation joints, as required 14. Select ultraviolet radiation protective method 15. Protect insulation from ultraviolet degradation 16. Determine type, length, and diameter of cost piping required 17. Cut CSST pipe to desired length 18. Join CSST piping connections 19. Test CSST Tubing & fittings for leaks
2-8.N Solar Thermal Piping: **(Reference: NABCEP 7.16-7.26)** • Flashing • Penetrations	**(Reference: NABCEP7.16-7.26)** 1. Determine type of pipe flashing to use for specific roof type 2. Determine the area where pipe flashing will be installed

• **Sealants** • **Slope Strategy** • **Hangers** • **Standoffs** • **Connection** • **Underground Piping Methods** • **Connection of components**	3. **Demonstrate roof penetrations** 4. **Install pipe flashing and sealant** 5. **Determine slope strategy of piping to avoid traps on horizontal runs** 6. **Demonstrate slope piping to avoid traps in horizontal pipe runs** 7. **Attach pipe hangers and supports** 8. **Install stand-off hangers beneath piping on roof if needed** 9. **Connect all system piping to water heater tank, collector, valves, pumps, etc.** 10. **Determine under-ground piping method**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
ABS (Acrylonitrile-butadiene-styrene) Air conditioning and refrigeration (ACR) tubing Bending spring Brazing CPVC (chlorinated polyvinyl chloride) PVC (polyvinylchloride) Double flare Flare Flare nut	Flux Nitrogen Pipe schedule Purging Reamer Silver brazing alloys Solvent Street fitting Swaging Thread sealant Work hardened Yoke	Annealing Carburizing flame Capillary action Flashback arrestor Neutral flame Oxidizing flame Oxyacetylene

Single flare Soldering Torch Welding		

Trade Math Crossover: When installing a duct less mini split a technician must consider the total liquid line length for proper refrigerant charging of the equipment for maximum efficiency. The manufactures data plate states that if liquid line exceeds 98.4 feet you must add an additional 1.08 ounces of refrigerant per every 5 feet of liquid line. When measured the liquid line measures 125 feet in total. What additional amount of refrigerant is needed if any?

Suggested Resources

Heating & Cooling Essentials: ISBN 13: 9781631260599

Chapter 4,6,7 Copper tubing, Soldering Brazing, Flame Cutting

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545

Chapter 8 Working with Tubbing

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5

Unit 7 Tubing & Piping

Unit 8 Leak Detection/ Evacuation

OSHA.Gov:

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Apprenticeship Correlation

A2113 Brazing & Cutting Metal

VOG Portfolio Collection Examples

When preparing to solder a copper connection a student will gather necessary soldering materials and properly prepare a connection to be soldered and will take necessary safety precautions while on a job site while soldering. (VOG – A Critical Thinker)

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 2-9: Effects of heat energy and pressure on the properties of matter	
Big Idea(s): **1. Controlling pressure and understanding heat transfer are key to maintaining the balance and performance of refrigeration and climate systems.**	
Essential Question(s): **1. What happens as water boils?** **2. Why does water boil at a different temperature for sea level to high elevations?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
2-9. A Matter and define its properties listed below: ● **Solid** ● **Liquid** ● **Vapor**	**1. Classify matter according to its different states.** **2. Explain how solids exert force down.** **3. Explain how liquids exert force down and outward.** **4. Explain how vapors exert force down, outward, and up.**
2-9.B The effects of a pressurized environment on matter: ● **Pressure** ● **Temperature**	**1. Explain how the atmospheric pressure at sea level is higher than that at high elevations.**
2-9.C The difference between heat and temperature: ● **Temperature is the measurement of molecular speed.** ● **Heat energy is a measurement of the speed of molecules and the number of molecules**	**1. Identify the different scales of temperature measurements.** **2. Explain how heat is energy that is measured in British Thermal Units.**
2-9.D The direction and rate of heat flow.	**1. Demonstrate how heat flows from hot to cold.**

	2. Explain the difference in temperature affects flow and rate.
2-9.E The three methods of heat transfer and summarize their placement in the HVAC/R industry.	**1. Identify radiant, conduction and convection heat transfer methods.**
2-9.F The reference points of temperature and identify a substance boiling point and freezing point.	**1. Identify temperature scales.** **2. Identify and demonstrate how the boiling, freezing and absolute zero points are used as reference for these scales.**
2-9.D The direction and rate of heat flow.	**1. Explain how the changes in heat content affects the states of matter.** **2. Explain how matter can exist as a solid, liquid and gas.**
2-9.E The three methods of heat transfer and summarize their placement in the HVAC/R industry.	**1. Explain how sensible heat causes temperature changes.**
2-9.F The reference points of temperature and identify a substance boiling point and freezing point.	**1. Identify how specific heat is different for amounts of sensible heat required to change the temperature of substances.**
2-9.g The direction and rate of heat flow.	**1. Identify how latent heat cannot be measured as states of matter changes.** **2. Discuss how a fluid can be at temperature that when heat is added or removed the fluid will change state.**
2-9.K The difference between latent and sensible heat.	**1. Describe how latent and sensible heat affects substances as they change between states.**
2-9.L Heat/Cool storage.	**1. Explain how heat energy or the ability to remove heat energy can be stored.**
2-9.M Latent heat of fusion.	**1. Explain the removal of latent heat causing a substance to change from a liquid to solid.**
2-9.N Latent heat of vaporization.	**1. Explain the addition of latent heat causing a substance to change from a liquid to vapor.**

Bristol TEC 2-Year HVAC Curriculum

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
Absolute zero	British thermal unit (Btu)	Ambient
Boiling point	Kilojoule (kJ)	Ice Melting Equivalent (IME)
Change of state	Physical states	Latent Heat Of condensation
Cold	Refrigeration	Latent heat of freezing
Conduction	Saturated condition	Latent Heat of melting
Convection	Saturation point	Latent heat of vaporization
Forced convection	First Law of	Latent heat of sublimation
Insulator	Thermodynamics	Subcooled
Latent heat	Second Law of Thermodynamics	Superheat
Natural convection	Specific heat	
Radiation		
Sensible heat		

Trade Math Crossover: A section of baseboard has an entering water temperature of 200*F and an existing water temperature of 180*F. What is the Delta T measurement?

Suggested Resources

Heating & Cooling Essentials: ISBN 13: 9781631260599

Chapter 9 Basic Thermal Dynamic Principles

Chapter 10 Temp/Pressure

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545

Chapter 4 Energy/ Matter

Chapter 5 Gasses

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5 Unit 2 Matter & Energy OSHA.Gov: https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593
Apprenticeship Correlation A0781 Refrigeration Fundamentals A0006 HVAC Math
VOG Portfolio Collection Examples While students are working on a gas warm air furnace, they can take temperatures of the supply, return air temperatures, and calculate the heat rise. (VOG – A Critical Thinker)

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 2-10: Relationship of pressures and fluids at saturation temperatures.	
Big Idea(s): 1. **The relationship between pressure and temperature helps technicians accurately charge and assess refrigeration systems.**	
Essential Question(s): 1. **When will an air conditioning system make you more comfortable and how?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
2-10.A Relationship of pressures and fluids at saturation temperatures.	1. **Describe the relationship of pressures and fluids at saturation temperatures.** 2. **Explain how pressure affects the saturation temperature of refrigerants.**
2-10.B Relationship between temperature and pressure using the P/T Chart.	1. **Identify the relationship between temperature and pressure using the P/T Chart.** 2. **Demonstrate temperature and pressure using the P/T Chart.**
2-10.C HVAC Systems pressure.	1. **Explain how pressure is a relationship of force per unit area i.e. pounds per square inch PSI.** 2. **Explain how pressure can be expressed in absolute, which adds the weight of the atmosphere to gauge readings.** 3. **Explain and define pressure.**
2-10.D Atmospheric pressure	1. **Explain absolute pressure.** 2. **Explain how the atmosphere exerts pressure on the Earth.** 3. **Explain how the pressure changes at different elevations.** 4. **Explain atmospheric pressure as it relates to inches of mercury and microns.**

	5. Explain the standard condition at which the atmospheric pressure is 14.696. **6. Explain how barometric pressure is a measurement of the weight of the air.** **7. Explain how barometric pressure changes with air conditions.**
2-10.E Gauge interpretation	**1. Explain the gauge that reads pressure above and below atmospheric pressure when atmospheric pressure is set at "0" psig.** **2. Read a compound gauge and describe what is considered above atmospheric pressure and below atmospheric pressure.**
2-10.F Standard gauge pressure.	**1. Explain how gauges are set at zero.** **2. Explain how pressure above the atmosphere increases readings.**
2-10.G Vacuum measured in inches of mercury absolute.	**1. Explain how 29.92" of mercury is an absolute pressure because it expresses the weight of the atmosphere.**
2-10.H Vacuum measured in micron.	**1. Explain how a micron is a more precise measurement of vacuum because 760,000 microns is equal to 29.92"hg.**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
Absolute zero	British thermal unit (Btu)	Ambient
Boiling point	Kilojoule (kJ)	Ice Melting Equivalent (IME)
Change of state	Physical states	Latent Heat Of condensation
Cold	Refrigeration	Latent heat of freezing
Conduction	Saturated condition	Latent Heat of melting
Convection	Saturation point	Latent heat of vaporization
Forced convection	First Law of	Latent heat of sublimation

Insulator Latent heat Natural convection Radiation Sensible heat	Thermodynamics Second Law of Thermodynamics Specific heat	Subcooled Superheat

Trade Math Crossover: A substance such as water has been heated to a temperature of 212.0*F. Additional heat was added to raise the water temperature to 232.0*F. The substance (water) has been superheated by how much?

Suggested Resources

Heating & Cooling Essentials: ISBN 13: 9781631260599

Chapter 10 Temperature and pressure

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545

Chapter 5 Gasses.

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5

Unit 2 Matter & Energy

OSHA.Gov:

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Apprenticeship Correlation

A0781 Refrigeration Fundamentals

A0006 HVAC Math

VOG Portfolio Collection Examples

While working with a refrigeration manifold gauge set a student will be able to recognize and explain the

difference between the low and high side gauges. (VOG – Work Ready)

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 2-11: Vapor compression refrigeration cycle	
Big Idea(s): **1. Mastering the refrigeration cycle allows technicians to diagnose, install, and repair cooling systems that are foundational to HVAC work.**	
Essential Question(s): **1. How does a refrigerator or air conditioner move heat to keep things cool?** **2.Why is each part of the refrigeration cycle (compressor, condenser, expansion device, and evaporator) important for making cooling happen?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
2-11.A The four major components of the vapor compression refrigeration system.	**1. Identify the four major components and explain the functions and refrigerant changes which occur in each component.** **2. Draw a simple refrigerant cycle diagram and label each of the basic components as well as the refrigerant lines.** **3. Place arrows on the diagram to show the direction of refrigerant flow.**
2-11.B Temperature / Enthalpy (T-H) Diagrams	**1. Describe the state and conditions of the refrigerant during a cycle.**
2-11.C Superheat affects the suction line gases; sub-cooling affects the refrigerant liquid line.	**1. Explain the importance of superheat and sub-cooling.** **2. Check and adjust superheat and sub-cooling to manufacturers' specifications.** **3. Write an essay on superheat, sub-cooling and how they are affected by the metering device.**
2-11. D Different types of metering devices and compare their function from the listed components below:	**1. Define types of metering devices:**

• **capillary tubes** • **thermal expansion valve** • **automatic expansion valve** • **low side float** • **high side float** • **hand expansion valve** • **restrictor orifices** • **solid state expansion valve**	2. **Identify various parts of the thermostatic expansion valve metering device from drawings.** 3. **Adjust and size metering devices when and where appropriate.**
2-11.E Types of evaporators	1. **Identify different types of evaporators and their applications** 2. **Explain the importance of proper coil air flow.** 3. **Explain evaporator coil performance.** 4. **Explain the size of the evaporator based on compressor capacities.**
2-11.F Types of compressors	1. **Identify and demonstrate open, semi-hermetic and hermetic compressors.**
2-11.G Methods of compression	1. **Identify different methods of compression including, reciprocating, rotary, scroll, screw and centrifugal Compressors.**
2-11.H The types of condensers	1. **Discuss air cooled and water-cooled condensers.** 2. **Discuss static and forced draft designs** 3. **Explain coil performance.**
2-11.I Proper air and water flow through condensers and evaporators	1. **Discuss reverse directional flow of water verse refrigerant.** 2. **Adjusting for proper coil air flow.**
2-11.J Heat reclaim systems.	1. **Explain recovering heat from condensers to heat spaces.**

2-11.K Proper location of all compressor accessories: ● **crankcase heaters** ● **crankcase pressure regulating valve** ● **defrost timers** ● **driers/filters** ● **evaporator pressure regulating valves** ● **head pressure controls** ● **heat exchangers** ● **hot gas bypass** ● **low pressure controls** ● **low ambient controls, mufflers** ● **oil separators** ● **receivers** ● **solenoid valves** ● **suction filters** ● **vibration, eliminators** ● **check valves** ● **water regulating valve** ● **Relief valve.** ● **accumulators**	**1. Identify components from drawing accessories.**
2-11.L The operation of the above listed and explain accessories.	**1. Define function of listed controls.**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
Basic refrigeration cycle	Condensation	Accumulator

Compressor	Evaporation	Crankcase heater
Condenser	High-pressure side	Cooling tower
Conduction	Hot Gas discharge line	Filter drier
Convection	Liquid line	Flash gas
Evaporator	Low-pressure side	Off cycle
Metering device	Pressure drop	On cycle
	Reciprocating	Liquid receiver
	Refrigerant	Series connection
	Subcooled/Superheat	Temperature difference (td)
	Suction line	Thermostatic expansion valve

Trade Math Crossover: A R22 refrigeration unit has a suction pressure of 68 psi and a saturation temperature of 40*F. The suction line temperature is 55*F. What is the superheat reading?

Suggested Resources

Heating & Cooling Essentials: ISBN 13: 9781631260599

Chapter 11 Basic Refrigeration Cycle

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545

Chapter 6 Basic Refrigeration Systems

Section 7 Refrigeration System Components

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5

Unit 21 Evaporators and Refrigeration Systems

Unit 22 Condensers

Unit 23 Compressors

OSHA.Gov:

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Apprenticeship Correlation

A0781 Refrigeration Fundamentals

VOG Portfolio Collection Examples

Students can locate the four basic refrigeration components while working on a refrigeration unit. (VOG-A Problem Solver)

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 2-12: Industry EPA standards for safety and environmental issues regarding refrigerants.	
Big Idea(s): **1. Following EPA refrigerant guidelines protects the environment and ensures technicians work safely and within federal regulations.**	
Essential Question(s): **1. Can you describe proper safety techniques that go with handling refrigerants?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
2-12.A Problems with mixing of refrigerants and the consequences of mixing refrigerants	**1. Explain the problems associated with mixing refrigerants and how to deal with mixed refrigerants.**
2-12.B Methods of determining when a recovery cylinder is full	**1. Determine when a recovery cylinder is full or will be full.**
2-12.C Problems with contaminants left in a refrigerant system after recovery	**1. Describe the problems associated with contaminants left in a refrigerant system after recovery and explaining what non condensable are and how they can affect a refrigeration system.**
2-12.D Manual pump down of a refrigeration system.	**1. Demonstrate manual pump down of systems.**
2-12.Isolate refrigeration components and explain the procedure.	**1. Describe how to isolate system components according to EPA regulations and demonstrate procedure.**
2-12.F Recycled and reclaimed refrigerant	**1. Describe system dependent and self-contained recovery equipment** **2. Explain the differences between the 3 "R"s**
2-12.G EPA certification requirements: **• Type I** **• Type II** **• Type III** **• Universal**	**1. Explain differences in certification types.** **2. Decide which type is right for them**
2-12.H Storage and handling of refrigerants and procedures.	**1. Explain safe refrigerant handling and applications.** **2. Demonstrate safe refrigerant handling and application.**
2-12.I Refrigeration system recovery.	**1. Demonstrate proper system recovery with different methods available.**
2-12.K ASHRAE Refrigerant Safety Classifications of Refrigerants for Toxicity and Flammability.	**1. Explain the different classes of refrigerants, physical and chemical properties.**

Bristol TEC 2-Year HVAC Curriculum

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
Active recovery Atmospheric balancing Capture Chlorine Clean Air Act (CAA) Environmental Protection Agency(EPA) Global warming Hazardous waste Montreal Protocol Pump down Reclaim Recover Recycle Refrigerants	Ozone depletion potential (ODP) Global warming potential (GWP) De minimis EPA certification Universal certification	Active recovery Back seated valve Front seated valve CFC HFC HCFC Mid-seated valve Low-loss fitting Motor vehicle air conditioning (MVAC) Passive recovery Recovery cylinder

Trade Math Crossover: When using an empty recovery tank with a W.C (water capacity) of 47.7 lbs. and a tare weight of 27.5lbs, use the 80% rule and calculate how much total refrigerant can be added to the recovery tank.

Suggested Resources

Heating & Cooling Essentials: ISBN 13: 9781631260599
Chapter 13 Refrigerants
Chapter 14 Zeotropic Blends
Chapter 15 Refrigerant recovery

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545
Section 4 Refrigerants

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5
Unit 9 Refrigerant management

OSHA.Gov:
https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Apprenticeship Correlation

A0787 EPA Refrigerant Standards

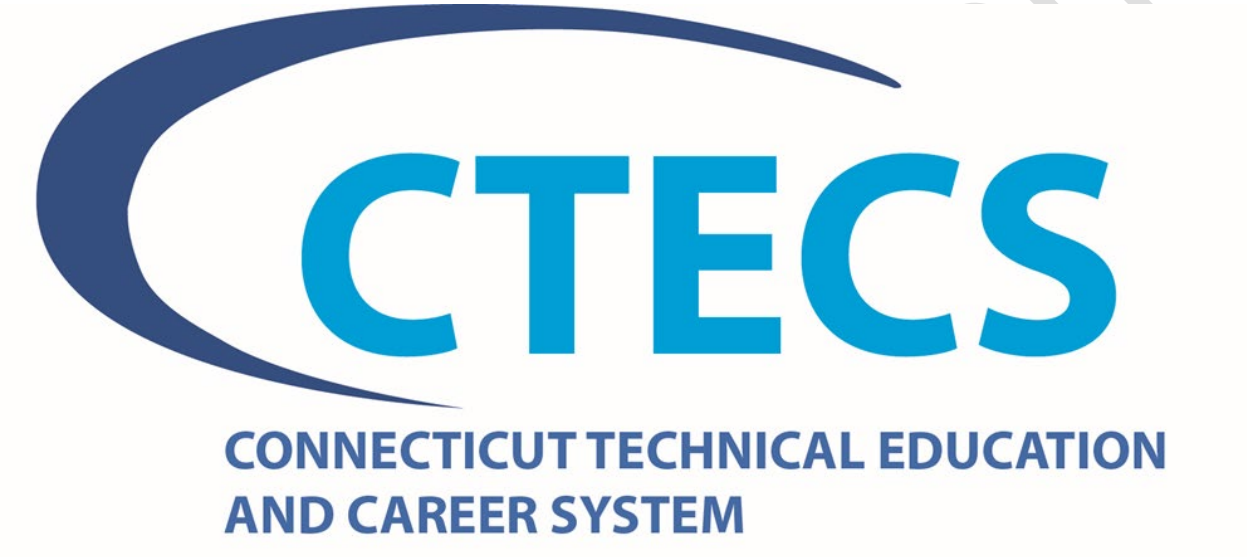
VOG Portfolio Collection Examples

Students will be able to properly and safely use recovery equipment to evacuate a refrigeration system. (VOG – Work Ready)

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 2-13: Find employment in the HVAC trade and become a quality employee.	
Big Idea(s): **1. Success in the HVAC industry depends not only on technical skills but also on mastering professional behaviors and communication expected by employers. Through practice in shop settings and real-world experiences like Work-Based Learning (WBL), students develop the essential soft skills—such as reliability, teamwork, and professionalism—that make them valuable and employable members of the workforce.**	
Essential Question(s): **1. What skills and strategies are most effective in securing employment in today's competitive job market, and how can individuals demonstrate their value to potential employers?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
2-13.A Work Based Learning	**1. Define expectations of each partner.** **2. Refer to the Work Study Guidelines for roles and expectations.** **3. Come to work every day on time.** **4. Is willing to take directions.** **5. Accomplish the task at hand.**
2-13.B Student contribution in the workplace.	**1. Formulate a list of what they can bring into the workplace and how each item may impact their job. School subjects; past experiences; self-concept and personality; needs, values and interests; knowledge skills and attitudes; career Priority Standards and plans.** **2. Demonstrate contributing to the success of a team.** **3. Self-assessment of skills using the above list as a guide.** **4. Explain how these skills would be valuable to the industry.** **5. Ability to read and interpret workplace documents.** **6. Demonstrate ability to respond in writing clearly and concisely.**
2-13.C Communication in the workplace.	**1. Discuss verbal and non-verbal communication. List ways negative nonverbal communication may be displayed.** **2. Role play ways of demonstrating effective verbal communication.**

	3. **Contribute innovative ideas.** 4. **Works with initiatives and co-workers.** 5. **Working cordially with customers and co-workers.** 6. **Communicate effectively with co-workers and customers.**
2-13.D Interview Skills	1. **Outline and describe the three stages of an interview –greeting, exchange and parting.** 2. **Role plays the stages of the interview.**
2-13.E Post interview	1. **Perform a follow-up activity after completion of the interview.** 2. **Review interview.**
2-13.F Worksite guide.	1. **Discuss work site items: transportation; hours of work; absence and tardiness; conflict resolution; role of student, teacher, and workplace supervisor; dress code; job description; expectations**
2-13.G Feedback	1. **Provide feedback about work placement.** 2. **Understand the guidelines for placement.**
VOG Project: Mock Interview & Professional Portfolio: Description: Students participate in a three-stage mock interview (greeting, exchange, and parting) and develop a guide for the worksite that includes conflict resolution and dress code expectations. (VOG Alignment: Skilled Socially & Effective Communicator.)	



HVAC

Year 2; Semester 1

Bristol TEC 2-Year HVAC Curriculum

Year 2, Semester 1 Curriculum

<table>
<tr><th colspan="2">Priority Standard 3-1: Safety expectations at the school and work sites.</th></tr>
<tr><td colspan="2">Big Idea(s):

1. Practicing professional behavior and safety builds a culture of trust and reliability in high-risk HVAC environments.</td></tr>
<tr><td colspan="2">Essential Question(s):

1. How does the culture of safety impact our lives outside of the classroom.</td></tr>
<tr><th colspan="2">Learning Outcomes</th></tr>
<tr><th>Students will know:</th><th>As evidenced by:</th></tr>
<tr><td>3-1.1 Proper clothing and safety equipment</td><td>1. Wearing and describing reasons for proper clothing and safety equipment</td></tr>
<tr><td>3-1.2 Effects of substance abuse on safety</td><td>1. Giving examples to the reasons why technicians can’t work safely while under the influence of any substance that interfere with coordination and decision making</td></tr>
<tr><td>3-1.3 Proper storage and handling of

● Oxygen
● Nitrogen
● Acetylene bottles</td><td>1. Demonstrating safe use of high-pressure regulators.

2. Showing how to safely store and handle high-pressure gasses and the importance of keeping cap in place and strapping and storing cylinders in their upright position.

3. Explaining the dangers associated with pressurized gasses and tanks becoming projectiles.

4. Explain how to safely store and handle high-pressure gasses and the importance of keeping cap in place.

5. Explain the reasons for storing acetylene upright</td></tr>
</table>

3-1.4 Precautions with servicing rotating components.	**1. Pointing out areas where personal injury could occur due to rotating parts while servicing a refrigeration system.** **2. Describe Dangers of being caught in rotating components & using precautions when working rotating components**
3-1.5 Safety concerns related to servicing refrigeration system.	**1. Exhibiting proper eye safety during service/testing procedures** **2. Identifying and listing the components in refrigeration systems that are a concern due to operating temperature extremes.**
3-1.6 Dangers of working on energized live equipment.	**1. Appraising the inherent dangers of working on energized/live/operating equipment.** **2. Observed electrical safety precautions and the safe use of electrical testing instruments during service/testing procedure.**
3-1.7 Unsafe driving consequences.	**1. Predicting the outcome of a DUI, speeding violation or other traffic violation on their employability, cost to employers and themselves.** **2. Identified the reasons why technicians cannot work safely while under the influence of any substance that interferes with coordination and decision making.** **3. Researching why the insurance companies of employers will require driving record**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
Air-purifying respirator Confined space	Hazard Communication Standard (HCS)	Globally Harmonized System (GHS)

lockout/tagout (LOTO) Occupational Safety and Health Act (OSHA) Personal protective equipment (PPE) Signal word	Pictogram hazard Safety data sheet (SDS) Stationary refrigerant Detector Supplied-air respirator	ASHRAE Standard 34 Authorized person Competent person Qualified person Designated person Worker's compensation

Suggested Resources

Heating & Cooling Essentials: ISBN 13: 9781631260599

Chapter 3. Safety

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545

Section 1, Chapter 2.

Basic Principles for Construction, 3rd Edition (Residential Construction Academy) 3rd Edition

ISBN-13: 978-1111307189

Chapter 3. Job Safety

OSHA.Gov:

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Apprenticeship Correlation

OSHA 30: A0099

VOG Portfolio Collection Examples

Students can present images of themselves wearing proper PPE for different tasks. (VOG – An Effective Communicator)

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 3-2: Knowledge of basic electricity, electrical circuits and AC electric motors	
Big Idea(s): **1. Applying knowledge of circuits and motors allows technicians to power, control, and troubleshoot HVAC systems efficiently.**	
Essential Question(s): **1. How does the flow of electric current impact the way we use energy in everyday life?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
3-2.1 Applications of magnetism in electricity	**1. Define magnetic theory** **2. Exhibit the use of the appropriate meter to check basic electrical components.**
3-2.2 Low voltage wiring and controls required for heating and cooling equipment to operate.	**1. Exhibit the wiring of a complete low voltage heating and air conditioning control circuit to accommodate a heating furnace with a split cooling system.** **2. Show how to program a programmable thermostat for heating/cooling including set-up and setback modes.** **3. Detect and compare single- and three-phase voltage and current**
3-2.3 Various three phase electric motor theories ● **Electronically controlled motor** ● **Variable-speed motor**	**1. Define the significance of power factor.** **2. Give examples for starting and over current**

• **Three-phase motor** • **Identify Wye and Delta motors**	**protection components associated with three-phase motors.** **3. Explain the operation and application of motors and supporting what problems could happen and where they would have occurred.** **4. Explain electric motor theory (i.e., magnetism, electromotive force, etc.).** **5. Explain operation and application of: different three phase motors**
3-2.4 Types of electrical loads; Capacitive, Inductive, resistive	**1. Define the significance of power factor.** **2. Give examples for starting and over current protection components associated with three-phase motors.** **3. Explain the operation and application of motors and supporting what problems could happen and where they would have occurred.** **4. Explain electric motor theory (i.e., magnetism, electromotive force, etc.).** **5. Explain operation and application of: different three phase motors**

	6. **Identify the relationships of voltage and amperage in different loads.**
3-2.5 Principles of solid-state switching devices	1. **Discuss how solid-state devices control flow of electrons without mechanical switches that ware out due to friction and sparks** 2. **Identify principles of solid-state switching devices**
3-2.6 Electricity production and distribution	1. **Explain how magnetically produced electricity is transformed and distributed from plants to users through electrical grid** 2. **Explain how a wire passed through a magnetic field will have a voltage created in it**
3-2.7 The differences in Wye (Y) and Delta (D) distribution systems	1. **Identify the different wiring of Wye and Delta and explaining the flow of electrons through the Wye and Delta systems** 2. **Identify the different voltages produced in Wye or Delta systems**
3-2.8 Operation and application of motors	1. **Identify different motor types and uses, small axial fans, squirrel blowers, compressors etc.**

	2. Explain proper horsepower of replacement motors
3-2.9 Starting components associated with single-phase and three-phase motors ● **centrifugal switch** ● **current coil relay** ● **potential relay** ● **PTC relay**	**1. Identify single phase starting components** **2. Identify contactors and motor starters**
3-2. Detailed instructions for wiring circuits interpretation.	**1. Identify electrical switch and load symbols used in diagrams.** **2. Draw basic electrical circuits that demonstrate an understanding of switches controlling loads**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
Alternating current(ac)	AWG	Bonding
ampere	Closed	Brushes
atom	Circuit	Capacitance
brushes	Circuit breaker	Capacitor
conductor	Dielectric	Electromagnet
coulomb	Electrical circuit	Electromagnetism
current	Electrical load	Farad(F)
electricity	Fuse	Induced magnetism
Direct current(dc)	Grounding	Induction
Electricity	Open circuit	Volt-amps
Electromotive force(emf)	Closed circuit	Voltage drop

Electron Ohm's law Switch	Ground fault interrupter Load Resistance Short circuit Single phase Three phase Watt's law	

Trade Math Crossover: If a circuit has a resistance of 5 ohms and voltage supplied is 240 volts what would the amperage total?

Suggested Resources

Resources to compliment learning

Heating & Cooling Essentials: ISBN 13: 9781631260599

Chapter 23 What is Electricity

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545

Chapter 13 electrical Power

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5

Unit 18 Application of motors

Unit 19 Motor Controls

OSHA.Gov:

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Apprenticeship Correlation

A0782 Electric Fundamentals

VOG Portfolio Collection Examples

Students can create then present posters which outline the distinct types of starting components used for compressors. (VOG - An Effective Communicator)

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 3-3: The use of building codes and manufacturers' installation instructions on current production jobs	
Big Idea(s): 1. **Understanding and following codes and manufacturer instructions ensures systems are installed safely, legally, and to industry standards.**	
Essential Question(s): 1. **Who writes the codes used for installing mechanical systems or building structures? Why are codes important? Who enforces the use of codes?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
3-3.A Codes for- • **Safe installations** • **Energy efficiency** • **Proper venting of combustion gases** • **Fresh air considerations**	1. **Explain the need for building codes to assure safety throughout our industry when installing, servicing, or repairing HVAC equipment.** 2. **Demonstrate an awareness of their limitations, altogether ensuring a safe alteration to building structure while cooperating with others on site.**
3-3.B The names of the three model codes • **BOCA** • **SBCCI** • **ICBO**	1. **Explain code models.**
3-3.C Codes and standards for the applicable area, locality, and state.	1. **Identify necessary codes from the International mechanical code when regulations are not specified otherwise.** 2. **Explain CT code models used in most area**
3-3. D Relationship between codes and manufacturers' installation instructions.	1. **Prepare to install or repair HVAC equipment, referring to the manufacturers' installation instructions.** 2. **Give examples of the local building and energy codes when directed to do so.**

	3. Explain how local codes and manufacture instructions super cede each other when the other is safer. **4. Explain enforcement of codes by building inspectors** **5. Analyze building plans to help prepare for the obstacles which may be encountered during system installation**
3-3.E How to identify pertinent standards published by AGA, AMCA, ANSI, ARI, ASHRAE, IED, ISO, SMACNA, and UL.	1. Describe about organizations which investigate and lobby for manufacture, installation, and service standards
3-3.F The methods for adapting a Solar Thermal System Design (Reference NABCEP 3.1-3.9)	(Reference NABCEP 3.1-3.9) 1. Determine active direct system components' location and system layout and configuration 2. Determine active indirect system components' location and system layout and configuration 3. Determine passive direct system components' location and system layout and configuration 4. Determine passive indirect system components' location and system layout and configuration 5. Determine solar pool system components' location and system layout and configuration. 6. Apply for building permits. 7. Estimate time, materials, tools, and labor required for installation. 8. Determine installation sequence to optimize use of time and materials.

	9. Inspect all provided system components for damage prior to installation
3-3.G Mechanical/Plumbing Equipment and other components onto Solar Thermal Systems: **Reference NABCEP: 8.1-8.5** • **System components** • **Location of components** • **System monitoring components** • **Heat exchanger** • **Heat exchanger fluids**	Reference NABCEP: 8.1-8.5 1. Determine system plumbing, valves and other components required, (This includes the following: valves, air vent, check, drain, auto drain down, expansion tanks, flow control, isolation, diverting, solenoid, mixing, anti-scald, pressure relief, temperature pressure relief, vacuum relief, balancing, freeze, etc. as well as the following monitoring components; flow meter, temperature gauge, pressure gauge, etc.) 2. Determine location of plumbing valves and other components 3. Install system plumbing valves and monitoring system components as specified in component manufacturers or solar manufacturer's installation manual and schematic. 4. Determine the heat exchanger location Install heat exchanger and heat exchanger fluids as specified in manufacturers installation manuals and schematics
Tiered Vocab:	
Tier One Words	
Service specialty certification, Building inspector certification, Energy auditor estimator, HVACR designer. HVACR drafter, HVACR engineer, Installation, RSES (Refrigeration Service Engineers Society)	
Apprenticeship Correlation A0729: International Mechanical Code	

A0730: Related Codes and Standards:

NFPA Book

WWW.ICCSAFE.org

WWW.SMACNA.ORG

Related Codes and Standards

VOG Portfolio Collection Examples

Students can highlight and present proper installations of production jobs following local building codes. (VOG- An Effective Communicator)

Project: Code Compliance Inspection Report: Description: Students analyze a "production job" installation and write a report comparing it against the International Mechanical Code and manufacturer's installation instructions. (VOG Alignment: Critical Thinker & Effective Communicator.)

Priority Standard 3-4: Calculate total heat gain/loss for the proper sizing of heating/cooling equipment.	
Big Idea(s): 1. **Accurate load calculations are essential for selecting properly sized HVAC equipment that delivers energy efficiency and comfort.**	
Essential Question(s): 1. **Can you explain the heat values and how to apply them to a blueprint?** 2. **Would it be possible to size a job by looking at structure design?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
3-4.A Heat transfer tables ("U," "K," "R").	1. **Define "U""K""R" value needed for heat/cool gains and loss calculations** 2. **Select and applying resistance to heat flow, ("R"), ("U") values to their respective areas for load calculations**
3-4.B Heat gain/loss calculation to select properly sized HVACR equipment	1. **Select properly sized HVACR equipment for applications from calculations.**
3-4.C Blueprints – size rooms, etc. for the breaking down values needed for the load calculation. • **Net exposed wall area** • **Ceiling area** • **Floor area** • **Windows (glass area)** • **Door area**	1. **Apply trade related math through calculating necessary net areas of the building structure, subject to heat gain/loss.** 2. **Calculate infiltration of windows and doors for heat loss** 3. **Validate heat loss and heat gain specific heat values times their design temperature difference for heating and cooling to calculate hourly sensible gains and losses**
3-4.D Tables of specific heat values, latent heat, and heat of respiration.	1. **Explain use of design conditions for different climates**

3-4.E Vapor barriers.	1. Explain vapor barriers and their effect on load calculations
	1. Determine design data from given blueprint

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
Crawlspace Heat gain Heat lag Heat leakage Heat load Heat loss Heat transfer rate Total cooling load Insulation	Outdoor design temperature (ODT) Manual j Total heat loss Sustainable Indoor design temperature (IDT)	Emissivity Heat transfer multiplier (HTM) thermal conductance (C-value) M) thermal conductivity (K-value) thermal resistance (R-value) thermal transmittance (U-value)

Trade Math Crossover: If you perform a heat gain on a building at the unit size is 3.5 tons, how many btus is the unit, and how many cfm are required when sizing the ducts?

Suggested Resources

Wright Soft 7 Load Calculation software

Wright Soft University

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545

- Chapter 50 Understanding heat Loads/ System thermal dynamics
- Chapter 37 Heating & Cooling Loads
- Chapter 45 energy management
- Chapter 46 Conservation

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5

- Unit 42 Heat gains Heat losses

OSHA.Gov:

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Apprenticeship Correlation

A0790 Forced air Heating & Cooling

VOG Portfolio Collection Examples

Students can present drawings of floor plans and even print outs of wright soft calculations from school software. (VOG – An Effective Communicator)

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 3-5: Airflow principles and design of air handling equipment.	
Big Idea(s): **1. Airflow design directly affects system performance and indoor comfort, making it a critical part of HVAC system planning and maintenance.**	
Essential Question(s): **1. How can you determine if a heating or air conditioning system was installed correctly?** **2. How would a tech lay out a trunk line for the equipment you must install?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
3-5.A Ductwork pressures	**1. Explain duct pressures** **2. Explain how ductwork pressures affect equipment, ductwork, and register/diffuser sizing**
3-5.B Air distribution system.	**1. Demonstrate ability to use duct calculator to find correct duct size, velocity, CFM, and friction loss** **2. Demonstrate how to use a duct work calculator to properly size an air distribution system.**
3-5.C Layout of duct systems.	**1. Draw layout of return and supply systems.**
3-5.D Trunk and branch ducts design	**1. Demonstrate ability to size trunk and branch ducts by equal friction method.**
3-5.E Registers, grilles, and diffusers.	**1. Demonstrate ability to size supply registers, return grilles, and diffusers.**
3-5.F Types of fans/blowers	**1. Explain different types of fans/blowers**
3-5.G Proper rotation of blowers	**1. Demonstrate the ability to check for proper rotation of single and three phase blowers and correct if rotation is incorrect**
3-5.H Fans/blowers' performance.	**1. Demonstrate the ability to check fans/blowers' performance.**

3-5.I Amp draws and fan speed adjustment	**1. Check amp draws and make fan speed adjustment**
3-5.J Fresh air controlling devices	**1. Explain the reasoning for supplying as well as monitoring and adjusting fresh make up in LEAD constructed buildings**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
Flow	Butterfly damper device	External static pressure
Fan	Friction rate	(ESP)
Diffuser	Friction loss	Device pressure losses
Duct	Forced draft	(DPL)
Duct board	Gable fan	Multiple-blade damper
Effective length	Induced draft	Total effective length
Elbow		(TEL)
Grille		Total pressure drop
Primary air		
Register		
Return air duct		
Starting collar		
Unvented attic		
Vented attic		
Whole house fan		

Trade Math Crossover: If an 8 ich duct is rated for 150 cfm how many branch runs are needed for a 2-ton system?

Suggested Resources

Heating & Cooling Essentials: ISBN 13: 9781631260599

Chapter 29 Ductwork

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545

Chapter 29 Air Distribution

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5

Unit 37 Air Distribution / Balance

OSHA.Gov:

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Apprenticeship Correlation

A0790 Forced air Heating & Cooling

VOG Portfolio Collection Examples

Students can present a duct drawing they created which shows sizes and cfm totals for each room. (VOG – A Critical Thinker)

Priority Standard 3-6: Work with fuel gases while comprehending industry environmental issues regarding storage and combustion.	
Big Idea(s): **1. Safe fuel gas handling protects lives and the environment, requiring strict adherence to procedures and storage protocols.**	
Essential Question(s): **1. What are the possible dangers associated with improper liquefied fuel gas storage? Why is proper and complete combustion of fuel gases so important to human safety and the environment?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
3-6.A Dangers associated with inhaling fuel gasses.	**1. Explain the dangers of Impairment while working.** **2. Explain how the protective coating on nerves can be damaged.** **3. Explain that permanent harm can be done to nerves and muscles with prolonged or excessive inhalation.** **4. Explain how inhaling gas fumes can have lethal consequences**
3-6.B Uncontrolled combustion of fuel gases	**1. Explain how the right amount of fuel gas can combine with the oxygen in the air and explode with heat or spark.** **2. Explain how explosions can cause loss of life or cause loss of hearing and/or limbs.** **3. Explain how severe burns are caused by not following safety precautions when working with fuel gases.** **4. Explain the financial cost associated with property loss due to explosions.**

3-6.C Incomplete combustion of fuel gases and improper venting.	**1. Explain reason for improper combustion and the formation of high concentrations of carbon monoxide.** **2. Explain with examples dangers of high levels of carbon monoxide and why this is so important with fuel gases.** **3. Explain causes of soot.**
3-6.D Fuel gas safety	**1. Detect gas leaks properly and following proper evacuation procedures** **2. Demonstrate proper venting while working on gas appliances.**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
100% shutoff Atmospheric gas burner Combination gas valve combustion Combustion air Direct-venting system Draft regulator Drip leg End switch Flame rectification Flammability Limit Gas burner Gas manifold	Annual fuel utilization efficiency (AFUE) Combustion efficiency Complete combustion Direct-spark ignition (DSI) Flame rollout Hard lockout Hot-surface igniter Hot-surface ignition (HSI) Glow coil Excess air	Category I furnace Category II furnace Category III furnace Category IV furnace Electric interlock electromagnetic interference (EMI)

High-efficiency gas furnace High-limit switch Ignition system Ignition temperature		

Trade Math Crossover: If 28 inches of water column equal 1psi, then what percentage of one psi is 10 inches of water column?

Suggested Resources

Heating & Cooling Essentials: ISBN 13: 9781631260599

Chapter 30 Gas Heat and A/C

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545

Section 41 Gas Fired Heating Systems

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5

Unit 31 Gas Heat

NFPA 54- 58

OSHA.Gov:

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Apprenticeship Correlation

A0784 Heating Fundamentals

VOG Portfolio Collection Examples

Students can take pictures and present how to analyze gas pressure of equipment using electronic manometers. (VOG – Work Ready)

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 3-7: Contemporary gas heating appliances.	
Big Idea(s): **1. Starting up and understanding modern gas heating systems ensures they operate safely, efficiently, and meet customer expectations.**	
Essential Question(s): **1. What would be good practice in terms of starting, testing and checking systems efficiencies?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
3-7.A Components used in all types of gas furnaces.	**Identify Furnace parts** **1. Heat Exchanger** **2. Gas components** **3. Blower components**
3-7.B Various types of gas heating appliances	**1. Explain the different type of gas appliances** **2. Describing the basic operation of gas heating appliances**
3-7.C Properties of natural gas and propane.	**1. Compare the characteristics of natural and propane fuel** **2. Identify the safety concerns related to natural and propane fuels**
3-7.D Gas venting and combustion air requirements ● **"B" Vent** ● **PVC**	**1. Identify the ignition and venting methods for various gas appliances.** **2. Measure fuel input and air required for complete combustion**
3-7.E Gas furnace operation	**1. Explain the sequence of operation for 70 to 90% efficient gas furnaces** **2. Explain different categories of furnaces**

	3. Explain department of energy standards for new equipment
3-7.F Ignition systems and pilot proving devices	**1. Describe the operation of ignition and pilot proving devices**
3-7.G Methods of fan control for gas furnaces	**1. Explain methods of fan control for the three categories of gas furnaces**
3-7.H Different gas valves	**1. Identify different types of gas valves**
3-7.I Temperature rise determination	**1. Explain the procedure necessary to obtain proper temperature rise**
3-7.J Gas burners adjustments	**1. Describe the methods of adjusting gas burners**
3-7.K Gas heating systems set-up to the proper manufacture specifications	**1. Adjust gas appliances to manufacture specifications**
3-7.L Safety limits check	**1. Demonstrate the ability to test heating appliance safety systems**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
100% shutoff Atmospheric gas burner Combination gas valve combustion Combustion air Direct-venting system Draft regulator Drip leg End switch Flame rectification	Annual fuel utilization efficiency (AFUE) Combustion efficiency Complete combustion Direct-spark ignition (DSI) Flame rollout Hard lockout Hot-surface igniter Hot-surface ignition	Category I furnace Category II furnace Category III furnace Category IV furnace Electric interlock electromagnetic interference (EMI)

Flammability Limit Gas burner Gas manifold High-efficiency gas furnace High-limit switch Ignition system Ignition temperature	(HSI) Glow coil Excess air	

Trade Math Crossover: If a furnace vent cannot exceed 80 feet and each elbow is considered 5 feet, how many elbows are allowed if the horizontal and vertical runs total 40 feet?

Suggested Resources

Heating & Cooling Essentials: ISBN 13: 9781631260599

Chapter 30 Gas Heat and A/C

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545

Section 41 Gas Fired Heating Systems

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5

Unit 31 Gas Heat

NFPA 54- 58

OSHA.Gov:

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Bristol TEC 2-Year HVAC Curriculum

Apprenticeship Correlation
A0784 Heating Fundamentals
VOG Portfolio Collection Examples
Students show examples of furnace vent types, high efficiency vs conventional. (VOG – Work Ready) Project: High-Efficiency System Start-Up: Description: Working in pairs, students perform a full start-up on a 90% efficient gas furnace, measuring fuel input, air combustion, and temperature rise to ensure it meets manufacturer specifications. (VOG Alignment: Work Ready.)

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 3-8: Ability to conduct a start-up on gas heating systems.	
Big Idea(s): **1. Systematic troubleshooting allows technicians to quickly diagnose and fix gas heating problems, minimizing downtime and maximizing safety.**	
Essential Question(s): **1. How does the initial startup procedure of a heating system ensure both safety and efficiency?** **2. What role does each component of a heating system (e.g., thermostat, controls, motors) play during the startup process, and how do they work together to achieve optimal performance?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
3-8.A Methods for startups and adjusting gas appliances for proper operation to the manufacturer's specifications and efficiency.	**1. Make proper air / fuel adjustments** **2. Adjust to obtain CO levels, and stack temperature.** **3. Adjust safe and efficient combustion** **4. Check the operation of an induced draft blower by blocking flue outlet** **5. Explain the procedure necessary to obtain proper temperature difference across a heat exchanger**
3-8.B Functions and applications of regulators.	**1. Check gas valve regulator operation**
3-8.C Operation and the methods of pilot/burner ignition	**2. Check the flame-sensing current of the flame sensing device.** **3. Test and change a thermocouple flame-sensing device.** **4. Test spark modules for proper operation.** **5. Test hot surface ignition modules for proper operation.**

Bristol TEC 2-Year HVAC Curriculum

3-8.D Gas heating systems adjustments to the proper manufacture specifications	**1. Explain the information required to start gas appliances to manufacture requirements**
3-8.E Heating appliance testing and safety systems	**1. Perform safety lockout test procedures for gas systems.** **2. Install and testing a fan/limit control to identify the proper set point of the control.**

Tiered Vocabs:

Tier One Words	Tier Two Words	Tier Three Words
100% shutoff Atmospheric gas burner Combination gas valve combustion Combustion air Direct-venting system Draft regulator Drip leg End switch Flame rectification Flammability Limit Gas burner Gas manifold High-efficiency gas furnace High-limit switch	Annual fuel utilization efficiency (AFUE) Combustion efficiency Complete combustion Direct-spark ignition (DSI) Flame rollout Hard lockout Hot-surface igniter Hot-surface ignition (HSI) Glow coil Excess air	Category I furnace Category II furnace Category III furnace Category IV furnace Electric interlock electromagnetic interference (EMI)

Ignition system Ignition temperature		

Trade Math Crossover: If a furnace supply air reads 130 degrees and the return is 60 degrees what is the temperature rise across the heat exchanger?

Suggested Resources

Heating & Cooling Essentials: ISBN 13: 9781631260599

Chapter 30 Gas Heat and A/C

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545

Section 41 Gas Fired Heating Systems

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5

Unit 31 Gas Heat

NFPA 54- 58

OSHA.Gov:

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Apprenticeship Correlation

A0784 Heating Fundamentals

VOG Portfolio Collection Examples

Students can display pictures of themselves recording temperature reading while checking temp rise across heat exchangers. (VOG – A Problem Solver)

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 3-9 Systematically troubleshoot and to service a gas system.	
Big Idea(s): **1. Proper refrigerant handling safeguards technicians and the environment, ensuring compliance with EPA and HVAC industry standards.**	
Essential Question(s): **1. What are the two major areas to check when trouble shooting a system?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
3-9.A Malfunctioning gas appliance testing	**1. Determining if the problem is electrical or mechanical**
3-9.B Faulty electrical components testing	**1. Using electrical diagrams and test instruments to determine which component is faulty**
3-9.C Faulty mechanical components testing	**1. Using test instruments to determine which component is faulty**
3-9.D Proper Repairs in professional manor	**1. Use proper technique will replace and test faulty component**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
100% shutoff Atmospheric gas burner Combination gas valve combustion Combustion air Direct-venting system Draft regulator Drip leg	Annual fuel utilization efficiency (AFUE) Combustion efficiency Complete combustion Direct-spark ignition (DSI) Flame rollout Hard lockout	Category I furnace Category II furnace Category III furnace Category IV furnace Electric interlock electromagnetic interference (EMI)

End switch Flame rectification Flammability Limit Gas burner Gas manifold High-efficiency gas furnace High-limit switch Ignition system Ignition temperature	Hot-surface igniter Hot-surface ignition (HSI) Glow coil Excess air	

Trade Math Crossover: What is the stepdown ratio of a control transformer that has a primary voltage of 120 and generates a secondary voltage of 24?

Suggested Resources

Heating & Cooling Essentials: ISBN 13: 9781631260599

Chapter 30 Gas Heat and A/C

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545

Section 41 Gas Fired Heating Systems

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5

Unit 31 Gas Heat

NFPA 54- 58

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Bristol TEC 2-Year HVAC Curriculum

Apprenticeship Correlation
A0784 Heating Fundamentals
VOG Portfolio Collection Examples
Students can document themselves recording voltage readings on equipment that is not operating correctly. (VOG – A Critical Thinker)

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 3-10: Handle refrigerants while comprehending industry environmental issues regarding them.	
Big Idea(s): **1. Understand superheat, subcooling, and coil temperature differences helps technicians evaluate system health and cooling efficiency.**	
Essential Question(s): **1. What are the reasons the 608 Certification to HVAC technicians?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
3-10.A Refrigerants Handling	**1. Exhibited safe refrigerant handling and applications.** **2. Demonstrated proper system charging by weight and superheat & sub-cooling, PT relationships.** **3. Describe the methods of determining when a recovery cylinder is full.** **4. Describe system dependent and self-contained recovery equipment.** **5. Describing the problems associated with mixing of refrigerants.** **6. Explaining how to determine empty cylinder weight.** **7. Calculating 80% full weight of cylinder and refrigerant** **8. Explaining the problems associated with contaminants such as acid, oil, and old refrigerant left in a refrigerant system after recovery**
3-10.B ASHRAE Refrigerant Safety Classification of Refrigerants for Toxicity and Flammability	**1. Categorize different classes of refrigerants, physical and chemical properties in essay form.**

3-10.C Improper handling or disposal and emission into the atmosphere.	**1. Apply all the Knowledge to pass a written test on safe refrigerant handling and applications.** **2. Explain HCFC, HFC, CFC** **3. Explain effects of Chlorine** **4. Compare effects on Earth Issues Human Health Issues**
3-10.D Proper recycle, recover, reclaim refrigerant to EPA 608 standards at all types 1, 2, and 3	**1. Demonstrate proper system recovery and recharging.** **2. Explain EPA section 608 standards for all types of certifications** **3. Describe difference between recycled and reclaimed refrigerant**
3-10.E Manually pump down a system with liquid line service valves	**1. Demonstrate manual pump down a system.**
3-10.F Isolate system components	**1. Demonstrate how to isolate system components.**
3-10.G EPA certification requirements	**1. Explain EPA 608 certifications** **2. Describe requirements associated with maintaining certifications** **3. List the EPA certification requirement types and levels of servicing**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
Active recovery	Ozone depletion potential (ODP)	Active recovery
Atmospheric balancing	Global warming potential (GWP)	Back seated valve
Capture	De minimus	Front seated valve
Chlorine	EPA certification	CFC
Clean Air Act (CAA)	Universal certification	HFC

Environmental Protection Agency (EPA) Global warming Hazardous waste Montreal Protocol Pump down Reclaim Recover Recycle Refrigerants		HCFC Mid-seated valve Low-loss fitting Motor vehicle air conditioning (MVAC) Passive recovery Recovery cylinder
Trade Math Crossover: Use tank weight listed on recovery bottles and calculate percentages to ensure they are not over filled.		

Suggested Resources

Heating & Cooling Essentials: ISBN 13: 9781631260599

- Chapter 13 Refrigerants
- Chapter 14 Zeotropic Blends
- Chapter 15 Refrigerant recovery

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545

Section 4 Refrigerants

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5

Unit 9 Refrigerant management

International Mechanical Code

OSHA.Gov:

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593
Apprenticeship Correlation A0787 EPA Refrigerant Standards
VOG Portfolio Collection Examples. Students can document themselves performing recovery of refrigerants. (VOG – Work Ready)

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 3-11: Refrigeration cycle and superheat, sub-cooling, and coil temperature differences.	
Big Idea(s): **1. HVAC systems work by moving heat using refrigerants in different forms.** **2. Knowing where the refrigerant is in the cycle and what it's doing helps techs fix and improve systems.** **3. Understanding superheat, subcooling, and temperature changes shows if a system is working right.**	
Essential Question(s): **1. Why would a technician need to know what the temperature and pressures are throughout the refrigeration system?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
3-11.A The four major components of the vapor compression refrigeration system.	**1. Label the four major components: refrigeration cycle diagram and refrigerant lines.** **2. List the components that separate the high side from the low side of the system.** **3. Draw a refrigeration cycle on a pressure-enthalpy chart**
3-11.B Types of evaporators and their uses in the refrigeration and air conditioning field.	**1. Explain that the evaporator absorbs heat from what is being cooled.** **2. Identify evaporator types** **3. Check and adjusting superheat to manufacturers' specifications where appropriate** **4. Explain measuring temperature difference between fluid entering the evaporator and leaving**

	5. Determine the Mean Effective Temperature Difference (METD) for evaporators **6. Calculate superheat om all evaporators**
3-11.C Types of condensers and uses in the refrigeration and air conditioning field.	**1. Explain that the condenser removes heat, absorbed in the evaporator and compressor.** **2. Identify air cooled condensers,** **3. Identify water cooled condensers.** **4. Determine proper air and water flow.** **5. Explain drawing air through coils** **6. Explain opposing flow water verse refrigerant** **7. Check and adjust sub-cooling to manufacturers' specifications** **8. Validate the correct performance of a condenser** **9. Calculate Sub-Cooling on all Condensors**
3-11.D State & condition of refrigerant in the system; Liquid, Vapor, Sub-cooled liquid, Superheated Vapor	**1. Explain the changes that the refrigerant goes through as it travels through the system moving heat**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
Basic refrigeration cycle	Condensation	Accumulator
compressor	Evaporation	Crankcase heater
condenser	High-pressure side	Cooling tower
conduction	Hot Gas discharge line	Filter drier
convection	Liquid line	Flash gas
evaporator	Low-pressure side	Off cycle

Metering device	Pressure drop Reciprocating Refrigerant Subcooled Suction line Superheat	On cycle Liquid receiver Series connection Temperature difference (td) Thermostatic expansion valve

Trade Math Crossover: If your liquid line temp reads 90 and your saturation refrigerant temp reads 102 what is the amount of sub cooling?

Suggested Resources

Heating & Cooling Essentials: ISBN 13: 9781631260599

Chapter 16 System evacuation

Chapter 19 Trouble Shooting

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545

Chapter 20 metering devices

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5

Unit 24 Expansion Devices

OSHA.Gov:

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Apprenticeship Correlation

A0787 EPA Refrigerant Standards

VOG Portfolio Collection Examples

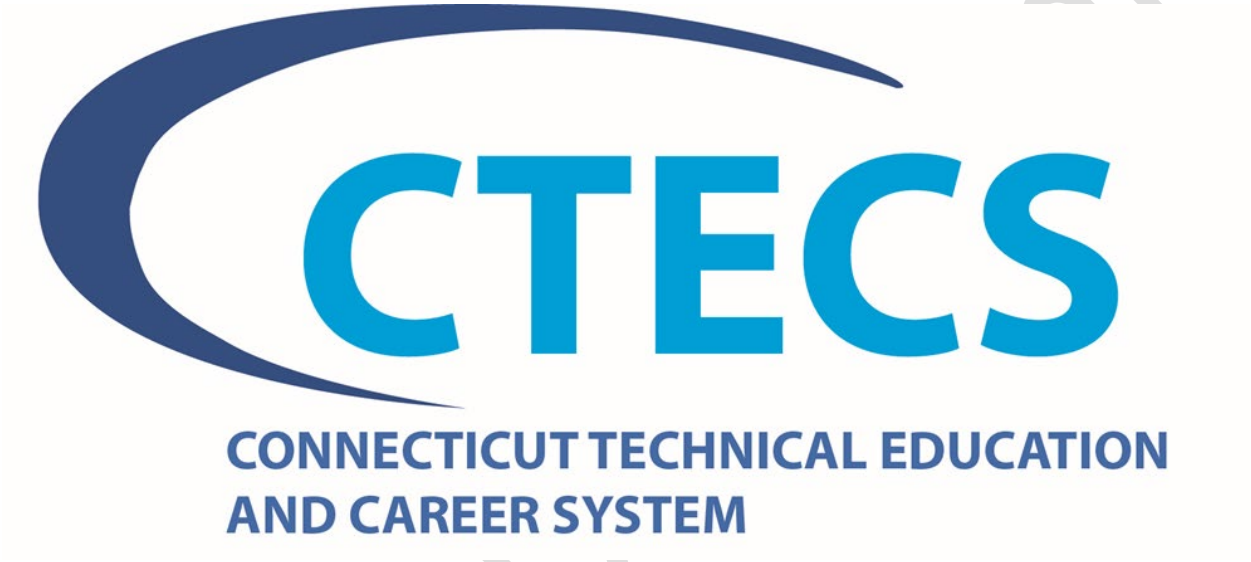
Students can document themselves performing superheat and subcooling calculations.

(VOG- Work Ready)

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 3-12: Inside and outside production and the possibility of Work based Learning (WBL)	
Big Idea(s): 1. **Good workers show up on time, communicate well, and act professionally.** 2. **WBL helps students practice real job skills and learn what employers expect.** 3. **Getting ready for interviews and the workplace helps students succeed in their careers.**	
Essential Question(s): 1. **What are marketable skills?** 2. **How can you benefit from WBL?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
3-12.A Expectations of all parties involved in work based learning.	1. **Define expectations of each partner.** 2. **Refer to the Work Study Guidelines for roles and expectations.** 3. **Come to work every day on time.** 4. **Will to take direction.** 5. **Motivate to accomplish the task at hand.**
3-12.B Factors that would affect the student contribution in the workplace	1. **Formulate a list of what they can bring into the workplace and how each item may impact their job. School subjects; past experiences; self-concept and personality; needs, values and interests; knowledge skills and attitudes; career Priority Standards and plans.** 2. **Demonstrate and contribute to the success of a team.** 3. **Doing a self-assessment of skills using the above list as a guide. Explain how these skills would be valuable to the industry.** 4. **Read and interpret workplace documents.** 5. **Demonstrate ability to respond in writing clearly and concisely.**
3-12.C Develop an awareness of building effective communication in the workplace.	1. **Discuss verbal and non-verbal communication. List ways negative**

	nonverbal communication may be displayed. 2. Role play ways of demonstrating effective verbal communication. 3. Contribute new ideas. 4. Work with initiatives and co-workers.
3-12.D Create a student guide in preparation for an interview.	1. Outline and describe the three stages of an interview –greeting, exchange and parting. 2. Students will role play the stages of the interview.
3-12.E Post interview procedures	1. Follow-up activity after completion of the interview. 2. Review interviews.
3-12. Develop a readiness guide for the worksite.	1. Discuss work site items: transportation; hours of work; absence and tardiness; conflict resolution; role of student, teacher, and workplace supervisor; dress code; job description; expectations



HVAC

Year 2; Semester 2

Bristol TEC 2-Year HVAC Curriculum

Year 2, Semester 2 Curriculum

Priority Standard 4-1: Comprehend industry environmental issues regarding storage and combustion.	
Big Idea(s) 1. **Working safely with fuel oil and understanding its environmental impact ensures responsible energy use and protects communities and ecosystems.**	
Essential Question(s) 1. **What are the possible dangers associated with improper oil storage?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
4-1.1 Dangers associated with fuel oil fumes and leaks	1. **Explain how leaking oil is toxic to animals and plants** 2. **Explain dangers of short-Term Exposure to fumes from heating oil** 3. **Explain long-Term Exposure to heating oil fumes.**
4-1.2 Environmental concerns with fuel oil combustion gases.	1. **Explain with examples dangers of elevated levels of carbon monoxide** 2. **Explain causes of soot and dangers of unburned carbon, unburned oil**
4-1.3 Fuel oil safety	1. **Protect skin from contact with oil** 2. **Demonstrate proper venting while working on burners**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
Boiler	Gap	Combustion
Furnace	Air band	Gun-type burner
Water heater	atomizing	Bleed port
Chimney	Burner fan	Pressure tap plug

Direct vent	Cad cell	Two-stage oil pump
Carbon	Draft control	Single-stage oil pump
Above ground tank	Electrodes	Solid-state igniter
Underground tank	Flexible coupling	Intermittent ignition
Supply line	Ignition transformer	Interrupted ignition
Return oil line	Isolation relay	
Vent pipe	Oil furnace	
Fill pipe	Oil pump	
Oil filter	orifice	
Fuel oil	Primary control	
vaporized	Spray angle	
Viscosity	Stack control	
Vent alarm	Transient light	

Trade Math Crossover: If one gallon of oil produces 140,000 BTU's what size burner nozzle is needed for a house with a calculated heat loss of 100,000 BTU's?

Suggested Resources

- Heating & Cooling Essentials: ISBN 13: 9781631260599
  Chapter 31 Oil Heat w/ A/C
- Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545
  Chapter 42 Oil Fired Heat
- Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5
  Unit 32 Oil Heat
- Beckett/ Carlin Manuals

OSHA.Gov:

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Apprenticeship Correlation

A0791 Oil Burner Controls & Servicing

Bristol TEC 2-Year HVAC Curriculum

VOG Portfolio Collection Examples

Students can present images of themselves wearing proper PPE while working with oil.

(VOG – Work Ready)

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 4-2: Contemporary oil heating appliances.	
Big Idea(s): **1. Becoming familiar with modern oil heating systems prepares technicians to install and maintain efficient, reliable heating solutions.**	
Essential Question(s): **1. How do modern heating appliances integrate technology to enhance energy efficiency, and what impact does this have on both cost and environmental sustainability?**	
Students will know:	*As evidenced by:*
4-2.A Components used in all types of oil systems.	**1. Identify oil systems parts**
4-2.B Types of oil heating appliances ● **Furnaces, Boiler, Water heaters**	**1. Explain the different type of oil appliances** **2. Describe the basic operation of oil heating appliances**
4-2.C The properties of fuel oil #1, #2, #6	**1. Compare the characteristics of fuel oil** **2. Identify the safety concerns related to fuel oil**
4-2.D Characteristics of fuel oil ● **Flash point** ● **Fire point** ● **Viscosity** ● **Carbon Residue** ● **Water and sediment** ● **Pour point** ● **Ash content** ● **Distillation quality**	**1. Explain characteristics of fuel oil**
4-2.E Fuel oil storage ● **One pipe**	**Describe oil tank installation and piping :** **1. One pipe**

• **Two pipe** • **Transfer pump to secondary storage**	**2. Two pipe** **3. Transfer pump to secondary storage**
4-2.F Operation of an oil delay valve Single limits	**1. Operation of an oil delay valve**
4-2.G Oil system limit controls uses • **Single limits** • **Triple aqua stats** • **Fan/limits**	**Testing limit controls** **1. Single limits** **2. Triple aqua stats** **3. Fan/limits**

Tier One Words	*Tier Two Words*	*Tier Three Words*
Boiler	Gap	Combustion
Furnace	Air band	Gun-type burner
Water heater	atomizing	Bleed port
Chimney	Burner fan	Pressure tap plug
Direct vent	Cad cell	Two-stage oil pump
Carbon	Draft control	Single-stage oil pump
Above ground tank	Electrodes	Solid-state igniter
Underground tank	Flexible coupling	Intermittent ignition
Supply line	Ignition transformer	Interrupted ignition
Return oil line	Isolation relay	
Vent pipe	Oil furnace	
Fill pipe	Oil pump	
Oil filter	orifice	
Fuel oil	Primary control	
vaporized	Spray angle	
Viscosity	Stack control	
Vent alarm	Transient light	

Trade Math Crossover: If the maximum allowable indoor gallon of oil is 660 gallons, what are possible tank combinations a customer could have in their house?

Suggested Resources

- Heating & Cooling Essentials: ISBN 13: 9781631260599
  Chapter 31 Oil Heat w/ A/C

- Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545
  Chapter 42 Oil Fired Heat
- Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5
  Unit 32 Oil Heat

Beckett/ Carlin Manuals

OSHA.Gov:

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Apprenticeship Correlation

A0791 Oil Burner Controls & Servicing

VOG Portfolio Collection Examples

A student could present a project outlining the several types of fuel tanks installed in the trade.

(VOG – Work Ready)

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 4-3: Ability to conduct a start-up on oil heating systems.	
Essential Question(s): **1. When performing an efficiency test, what four individual procedures are required and how are they done?**	
Big Idea(s): **1. Proper start-up procedures are vital for verifying safe and effective operation of oil heating systems in residential and commercial applications.**	
Learning Outcomes	
Students will know:	*As evidenced by:*
4-3.A Startup and adjusting oil burners for proper operation to the manufacturer's specifications and efficiency	**1. Demonstrate how to adjust oil burners per manufacturers' instructions.**
4-3. B Safe start-up of oil-fired equipment ● **Choosing nozzle** ● **Bleeding fuel unit** ● **Adjust nozzle pressure** ● **Adjust combustion air coarse and fine** ● **Set electrodes** ● **Blower speeds** ● **Combustion efficiency**	**1. Demonstrate a warm air start-up and make a proper fan speed selection Belt or Direct drive** **2. Demonstrate testing an oil-fired burner Analyzing and adjusting, smoke level, net stack temperature, over-fire draft, and CO2 level to obtain safe combustion.** **3. Service an oil-fired burner with checking the following:** **4. Electrode settings** **5. Flame retention head** **6. Cad cell eye** **7. Oil pump screen** **8. Oil filter** **9. Fuel nozzle**

Bristol TEC 2-Year HVAC Curriculum

12-3.C Order of operation of an oil-fired burner primary cad cell safety control circuit.	**1. Measure resistances of a cad cell under different lighting circumstances.** **2. Perform safety lockout procedures for oil burners**
4-3.D Methods of checking safety limits	**1. Demonstrate the ability to test heating appliance safety systems**
4-3.E Fuel oil combustion	**1. Explain fuel to air adjustment**
4-3.F Oil heating systems adjustment to the proper manufacture specifications	**1. Adjust oil appliances to manufacture specifications**
4-3.G Temperature rise	**1. Explain the procedure necessary to obtain proper temperature rise**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
Boiler	Gap	Combustion
Furnace	Air band	Gun-type burner
Water heater	atomizing	Bleed port
Chimney	Burner fan	Pressure tap plug
Direct vent	Cad cell	Two-stage oil pump
Carbon	Draft control	Single-stage oil pump
Above ground tank	Electrodes	Solid-state igniter
Underground tank	Flexible coupling	Intermittent ignition
Supply line	Ignition transformer	Interrupted ignition
Return oil line	Isolation relay	
Vent pipe	Oil furnace	
Fill pipe	Oil pump	
Oil filter	orifice	
Fuel oil	Primary control	

Vaporized Viscosity Vent alarm	Spray angle Stack control Transient light	

Trade Math Crossover: Follow code requirements to determine fresh air for complete combustion of fuels or ventilation requirements for enclosed spaces

Suggested Resources

- Heating & Cooling Essentials: ISBN 13: 9781631260599
  Chapter 31 Oil Heat w/ A/C
- Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545
  Chapter 42 Oil Fired Heat
- Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5
  Unit 32 Oil Heat

Beckett/ Carlin Manuals

OSHA.Gov:

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Apprenticeship Correlation

A0791 Oil Burner Controls & Servicing

VOG Portfolio Collection Examples

Student could document themselves performing a combustion test on an oil-fired system

(VOG- A Problem Solver)

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 4-4: Systematically troubleshoot and service an oil system.	
Big Idea(s): **1. Effective troubleshooting of oil systems requires critical thinking, technical skills, and adherence to safety protocols to ensure peak system performance.**	
Essential Question(s): **1. What three areas would we investigate when trying to determine the cause for a malfunctioning oil burner?** **2. How do we test ignition and safety controls for operation?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
4-4.A Oil primary control	**1. Demonstrate testing oil primary control**
4-4.B Ignition transformer	**1. Demonstrate testing Ignition transformer**
4-4.C Fuel unit pressures ● **Nozzle** ● **Vacuum**	**Demonstrate testing of fuel unit pressures** **1. Nozzle** **2. Vacuum**
4-4.D Limit controls ● **Single limits** ● **Triple aqua stats** ● **Fan/limits**	**Explain testing limit controls** **1. Single limits** **2. Triple aqua stats** **3. Fan/limits**
4-4.E Clogged oil line Maintenance	**Explain how to clear a clogged oil line**
4-4.F Oil filter Maintenance	**Explain how to change oil filter**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
Boiler	Gap	Combustion
Furnace	Air band	Gun-type burner
Water heater	atomizing	Bleed port

Chimney	Burner fan	Pressure tap plug
Direct vent	Cad cell	Two-stage oil pump
Carbon	Draft control	Single-stage oil pump
Above ground tank	Electrodes	Solid-state igniter
Underground tank	Flexible coupling	Intermittent ignition
Supply line	Ignition transformer	Interrupted ignition
Return oil line	Isolation relay	
Vent pipe	Oil furnace	
Fill pipe	Oil pump	
Oil filter	orifice	
Fuel oil	Primary control	
vaporized	Spray angle	
Viscosity	Stack control	
Vent alarm	Transient light	

Trade Math Crossover: BTU conversions using oil nozzle ratings and oil pump pressure.

Suggested Resources

Heating & Cooling Essentials: ISBN 13: 9781631260599

Chapter 31 Oil Heat w/ A/C

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545

Chapter 42 Oil Fired Heat

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5

Unit 32 Oil Heat

Beckett/ Carlin Manuals

OSHA.Gov:

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Apprenticeship Correlation

A0791 Oil Burner Controls & Servicing

VOG Portfolio Collection Examples

Students can show pictures of themselves replacing oil nozzles or recording cad cell readings using a multimeter. (VOG – Work Ready)

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 4-5: Industry EPA standards for safety and environmental issues regarding refrigerant.	
Big Idea(s): 1. **EPA regulations promote sustainability, and HVAC professionals must follow these guidelines to minimize environmental harm and maintain certification.**	
Essential Question(s): 1. **Can you describe proper safety techniques that go with handling refrigerants?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
4-5.A EPA certification requirements • **Type I** • **Type II** • **Type III** • **Universal**	1. **Explain differences in certification types.** 2. **Decide which type is right for them**
4-5.B Proper storage and handling of refrigerants.	1. **Explain safe refrigerant handling and applications**
4-5.C Isolate system components.	1. **Describe and demonstrating how to isolate system components according to EPA regulations**
4-5.D Manually pump down a system	1. **Demonstrate manual pump down of systems.**
4-5.E Recycled and reclaimed refrigerant.	1. **Describe system dependent and self-contained recovery equipment**
4-5.F System recovery	1. **Demonstrate proper system recovery with different methods available**
4-5.G Perform the methods of determining when a recovery cylinder is full	1. **Determine when a recovery cylinder is full or will be full.**

Bristol TEC 2-Year HVAC Curriculum

4-5.H Problems associated with contaminants left in a refrigerant system after recovery	**1. Describe the problems associated with contaminants left in a refrigerant system after recovery.**
4-5.I Problems associated with mixing of refrigerants	**1. Explain the problems associated with mixing of refrigerants and how to deal with mixed refrigerants**
4-5.J Charge a system using; Frost pattern, Weight, Pressure/temperature including superheat/sub-cooling	**1. Demonstrate proper system charging**
4-5.K ASHRAE Refrigerant Safety Classifications of Refrigerants for Toxicity and Flammability.	**1. Explain the different classes of refrigerants, physical and chemical properties**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
Active recovery	Ozone depletion potential (ODP)	Active recovery
Atmospheric balancing	Global warming potential (GWP)	Back seated valve
Capture	De minimus	Front seated valve
Chlorine	EPA certification	CFC
Clean Air Act (CAA)	Universal certification	HFC
Environmental Protection Agency(EPA)		HCFC
Global warming		Mid-seated valve
Hazardous waste		Low-loss fitting
Montreal Protocol		Motor vehicle air conditioning (MVAC)
Pump down		Passive recovery
Reclaim		Recovery cylinder
Recover		
Recycle		
Refrigerants		

Trade Math Crossover: Use tank weight listed on recovery bottles and calculate percentages to ensure they are not over filled.		

Suggested Resources

Heating & Cooling Essentials: ISBN 13: 9781631260599

Chapter 13 Refrigerants

Chapter 14 zeotropic Blends

Chapter 15 Refrigerant recovery

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545

Section 4 Refrigerants

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5

Unit 9 Refrigerant management

OSHA.Gov:

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Apprenticeship Correlation

A0787 EPA Refrigerant Standards

VOG Portfolio Collection Examples

Demonstrate refrigerant handling tools for use, such as vacuum pump, scale, recovery machine.

(VOG – An Effective Communicator)

Project: Zero-Tolerance Recovery Simulation: Description: Students must demonstrate proper system recovery and charging while strictly following EPA regulations to prevent environmental harm. They must

evaluate the risks of mixing refrigerants and use weight/pressure methods for precision. (VOG Alignment: Critical Thinker.)

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 4-6: Describe the mechanical refrigeration cycle and be able to troubleshoot problems.	
Big Idea(s): **1. Understanding the mechanical refrigeration cycle enables technicians to detect faults, make repairs, and ensure consistent system cooling.**	
Essential Question(s): **1. How does understanding the mechanical refrigeration cycle help technicians diagnose and resolve common system malfunctions, and what are the key indicators of potential issues at each stage of the cycle?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
4-6.A Refrigeration system's performance ● **Evaporator** ● **Condenser** ● **Compressor**	**1. Demonstrate the proper use and installation of refrigeration gauges.** **2. Verify a system is properly charged** **3. Be able to explain testing procedures** **4. Identify requirements to check evaporator performance** **5. Identify requirements to check condenser performance** **6. Identify requirements to check compressor performance**
4-6.C Service valve positions ● **Front seat, Mid seat, Back seat**	**1. Demonstrate how to front, mid and back seat position for proper operation of 3-way service valves.**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
Basic refrigeration cycle	Condensation	Accumulator
Compressor	Evaporation	Crankcase heater
Condenser	High-pressure side	Cooling tower

Conduction	Hot Gas discharge line	Filter drier
Convection	Liquid line	Flash gas
Evaporator	Low-pressure side	Off cycle
Metering device	Pressure drop	On cycle
	Reciprocating	Liquid receiver
	Refrigerant	Series connection
	Subcooled	Temperature difference (td)
	Suction line	Thermostatic expansion valve
	Superheat	

Trade Math Crossover: Measure line set length to determine correct number of ounces needed to properly charge refrigeration equipment.

Suggested Resources

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545

Chapter 53, 54 Trouble shooting Commercial systems

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-64447-5

Trouble Shooting & Typical Operating Conditions for Commercial Refrigeration

OSHA.Gov:

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Apprenticeship Correlation

A0721 Refrigeration Special Systems

VOG Portfolio Collection Examples

Students can present a demonstration how to position service valves for gauge hookup

(VOG- A problem Solver)

Priority Standard 4-7: Testing procedures of an air-conditioning system	
Big Idea(s): **1. Thorough start-up and testing procedures validate that air conditioning systems operate correctly and efficiently upon installation or service.**	
Essential Question(s): **1. How do specific testing procedures for an air conditioning system ensure its optimal performance and longevity, and what are the key indicators that help technicians identify when the system is underperforming?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
4-7.A Tools and instruments needed for checking out air-conditioning and heating systems for proper operation. ● **Manifold Gauges** ● **Thermometers** ● **Amp meters** ● **Velocity meters** ● **Psychrometer** ● **Oil pump** ● **Leak detectors** ● **Micron meters**	**1. Use and demonstrate proper techniques with various tools and instruments needed for checking and testing combination air-conditioning and heating systems.**
4-7.B Air-conditioning components. ● **System Charge** ● **Motor Amperage** ● **Air flow** ● **Safety controls**	**1. Check system operation while following all safety procedures.** **2. Determine equipment electrical, mechanical and code requirements.** **3. Verify equipment air flow and distribution requirements.**

• **Voltages** • **3 phase motor rotation**	**4. Demonstrate checking operation of electrical control components such as isolating relays etc.** **5. Check for correct superheat and sub-cool, adjust to manufacturers' specifications**
4-7.C Methods for properly charging a system	**1. Demonstrate proper system charging by weight and superheat & sub-cooling, PT relationships**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
Refrigeration	Liquid line	Vapor
Amperage	Suction line	Saturated
Supply	Gauge pressure	Superheat
Return	Service valve	Sub cooling
Register	Gas	Cfm
Condensing unit	Liquid	Heat gain
Air handler	btu	Solar gain
Evaporator		Watts
Line set		
Insulation		
Thermostat		

Trade Math Crossover: Superheat/subcooling conversions, cfm calculations based on heat gain conversions.

Suggested Resources

Heating & Cooling Essentials: ISBN 13: 9781631260599

Chapter 16 System evacuation & Recharging

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5

Unit 36 Refrigeration Applied to Air Conditioning

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545

Chapter 53, 54 Trouble shooting Commercial systems

Various Install Manuals from OEM Equipment

OSHA.Gov:

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Apprenticeship Correlation

A0785 Air Conditioning

A0790 Forced Air Heating & Cooling

VOG Portfolio Collection Examples

Perform an amp draw test of compressor while charging, demonstrate refrigerant manifold gauge use. (VOG – Work Ready)

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 4-8: Theory of a heat pump systems operation and its functioning ability	
Big Idea(s): 1. **Heat pumps offer year-round comfort, and understanding their operation allows technicians to service systems that reduce energy use and carbon impact.**	
Essential Question(s): 1. **What are the advantages of energy efficient systems? How can an AC system be used to heat? Can you identify the components of a heat pump? Do you understand why a heat pump must have a defrost cycle?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
4-8.A Identify the components of the heat pump systems, • **Electrical** • **Defrost system** • **Reversing valve** • **Crankcase heater** • **Supplemental heat** • **Mechanical** • **Reversing vale** • **Metering devices** • **Check Valves**	1. **Ability to identify the components of the heat pump system and understand the difference compared to a standard air conditioning system.** 2. **Explain the operation of the heat pump components**
4-8.B Heat pump system's performance	1. **Show understanding of COP and balance point, evaluating heat pump performance.**
4-8.C Recommend a repair, then validate and make the repair with proper trade techniques.	1. **Show troubleshooting techniques both in (electrical and mechanical) on a heat-pump system. (VOG-Problem Solver)**
4-8.D The history of heat pumps • **Air to air**	1. **Explain the history of heat pump systems as well as different types used.**

- **Geothermal**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
Air coil Auxiliary heat Balance point charge Compensator tank demand defrost Heat pump Flow check piston Ground coil Ground loop Indoor coil Outdoor coil riser Water coil Water loop	Air-source heat pump (ASHP) Air-to-air heat pump Air-to-water heat pump Pilot-operated reversing Valve Reverse cycle	Biflow bypass TXV Biflow metering TXV Biflow thermostatic expansion valve Closed-loop ground-source heat pump System Direct-acting reversing valve Direct exchange (DX) Ground-source heat pump (GSHP) Open-loop ground-source Heat pump system Water-source heat pump(WSHP

Trade Math Crossover: Calculate different size rooms for heat loss and then determine correct cfm needed for proper duct installations.

Suggested Resources

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5

Unit 43 Air Source Heat Pumps

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545

Chapter 40 Heat Pumps

Heating & Cooling Essentials: ISBN 13: 9781631260599

Chapter 33 Heat Pumps

OSHA.Gov:

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Apprenticeship Correlation

A0785 Air Conditioning

VOG Portfolio Collection Examples

Students could present the different components of a heat pump while describing their functions.

(VOG – An Effective Communicator)

Project: Energy Efficiency Comparison Study: Description: Students evaluate the performance of a heat pump versus a standard AC system, calculating the Coefficient of Performance (COP) and balance points to recommend energy-efficient repairs for a customer. **VOG** - **Problem Solver**.

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 4-9: Systematically troubleshoot and service an air conditioning system.	
Big Idea(s): **1. Advanced diagnostic skills in air conditioning systems reduce downtime and improve customer satisfaction through precise, timely repairs.**	
Essential Question(s): **1. When troubleshooting for a suspected electrical problem, list a good step by step procedure to take us to the problem?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
4-9. Air conditioning systems performance and operating problems ● **High, high side pressure** ● **High, low side pressure** ● **Low, high side pressure** ● **Low, low side pressure** ● **Improper pressure differential** ● **Evaporator frosting** ● **Air flow problems high and low side** ● **Low voltages, control** ● **High voltages, control** ● **Open Electrical loads** ● **Electrical Shorts** ● **Contact resistance** ● **Bad capacitors** ● **Faulty starting components** ● **Worn belts**	**1. Give an overview of the history as well as different types of air conditioning systems** **2. Identify the components (electrical and mechanical) of the high efficiency air conditioning system and understanding the difference compared to a standard air conditioning system. (VOG-Critical Thinker)** **3. Explain the operation of the components and typical failures of each.** **4. Demonstrate troubleshooting techniques both in (electrical and mechanical) on an air conditioning system.** **5. Demonstrate use of tools and test equipment following safety practices.**

• **Worn bearings**	
4-9.B Heating Systems repair	**1. Identify potential causes of system failure** **2. Describe how to correct problems** **3. Make repairs** **4. Explain why a component failed accurately**
4-9.C Air conditioning system problems	**1. Pass test on air conditioning system problems**
4-9.D Typical heating system problems	**1. Pass test on heating system problems**
4-9.E Electrical test instruments to diagnose electrical troubles	**1. Pass test on HVAC electrical problems** **2. Use electrical test instruments to diagnose electrical troubles and correct electrical system problems (VOG-Problem Solver)**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
Refrigeration	Liquid line	Vapor
Amperage	Suction line	Saturated
Supply	Gauge pressure	Superheat
Return	Service valve	Sub cooling
Register	Gas	Cfm
Condensing unit	Liquid	Heat gain
Air handler	btu	Solar gain
Evaporator		Watts
Line set		
Insulation		
thermostat		

Trade Math Crossover: Use compressor ohm readings to determine run and start windings while wiring starting components.

Suggested Resources

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545

Chapter 54,54,55 Trouble shooting appendix B

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5

Unit 41 Trouble Shooting

OSHA.Gov:

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Apprenticeship Correlation

A0785 Air Conditioning

A0790 Forced Air Heating & Cooling

VOG Portfolio Collection Examples

Students can show evidence of condensing unit wiring highlighting contactor and capacitor wiring.

(VOG – A Critical Thinker)

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 4-10: Become acquainted with hydronic heating systems	
Big Idea(s): **1. Hydronic systems offer efficient, even heating, and understanding their components and applications expands a technician's skill set and service options.**	
Essential Question(s): **1. If air needs to be removed from the system how do the circulator, air scoop and vent work together to purge out the air?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
4-10.A Components of hydronic heating systems.	**Explain the purpose of the hydronic heating system component.** **1. Expansion tank** **2. Air scoop** **3. Auto feeder** **4. Backflow preventer** **5. Auto Vent** **6. Bleeder** **7. Flow check Valve** **8. Circulator** **9. Boiler P/T gauge** **10. Pressure relief** **11. Low water cut-off** **12. Size Solar pump equipment and accessories based on manufacturers specifications for specific applications.** **13. (Reference NABCEP 8.6, 8.7, 9.3) Determine pump location for solar thermal installations**

	14. Install the solar thermal pump according to the manufacturer's installation manual **15. Install photovoltaic module controller and pump**
4-10.B Requirements of water pressure in hydronic systems to ensure water will be at the highest point in a system	**1. Correct pressurizing a Hydronic system to insure water to proper level**
4-10.C Air bleeding a hydronic system	**1. Purge from a hydronic system**
4-10.D Anti-freeze protection	**1. Explain when anti-freeze is required**
4-10.E Effects of anti-freeze on heat transfer	**1. Explain how anti-freeze reduces the ability to transfer heat (specific heat is lower than water)**

Tiered Vocab:

Tier One Words	Tier Two Words	Tier Three Words
Air bound	Condensing boiler	Direct return hydronic system
Air scoop	Conventional boiler	Reverse return system
Air vent	Dry-base boiler	Thermostatic mixing valve
aqua stat	Underfloor radiant	Two pipe hydronic system
Backflow preventer	heating system	Wet base boiler
DE aeration	Expansion steam trap	
Expansion tank	Fan convector	
High limit control	Flow-control valve	
Mixing valve		
Water feeder		
Circulator pump		
Relief valve		
Zone valve		

Radiator Series loop Steam Boiler drain Low water cutoff		

Trade Math Crossover: If we consider conventional baseboard to be rated at 500 btus per foot how much is needed in a room that requires 12000 btus?

Suggested Resources

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545

Chapter 39 Hydronic heating Fundamentals

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5

Unit 33 Hydronic Heat

OSHA.Gov:

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Apprenticeship Correlation

A0789 Heating Hydronic & Steam

VOG Portfolio Collection Examples

Students can present boiler piping projects including all necessary near boiler components.

(VOG – Work Ready)

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 4-11: Startup and testing procedures of a hydronic system	
Big Idea(s): **1. Testing and starting up hydronic systems ensure balanced operation and optimal performance across modern radiant heating installations.**	
Essential Question (s): **1. How do the startup and testing procedures of a hydronic heating system ensure proper operation and system longevity, and what critical factors should technicians monitor during these processes to prevent potential system failures?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
4-11A. Purge a hydronic system of air	**1. Use proper techniques to correctly purge hydronic systems of air.**
4-11.B Water pressure in hydronic systems to ensure water will be at the highest point in a system	**1. Correct pressurizing a hydronic system to insure water to proper level**
4-11.D Anti-freeze protection requirements	**1. Explain when anti-freeze is required**
4-11.E Anti-freeze on heat transfer	**1. Explain how anti-freeze reduces the ability to transfer heat (specific heat is lower than water)**
4-11.F Anti-freeze protection level testing	**1. Explain how to test anti-freeze level with appropriate tester**

Tiered Vocab:		
Tier One Words	Tier Two Words	Tier Three Words

Air bound	Condensing boiler	Direct return hydronic system
Air scoop	Conventional boiler	Reverse return system
Air vent	Dry-base boiler	Thermostatic mixing valve
aqua stat	Underfloor radiant	Two pipe hydronic system
Backflow preventer	heating system	Wet base boiler
DE aeration	Expansion steam trap	
Expansion tank	Fan convector	
High limit control	Flow-control valve	
Mixing valve		
Water feeder		
Circulator pump		
Relief valve		
Zone valve		
Radiator		
Series loop		
Steam		
Boiler drain		
Low water cutoff		

Trade Math Crossover: Using boiler psi how much is needed to raise water 20 feet?

Suggested Resources

Modern Refrigeration & Air Conditioning ISBN 13: 9781631263545

Chapter 39 Hydronic heating Fundamentals

Refrigeration and Air Conditioning Technology ISBN 13: 978-1-111-64447-5

Unit 33 Hydronic Heat

Burnham Heating Helper

OSHA.Gov:

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10593

Apprenticeship Correlation

A0789 Heating Hydronic & Steam

VOG Portfolio Collection Examples

Students can present purging air from hydronic lines connected to a boiler.

(VOG – Work Ready)

Bristol TEC 2-Year HVAC Curriculum

Priority Standard 4-12: Workplace skills for inside and outside production and the possibility of Work based Learning (WBL)	
Big Idea(s): **1. Success in the workplace depends on understanding expectations, practicing safe and respectful behavior, and building strong communication and teamwork skills—both in the classroom and through real-world experiences like Work-Based Learning.**	
Essential Question(s): **1. What are some possibilities that can happen if you disregard safety at a job site?** **2. Could you explain safety and how it applies to the HVAC trade?**	
Learning Outcomes	
Students will know:	*As evidenced by:*
4-12.A Work-based learning.	**1. Define expectations of each partner.** **2. Refer to the Work Study Guidelines for roles and expectations.** **3. Come to work every day on time.** **4. Take directions.** **5. Motivateto accomplish the task at hand.**
4-12.B The student contribution in the workplace	**1. Formulate a list of what they can bring into the workplace and how each item may impact their job. School subjects; past experiences; self-concept and personality; needs, values and interests; knowledge skills and attitudes; career goals and plans.** **2. Demonstrate contributing to the success of a team.** **3. Read and interpret workplace documents.** **4. Demonstrate ability to respond in writing clearly and concisely.**
4-12.C Communication in the workplace.	**1. Discuss verbal and non-verbal communication. List ways negative nonverbal communication may be displayed.** **2. Role play ways of demonstrating effective verbal communication.** **3. Contribute innovative ideas.** **4. Work with initiatives and co-workers.** **5. Communicate effectively with co-workers and customers.**
4-12.D Create a student guide in preparation for an interview.	**1. Outline and describe the three stages of an interview –greeting, exchange and parting.** **2. Role playing the stages of the interview.**

4-12.E Post interview process	**1. Follow-up activity after completion of the interview.** **2. Review an interview.**
4-12.F Develop a ready-made guide for the worksite.	**1. Discuss work site items: transportation; hours of work; absence and tardiness; conflict resolution; role of student, teacher, and workplace supervisor; dress code; job description; expectations**
4-12.G Discuss feedback from the work placement.	**1. Provide feedback about work placement.** **2. Understand the guidelines for placement.**