

2005 Mississippi Curriculum Framework

Secondary Heating and Air Conditioning

(Program CIP: 47.0201 – Heating, Air Conditioning, Ventilation, and Refrigeration Maintenance Technology/Technician)

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Foreword

Secondary vocational-technical education programs in Mississippi are faced with many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing true learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, Mississippi Code of 1972, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, ch. 487, §14; Laws, 1991, ch. 423, §1; Laws, 1992, ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act III, 1998; and No Child Left Behind Act of 2001).

Each secondary vocational-technical course consists of a series of instructional units which focus on a common theme. All units have been written using a common format which includes the following components:

- Unit Number and Title
- Suggested Time on Task - An estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75-80 percent of the time in the course.
- Competencies and Suggested Objectives
 - A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies.
 - The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.
- Suggested Teaching Strategies - This section of each unit indicates strategies that can be used to enable students to master each competency. Emphasis has been placed on strategies which reflect active learning methodologies. Teachers should feel free to modify or enhance these suggestions based on needs of their students and resources available in order to provide optimum learning experiences for their students.
- Suggested Assessment Strategies - This section indicates strategies that can be used to measure student mastery. Examples of suggested strategies could include rubrics, class participation, reflection, and journaling. Again, teachers should feel free to modify or enhance these suggested assessment strategies based on local needs and resources.

- Integrated Academic Topics, Workplace Skills, Technology Standards, and Occupational Standards - This section identifies related academic topics as required in the Subject Area Assessment Program (SATP) in Algebra I, Biology I, English II, and U. S. History from 1877, which are integrated into the content of the unit. It also identifies the general workplace skills as identified in the Secretary's Commission on Achieving Necessary Skills (SCANS) report as being critical for all workers in the 21st Century. In addition, national technology standards and occupational skills standards associated with the competencies and suggested objectives for the unit are also identified.
- References - A list of suggested references is provided for each unit. The list includes some of the primary instructional resources that may be used to teach the competencies and suggested objectives. Again, these resources are suggested and the list may be modified or enhanced based on needs and abilities of students and on available resources.

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Program Description

Heating and Air Conditioning is an instructional program designed to teach students to install, operate, test, repair, and maintain residential heating and air conditioning systems. Upon successful completion of the program, the student should be prepared for an entry level heating and air conditioning technician or related position and may pursue postsecondary education.

Certification by the National Center for Construction Education and Research (NCCER):

This curriculum has been aligned to modules in the Contren Learning Series as endorsed by the National Center for Construction Education and Research (NCCER). Students who study this curriculum using the Contren Learning Series materials under the supervision of an instructor who has been certified by the NCCER are eligible to be tested on each module. Students who successfully pass these tests may be certified to the NCCER by the instructor and will receive documentation from NCCER.

Course Outline

Heating and Air Conditioning I

Course CIP Code: 47.0201

Unit	Title	Hours
Unit 1:	Introduction and Orientation	12.0
Unit 2:	Basic Safety	18.0
Unit 3:	Basic Math	18.0
Unit 4:	Hand and Power Tools	15.0
Unit 5:	Introduction to Blueprints	7.5
Unit 6:	Basic Rigging	10.0
Unit 7:	Manifold Gauges and Refrigerant Cylinder	25.0
Unit 8:	Leak Detection and Vacuum Pump/Recovery Service Operations	38.0
Unit 9:	Copper and Plastic Tubing Practices	40.0
Unit 10:	Soldering and Brazing Procedures	40.0

Heating and Air Conditioning II

Course CIP Code: 47.0290

Unit	Title	Hours
Unit 1:	Orientation Review	12.0
Unit 2:	Basic Safety (Review and Reinforcement)	18.0
Unit 3:	Basic Electricity	40.0
Unit 4:	Introduction to Heating	61.0
Unit 5:	Introduction to Air Conditioning	66.0

Heating and Air Conditioning I
Unit 1: Introduction and Orientation

(12 hours)

Competencies and Suggested Objectives	Suggested Strategies for Competencies
<p>1. Describe local program and vocational center policies and procedures.</p> <p>a. Describe local program and vocational center policies and procedures including dress code, attendance, academic requirements, discipline, and transportation regulations.</p>	<p>Teaching:</p> <ul style="list-style-type: none"> • Present local program and vocational center policies and procedures. • Students will read the handbook to become aware of what is expected of them in relation to the policies and procedures of the school. This will include dress code, attendance, academic requirements, discipline, and transportation regulations. Students will work together in pairs. A student with a higher reading ability will team up with a student with a lower reading ability to get a better understanding of the school’s program policies and procedures.^{E2, E3, E8} <p>Assessment:</p> <ul style="list-style-type: none"> • Students will have a test on applicable policies and procedures. • Students will submit written report on rules and regulations. • Explanation of local student handbook requirements. • Exercises to identify equipment and functions found in the school lab. • Assess student orientation knowledge through teacher observations and written unit test. File completed test to document student mastery of the school and program policies and procedures.
<p>2. Describe employment opportunities and responsibilities.</p> <p>a. Describe employment opportunities including potential earnings, employee benefits, job availability, place of employment, working conditions, and educational requirements.</p> <p>b. Describe basic employee responsibilities.</p>	<p>Teaching:</p> <ul style="list-style-type: none"> • Use the Contren Series Core Text, Basic Employability Skills Unit to define trade terms related to basic employability skills. Discuss the chapter and perform the related activities to promote awareness of employability skills.^{E2} • Students will use career software, such as Choices, to measure their aptitudes and abilities for particular careers.^{E3, E8} • Students will use the Internet to research a list of careers for which they will be qualified upon program completion.^{E2, E3, E4,}

	<p>E5, E10</p> <ul style="list-style-type: none"> • Students will use available resources (college catalogs, college websites) to research information about postsecondary educational opportunities. ^{E2, E3, E4, E5, E10} • Students will select a career in the field and outline educational and skill requirements, expected job growth, and entry-level salaries. ^{E1, E3, E8, E9} • Discuss the parts of a resume and cover letter, and/or job application and provide each student a written sample. • Have each student use the Internet or newspapers to choose a job for which they are qualified and prepare a resume and cover letter that can be used to apply for the selected job. ^{E1, E2, E4, E10} <p>Assessment:</p> <ul style="list-style-type: none"> • Assessment will be determined by matching test for definitions and the level of success regarding the Contren activities. Lessons involving writing and math skill will be integrated with the appropriate department. • Use a checklist to evaluate the resume and cover letter. • Use a checklist to evaluate the presentation. • Review career software printout to assess student aptitudes and abilities.
<p>3. Explore leadership skills and personal development opportunities provided students by student organizations to include SkillsUSA.</p> <ol style="list-style-type: none"> a. Demonstrate effective teambuilding and leadership skills. b. Practice appropriate work ethics. 	<p>Teaching:</p> <ul style="list-style-type: none"> • Discuss the role of a team member and leader. Assign the students roles within a team and have them role play a situation in which there is a conflict which must be resolved. Utilize the lessons from SkillsUSA, Contren Tools for Success, or other resources to provide additional training. ^{E3, E8} • Discuss appropriate work ethics standards. Have the students list what they believe to be the most common problems within the HVAC profession. <p>Assessment:</p> <ul style="list-style-type: none"> • Assess the role play using a checklist for documentation. • Lessons from other resources should be

	<p>assessed according to the recommended resource guide.</p>
<p>4. Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations.</p>	<p>Teaching:</p> <ul style="list-style-type: none"> • Have the students perform an activity involving verbal instructions. Divide the students into groups and have one team be the customer and the other be the contractor. The customer will describe the project and the contractor will have to provide a brief plan for the construction of the project. Have the groups switch roles and the customer will provide the contractor with a written plan and blueprint. The contractor will describe the procedure for construction of the project.^{E2, E3, E4, E8} <p>Assessment:</p> <ul style="list-style-type: none"> • The lesson will be assessed using a rubric or a checklist for the written projects and presentation.
<p>5. Discuss the basic principles of heating, ventilation, and air conditioning to include materials and techniques.</p>	<p>Teaching:</p> <ul style="list-style-type: none"> • Discuss the history and principles of HVAC and utilize the Contren Level I Introduction to HVAC Unit. Have the students research the history of HVAC to present day and develop a short presentation on each topic. The students will present to the class.^{H1, H2} • Students will perform an activity relating to principles of HVAC and the Clean Air Act using the Contren Level I Introduction to HVAC Unit.^{E2, E3, E4, E8} <p>Assessment:</p> <ul style="list-style-type: none"> • Assess the presentation using a checklist. • Activity will be assessed using the Contren Level I materials.

STANDARDS

Contren Learning Series Best Practices

Core Curriculum Best Practices

COM1 Demonstrate the ability to understand information and instructions that are presented in both written and verbal form.

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COM2 Demonstrate the ability to communicate effectively in on-the-job situations using written and verbal skills.

EMP1 Explain the construction industry, the role of the companies that make up the industry, and the role of individual professionals in the industry.

EMP2 Demonstrate critical thinking skills and the ability to solve problems using those skills.

EMP3 Demonstrate knowledge of computer systems and explain common uses for computers in the construction industry.

EMP4 Demonstrate effective relationship skills with teammates and supervisors, exhibit the ability to work on a team, and demonstrate appropriate leadership skills.

EMP5 Be aware of workplace issues such as sexual harassment, stress, and substance abuse.

Level I

INT1 Explain the basic principles of heating, ventilation, and air conditioning.

INT2 Identify career opportunities available to people in the HVAC trade.

INT3 Explain the purpose and objectives of an apprentice training program.

INT4 Describe how certified apprentice training can start in high school.

INT5 Describe what the Clean Air Act means to the HVAC trade

Academic Standards

A5 Utilize various formulas in problem-solving situations.

E1 Produce writing which reflects increasing proficiency through planning, writing, revising, and editing and which is specific to audience and purpose.

E2 Communicate ideas for a variety of school and other life situations through listening, speaking, and reading aloud.

E3 Read, evaluate, and use print, non-print, and technological sources to research issues and problems, to present information, and to complete projects.

E4 Work individually and as a member of a team to analyze and interpret information, to make decisions, to solve problems, and to reflect, using increasingly complex and abstract thinking.

E5 Complete oral and written presentations which exhibit interaction and consensus within a group.

E9 Sustain progress toward fluent control of grammar, mechanics, and usage of standard English in the context of writing and speaking.

E10 Use language and critical thinking strategies to serve as tools for learning.

H1 Explain how geography, economics, and politics have influenced the historical development of the United States in the global community.

H2 Describe the impact of science and technology on the historical development of the United States in the global community.

Workplace Skills for the 21st Century

- WP2 Acquires, evaluates, organizes and maintains, and interprets/communicates information, including the use of computers.
- WP3 Practices interpersonal skills related to careers including team member participation, teaching other people, serving clients/customers, exercising leadership, negotiation, and working with culturally diverse.
- WP6 Employs thinking skills including creative thinking, decision making, problem solving, reasoning, and knowing how to learn.
- WP7 Basic Skills: Employs basic academic skills including reading, writing, arithmetic and mathematics, speaking, and listening.
- WP8 Personal Qualities: Practices work ethics related to individual responsibility, integrity, honesty, and personal management

National Educational Technology Standards for Students

- T1 Basic operations and concepts
- T3 Technology productivity tools

Suggested References

- Choices [Computer software]. Ogdensburg, NY: Careerware, IMS Information Systems Management.
- Davies, D. (1997). *Grammar? No problem!* Mission, KS: SkillPath.
- Gould, M. C. (2002). *Developing literacy & workplace skills*. Bloomington, IN: National Education Service.
- Jeffus, L. (2004). *Refrigeration and air conditioning*. Upper Saddle River, NJ: Pearson Prentice Hall.
- Local District Policy Handbook
- National Center for Construction Education and Research. (2004). *Core curriculum*. Upper Saddle River, NJ: Pearson Prentice Hall.
- National Center for Construction Education and Research. (2001). *HVAC level I*. Upper Saddle River, NJ: Pearson Prentice Hall.
- National Center for Construction Education and Research. (2004). *Tools for success*. Upper Saddle River, NJ: Pearson Prentice Hall.
- SkillsUSA. (2002). *Leadership and competition curricula*. Tinley Park, IL: Goodheart-Wilcox.

Heating and Air Conditioning I
Unit 2: Basic Safety

(18 hours)

Competencies and Suggested Objectives	Suggested Strategies for Competencies
<p>1. Describe general safety rules for working in a shop/lab and industry.</p> <ol style="list-style-type: none"> a. Describe how to avoid on-site accidents. b. Explain the relationship between housekeeping and safety. c. Explain the importance of following all safety rules and company safety policies. d. Explain the importance of reporting all on-the-job injuries, accidents, and near misses. e. Explain the need for evacuation policies and the importance of following them. f. Explain the employer’s substances abuse policy and how it relates to safety. g. Explain the safety procedures when working near pressurized or high temperature. 	<p>Teaching: This can be used for the entire unit.</p> <ul style="list-style-type: none"> • Identify, discuss, and demonstrate terms, rules, and procedures related to shop/lab and industry safety (Contren Core Text Basic Safety Unit).^{E3, E8} • Required written tests will follow each section of guidelines for safety rules and procedures. • Provide the students with a list of terms and have them define the terms. Pair the students to quiz each other on the definitions in preparation for a written exam.^{E2, E3, E4, E8} • Use the guidelines provided for personal safety (i.e., clothing, jewelry, hair, eyes, and ears). Divide the students into pairs and assign each pair one of the guidelines. Each pair will demonstrate the “do’s and don’ts” of the guideline. • Have an industry speaker present to the class the necessity of safety in the work environment. The students will write a summary of the presentation.^{E1, E2, E9} • Divide the students into teams and have them develop scenarios of hazards and accidents using the Contren Series Core Text, Basic Safety Unit, other publications, and the Internet. This will include tools, spills, working around welding, improper use of barriers, ladders or scaffolds, use of MSDS information, fires, and electrical situations. In a game type situation, one team will read a scenario and the other teams will compete to be the first to provide the proper safety measures which should have been used to prevent the hazardous situation or accident. Points will be awarded to the teams with the correct answers.^{E2, E4} • Required written tests will follow each section of guidelines for safety rules and
<p>2. Identify and apply safety around welding operations.</p> <ol style="list-style-type: none"> a. Use proper safety practices when welding or working around welding operations. b. Use proper safety practices when welding in or near trenches and excavations. c. Explain the term <i>proximity work</i>. 	
<p>3. Identify and explain use of various barriers and confinements.</p> <ol style="list-style-type: none"> a. Explain the safety requirements for working in confined areas. b. Explain and practice lockout/tagout procedures. c. Explain the different barriers and barricades and how they are used. d. Recognize and explain personal protective equipment. e. Inspect and care for personal protective equipment. 	

<p>4. Explain lifting and the use of ladders and scaffolds.</p> <ol style="list-style-type: none"> Identify and explain the procedures for lifting heavy objects. Inspect and safely work with various ladders and scaffolds. 	<p>procedures.</p> <ul style="list-style-type: none"> NOTE: SAFETY IS TO BE TAUGHT AS AN ONGOING PART OF THE COURSE THROUGHOUT THE YEAR. <p>Assessment:</p> <ul style="list-style-type: none"> Student participation will be monitored by the teacher and the written exam will be graded. The “do’s and don’ts” exercise will be critiqued with a peer review. The summary of the speaker’s presentation will be critiqued using a rubric. The teams will be rewarded according to the points earned from the game. This could be extra points, classroom privileges, etc. Written exams will be graded.
<p>5. Explain the Material Safety Data Sheet (MSDS).</p> <ol style="list-style-type: none"> Explain the function of the MSDS. Interpret the requirements of the MSDS. 	
<p>6. Explain fires.</p> <ol style="list-style-type: none"> Explain the process by which fires start. Explain fire prevention of various flammable liquids. Explain the classes of fire and the types of extinguishers. 	
<p>7. Explain safety in and around electrical situations.</p> <ol style="list-style-type: none"> Explain injuries when electrical contact occurs. Explain safety around electrical hazards. Explain action to take when an electrical shock occurs. 	

STANDARDS

Contren Learning Series Best Practices

Core Curriculum Best Practices

- SAF1 Identify the responsibilities and personal characteristics of a professional craftsperson.
- SAF2 Explain the role that safety plays in the construction crafts.
- SAF3 Describe what job-site safety means.
- SAF4 Explain the appropriate safety precautions around common job-site hazards.
- SAF5 Demonstrate the use and care of appropriate personal protective equipment.
- SAF5 Follow safe procedures for lifting heavy objects.
- SAF6 Describe safe behavior on and around ladders and scaffolds.
- SAF7 Explain the importance of the HazCom (Hazard Communication Standard) requirement and MSDSs (Material Safety Data Sheets).
- SAF8 Describe fire prevention and fire fighting techniques.
- SAF9 Define safe work procedures around electrical hazards.

Academic Standards

- A5 Utilize various formulas in problem-solving situations.
- E1 Produce writing which reflects increasing proficiency through planning, writing, revising, and editing and which is specific to audience and purpose.
- E2 Communicate ideas for a variety of school and other life situations through listening, speaking, and reading aloud.
- E3 Read, evaluate, and use print, non-print, and technological sources to research issues and problems, to present information, and to complete projects.
- E4 Work individually and as a member of a team to analyze and interpret information, to make decisions, to solve problems, and to reflect, using increasingly complex and abstract thinking.
- E5 Complete oral and written presentations which exhibit interaction and consensus within a group.
- E9 Sustain progress toward fluent control of grammar, mechanics, and usage of standard English in the context of writing and speaking.
- E10 Use language and critical thinking strategies to serve as tools for learning.

Workplace Skills for the 21st Century

- WP2 Acquires, evaluates, organizes and maintains, and interprets/communicates information, including the use of computers.
- WP3 Practices interpersonal skills related to careers including team member participation, teaching other people, serving clients/customers, exercising leadership, negotiation, and working with culturally diverse.
- WP6 Employs thinking skills including creative thinking, decision making, problem solving, reasoning, and knowing how to learn.
- WP7 Basic Skills: Employs basic academic skills including reading, writing, arithmetic and mathematics, speaking, and listening.
- WP8 Personal Qualities: Practices work ethics related to individual responsibility, integrity, honesty, and personal management

National Educational Technology Standards for Students

- T1 Basic operations and concepts
- T3 Technology productivity tools

Suggested References

- Jeffus, L. (2004). *Refrigeration and air conditioning*. Upper Saddle River, NJ: Pearson Prentice Hall.
- National Center for Construction Education and Research. (2004). *Core curriculum*. Upper Saddle River, NJ: Pearson Prentice Hall.

National Center for Construction Education and Research. (2001). *HVAC level I*. Upper Saddle River, NJ: Pearson Prentice Hall.

Silberstein, E. (2005). *Residential construction academy: HVAC*. Albany, NY: Delmar.

Whitman, W., Johnson, W., & Tomczyk, J. (2005). *Refrigeration and air conditioning technology*. Albany, NY: Delmar.

Heating and Air Conditioning I
Unit 3: Basic Math

(18 hours)

Competencies and Suggested Objectives	Suggested Strategies for Competencies
<p>1. Apply the four basic math skills with whole numbers, fractions, and percent.</p> <ol style="list-style-type: none"> a. Add, subtract, multiply, and divide whole numbers, decimals, and fractions. b. Convert whole numbers to fractions, and convert fractions to whole numbers. c. Convert decimals to percent, and convert percent to decimals. d. Convert fractions to decimals. e. Convert fractions to percent. 	<p>Teaching:</p> <ul style="list-style-type: none"> • Have students complete a short pretest to apply the four basic math skills with whole numbers, fractions, and percent (may use Contren Core Text, Basic Math Unit and Level I Trade Math).^{A1, A5} • Give students the correct answers to problems, and ask at least one student who got the answers for whole numbers correct to write the problems on the chalkboard or a piece of chart paper. Have students who did not get the problems correct listen as the student at the board or paper works the problems. Do this procedure for fractions and percent as well, having students rotate through the skills until each student has spent time with each set of problems. Have a different student lead the discussion each time students rotate so that the students who are just learning how to work the problems have a chance to teach the other students.^{E2, E4, E5} • Provide students with additional problems to apply the four basic math skills with whole numbers, fractions, and percent while working in small groups and then alone.^{A1, A5} <p>Assessment:</p> <ul style="list-style-type: none"> • Monitor group work as students perform calculations. • Evaluate students on a posttest with whole number, fraction, and percent problems.
<p>2. Use the metric system.</p> <ol style="list-style-type: none"> a. Use a standard and metric ruler to measure. b. Explain what the metric system is and its importance. c. Recognize and use metric units of length, weight, volume, and temperature. 	<p>Teaching:</p> <ul style="list-style-type: none"> • Discuss the metric system and its importance. • Divide students into groups and have them design a small building project appropriate for the program, including dimensions in standard and metric measurements.^{A1} • Have students use stiff paper (or materials in the shop) to build a simple model, measuring the pieces using both standard

	<p>and metric rulers to ensure that the model is to proper scale with the design.^{A2}</p> <ul style="list-style-type: none"> • Distribute a variety of metric measuring tools for length, weight, volume, and temperature. Have students measure assigned materials using the appropriate tools and record the measurements.^{A2} • Have each student write or type (if technology resources are available) a paper comparing the use of the standard and metric systems and proposing why the United States should or should not use the metric system.^{E1, E9, E10} <p>Assessment:</p> <ul style="list-style-type: none"> • Compare design specifications to the constructed model to ensure that measurements are correct. • Evaluate each student’s measurements for accuracy. • Evaluate each student’s paper for content as well as grammar and organization.
<p>3. Apply basic mathematics for heating, ventilation, and air conditioning.</p> <ol style="list-style-type: none"> a. Solve basic algebraic equations. b. Calculate volume, weight, pressure, vacuum, and temperature. c. Construct simple geometric figures and solve basic geometry problems. 	<p>Teaching:</p> <ul style="list-style-type: none"> • Discuss and demonstrate the basic mathematic applications in HVAC.^{A1, A3, A5} • Have students apply the applications in solving real work related problems using the Contren HVAC Level 1 Trade Mathematics Unit or other materials.^{A1, A3, A5} <p>Assessment:</p> <ul style="list-style-type: none"> • Assessment of the problems will be Contren examinations and performance examinations.

STANDARDS

Contren Learning Series Best Practices

Core Curriculum Best Practices

- MAT1 Add, subtract, multiply, and divide whole numbers, with and without a calculator.
- MAT2 Use a standard ruler and a metric ruler to measure.
- MAT3 Add, subtract, multiply, and divide fractions.
- MAT4 Add, subtract, multiply, and divide decimals, with and without a calculator.
- MAT5 Convert decimals to percents and percents to decimals.
- MAT6 Convert fractions to decimals and decimals to fractions.

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- MAT7 Explain what the metric system is and how it is important in the construction trade.
MAT8 Recognize and use metric units of length, weight, volume, and temperature.
MAT9 Recognize some of the basic shapes used in the construction industry and apply basic geometry to measure them.

Level I

- TMA1 Identify similar units of measurement in both the inch-pound (English) and metric systems and know which units are larger.
TMA2 Convert measured values in the inch-pound system to equivalent metric values and vice versa.
TMA3 Express numbers as powers of ten.
TMA4 Determine the powers and roots of numbers.
TMA5 Solve basic algebraic equations.
TMA6 Recognize various geometric figures.
TMA7 Use the Pythagorean theorem to make calculations involving right triangles.
TMA7 Convert decimal feet to feet and inches and vice versa.

Academic Standards

- A1 Recognize, classify, and use real numbers and their properties.
A3 Simplify algebraic expressions, solve and graph equations, inequalities and systems in one and two variables.
A5 Utilize various formulas in problem-solving situations.
E2 Communicate ideas for a variety of school and other life situations through listening, speaking, and reading aloud.
E3 Read, evaluate, and use print, non-print, and technological sources to research issues and problems, to present information, and to complete projects.
E4 Work individually and as a member of a team to analyze and interpret information, to make decisions, to solve problems, and to reflect, using increasingly complex and abstract thinking.
E5 Complete oral and written presentations which exhibit interaction and consensus within a group.
E9 Sustain progress toward fluent control of grammar, mechanics, and usage of standard English in the context of writing and speaking.
E10 Use language and critical thinking strategies to serve as tools for learning.

Workplace Skills for the 21st Century

- WP2 Acquires, evaluates, organizes and maintains, and interprets/communicates information, including the use of computers.
WP3 Practices interpersonal skills related to careers including team member participation, teaching other people, serving clients/customers, exercising leadership, negotiation, and working with culturally diverse.
WP6 Employs thinking skills including creative thinking, decision making, problem solving, reasoning, and knowing how to learn.

- WP7 Basic Skills: Employs basic academic skills including reading, writing, arithmetic and mathematics, speaking, and listening.
- WP8 Personal Qualities: Practices work ethics related to individual responsibility, integrity, honesty, and personal management

National Educational Technology Standards for Students

- T1 Basic operations and concepts
- T3 Technology productivity tools
- T6 Technology problem-solving and decision-making tools

Suggested References

- Barrows, R., & Jones, B. (2002). *Fundamentals of math with career applications*. Upper Saddle River, NJ: Pearson Prentice Hall.
- Boyce, J. G., Margolis, L., & Slade, S. (2000). *Mathematics for technical and vocational students*. Upper Saddle River, NJ: Prentice Hall.
- Carman, R. A., & Saunders, H. M. (2005). *Mathematics for the trades: A guided approach*. Upper Saddle River, NJ: Pearson Prentice Hall.
- Cook, N. P. (2004). *Mathematics for technical trades*. Upper Saddle River, NJ: Pearson Prentice Hall.
- Cook, N. P. (2004). *Introductory mathematics*. Upper Saddle River, NJ: Pearson Prentice Hall.
- National Center for Construction Education and Research. (2004). *Core curriculum*. Upper Saddle River, NJ: Pearson Prentice Hall.
- National Center for Construction Education and Research. (2001). *HVAC level I*. Upper Saddle River, NJ: Pearson Prentice Hall.
- Silberstein, E. (2005). *Residential construction academy: HVAC*. Albany, NY: Delmar.

Heating and Air Conditioning I
Unit 4: Hand and Power Tools

(15 hours)

Competencies and Suggested Objectives	Suggested Strategies for Competencies
<p>1. Demonstrate the use and maintenance of hand and power tools.</p> <ol style="list-style-type: none"> a. Identify and discuss the use of common hand and power tools. b. Discuss rules of safety. c. Select and demonstrate the use of tools. d. Explain the procedures for maintenance. 	<p>Teaching:</p> <ul style="list-style-type: none"> • Identify basic hand and power tools (e.g., vacuum pump, multimeter, leak detector, manifold gauges, tubing cutters) used in the field (Contren Core Text Introduction to Hand Tools and Introduction to Power Tools Units and Level I Tools of the Trade Unit) and how they have advanced through time.^{E3, E8, H2} • Discuss safety factors, proper use, and maintenance.^{E2, E5} • Describe accidents that can occur while using tools. • Divide students into groups and give each group a scenario or case study (written or on video) involving an accident. Have each group identify safety mistakes in each situation; determine correct procedures; and present the scenario, mistakes found, and procedures which should have been used to the class.^{E2, E3, E4, E5, E9, E10} • Demonstrate the uses of various hand and power tools for the class. • Provide each student with a description of a project to be completed. Have the student select the appropriate tool for the project and demonstrate its proper use to the class.^{E2, E3, E4, E5, E9, E10} • Assign each student a specific set of tools (i.e., recovery unit, swaging block, pinch off tools, striker, etc.). Have students use the Internet to research and write or type (if technology resources are available) a report on the proper procedures for maintenance of the assigned set of tools.^{E1, E3, E4, E5, E9, E10} <p>Assessment:</p> <ul style="list-style-type: none"> • Have each student complete a test to identify specific tools. • Evaluate the case study presentation for content and delivery. • Evaluate the selection of the proper tool for the assigned project and demonstration of

	<p>its use.</p> <ul style="list-style-type: none"> • Evaluate the maintenance report using a rubric or checklist.
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STANDARDS

Contren Learning Series Best Practices

Core Curriculum Best Practices

HTO1 Recognize and identify some of the basic hand tools used in the construction trade.

HTO2 Use these tools safely.

HTO3 Describe the basic procedures for taking care of these tools.

PTO1 Identify commonly used power tools of the construction trade.

PTO2 Use power tools safely.

PTO3 Explain how to maintain power tools properly.

Level I

TOT1 Identify and state the use of the following tools:

⟨Pipe wrenches

⟨Torque wrenches

⟨Tinner's and soft-faced hammers

⟨Hand cutting snips

⟨Hand and power hacksaws

⟨Drill press

⟨Measuring tools

TOT2 Describe the general procedures for maintenance of most hand and power tools.

TOT3 Describe or demonstrate the general safety precautions that must be followed when using most hand and power tools.

Academic Standards

A1 Recognize, classify, and use real numbers and their properties.

A2 Recognize, create, extend, and apply patterns, relations, and functions and their applications.

E1 Produce writing which reflects increasing proficiency through planning, writing, revising, and editing and which is specific to audience and purpose.

E2 Communicate ideas for a variety of school and other life situations through listening, speaking, and reading aloud.

E3 Read, evaluate, and use print, non-print, and technological sources to research issues and problems, to present information, and to complete projects.

E4 Work individually and as a member of a team to analyze and interpret information, to make decisions, to solve problems, and to reflect, using increasingly complex and abstract thinking.

- E5 Complete oral and written presentations which exhibit interaction and consensus within a group.
- E8 Read, discuss, analyze, and evaluate literature from various genres and other written material.
- E9 Sustain progress toward fluent control of grammar, mechanics, and usage of standard English in the context of writing and speaking.
- E10 Use language and critical thinking strategies to serve as tools for learning.

Workplace Skills for the 21st Century

- WP2 Acquires, evaluates, organizes and maintains, and interprets/communicates information, including the use of computers.
- WP3 Practices interpersonal skills related to careers including team member participation, teaching other people, serving clients/customers, exercising leadership, negotiation, and working with culturally diverse.
- WP6 Employs thinking skills including creative thinking, decision making, problem solving, reasoning, and knowing how to learn.
- WP7 Basic Skills: Employs basic academic skills including reading, writing, arithmetic and mathematics, speaking, and listening.
- WP8 Personal Qualities: Practices work ethics related to individual responsibility, integrity, honesty, and personal management

National Educational Technology Standards for Students

- T1 Basic operations and concepts
- T3 Technology productivity tools
- T5 Technology research tools
- T6 Technology problem-solving and decision-making tools

Suggested References

- Jeffus, L. (2004). *Refrigeration and air conditioning*. Upper Saddle River, NJ: Pearson Prentice Hall.
- National Center for Construction Education and Research. (2004). *Core curriculum*. Upper Saddle River, NJ: Pearson Prentice Hall.
- National Center for Construction Education and Research. (2004). *HVAC level I*. Upper Saddle River, NJ: Pearson Prentice Hall.
- Silberstein, E. (2005). *Residential construction academy: HVAC*. Albany, NY: Delmar.
- Whitman, W., Johnson, W., & Tomczyk, J. (2005). *Refrigeration and air conditioning technology*. Albany, NY: Delmar.

**Heating and Air Conditioning I
Unit 5: Introduction to Blueprints**

(7.5 hours)

Competencies and Suggested Objectives	Suggested Strategies for Competencies
<p>1. Read, analyze, and design a blueprint.</p> <ul style="list-style-type: none"> a. Identify terms and symbols commonly used on blueprints. b. Interpret various symbols to locate various elements. c. Interpret a plan to determine layout. d. Interpret basic electrical specifications. e. Interpret electrical drawings including site plans, floor plans, and detail drawings. f. Read equipment schedule. g. Explain basic layout of a blueprint. h. Describe the information in a title block. i. Identify the lines used on blueprints. j. Explain the architect's and engineer's scales. k. Design a blueprint. l. Construct a structure based on a blueprint. 	<p>Teaching:</p> <ul style="list-style-type: none"> • Using a blueprint (may use AutoCAD if available), explain all terms, symbols, and abbreviations on the blueprint and how they are used to locate various elements. Give each student a copy of the symbols and abbreviations (Contren Core Text Introduction to Blueprints Unit). Discuss electrical specifications and drawings, equipment schedules, blueprint components, and architect's and engineer's scales.^{E3, E8} • Divide students into pairs and have them quiz each other on the terms and symbols. • Have each student interpret a plan, electrical specifications, and electrical drawings; match them to an actual picture of the area; and interpret the information to the class.^{E2, E4, E9} • Have students work as a team to prepare a blueprint of a corner of the classroom to present to a client (Contren Core Text Introduction to Blueprints Unit). Have students type a letter or report to the client and prepare blueprints including symbols, electrical specifications and drawings, equipment schedule, title block, lines, and scales for the client.^{E1, E4, E5, E9} • Have students contact a building store manager (may simulate a call) or review advertisements on the Internet to determine the procedure for purchase of the materials and the estimated cost. Have students include an estimated cost of materials in the information sent to the client in the activity above.^{A1, A5, E9, E10} • To determine the accuracy of the blueprint, have students complete a project according to the blueprint specifications (Contren Core Text Introduction to Blueprints Unit).^{A1, A5, E10}

	<p>Assessment:</p> <ul style="list-style-type: none"> • Monitor group work as students quiz each other, and use a checksheet of symbols to monitor student success (Contren Core Text Introduction to Blueprints Unit). • Determine if each student matches the plan to the correct picture, and evaluate his or her interpretation of the information to the class for accuracy, clarity, and presentation skills. • Review the blueprint for accuracy, and grade the letter or report for accuracy of content, grammar, and organization. Evaluate the equipment schedule and estimated cost of materials for cost effectiveness. • Evaluate the project according to a checklist or rubric from Contren Unit.
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STANDARDS

Contren Learning Series Best Practices

Core Curriculum Best Practices

- BLU1 Recognize and identify basic blueprint terms, components, and symbols.
- BLU2 Relate information on blueprints to actual locations on the print.
- BLU3 Recognize different classifications of drawings.
- BLU4 Interpret and use drawing dimensions.

Academic Standards

- A1 Recognize, classify, and use real numbers and their properties.
- A2 Recognize, create, extend, and apply patterns, relations, and functions and their applications.
- E1 Produce writing which reflects increasing proficiency through planning, writing, revising, and editing and which is specific to audience and purpose.
- E2 Communicate ideas for a variety of school and other life situations through listening, speaking, and reading aloud.
- E3 Read, evaluate, and use print, non-print, and technological sources to research issues and problems, to present information, and to complete projects.
- E4 Work individually and as a member of a team to analyze and interpret information, to make decisions, to solve problems, and to reflect, using increasingly complex and abstract thinking.

- E5 Complete oral and written presentations which exhibit interaction and consensus within a group.
- E8 Read, discuss, analyze, and evaluate literature from various genres and other written material.
- E9 Sustain progress toward fluent control of grammar, mechanics, and usage of standard English in the context of writing and speaking.
- E10 Use language and critical thinking strategies to serve as tools for learning.

Workplace Skills for the 21st Century

- WP1 Allocates resources (time, money, materials and facilities, and human resources).
- WP2 Acquires, evaluates, organizes and maintains, and interprets/communicates information, including the use of computers.
- WP3 Practices interpersonal skills related to careers including team member participation, teaching other people, serving clients/customers, exercising leadership, negotiation, and working with culturally diverse.
- WP6 Employs thinking skills including creative thinking, decision making, problem solving, reasoning, and knowing how to learn.
- WP7 Basic Skills: Employs basic academic skills including reading, writing, arithmetic and mathematics, speaking, and listening.
- WP8 Personal Qualities: Practices work ethics related to individual responsibility, integrity, honesty, and personal management

National Educational Technology Standards for Students

- T1 Basic operations and concepts
- T3 Technology productivity tools
- T5 Technology research tools
- T6 Technology problem-solving and decision-making tools

Suggested References

National Center for Construction Education and Research. (2004). *Core curriculum*. Upper Saddle River, NJ: Pearson Prentice Hall.

Heating and Air Conditioning I
Unit 6: Basic Rigging

(10 hours)

Competencies and Suggested Objectives	Suggested Strategies for Competencies
<p>1. Explain and identify safe rigging and equipment.</p> <ul style="list-style-type: none"> a. Explain and practice safe rigging. b. Identify and explain rigging equipment. c. Inspect rigging equipment. 	<p>Teaching:</p> <ul style="list-style-type: none"> • Using industry pictures of safe rigging from Contren Core Text Basic Rigging Unit, trade publications and overheads of rigging equipment, identify, inspect and explain the techniques of safe rigging.^{E1} • Students will be given scale models of rigging equipment and will practice the rigging process. • Take students on a field trip to a local industry to observe rigging procedures. Students will be divided into groups, take pictures of rigging, write or type an individual report describing their pictures and present their report to the class.^{E1, E2, E5} <p>Assessment:</p> <ul style="list-style-type: none"> • Monitor the students as they quiz each other while working with the scale models. • Teacher will monitor the students at the field trip site and industry personnel will provide instruction on proper rigging techniques. • The written report, pictures, and presentation will be graded on content and delivery.
<p>2. Discuss the proper use of load-handling and signaling practices.</p> <ul style="list-style-type: none"> a. Discuss the proper procedures for estimating size, weight, and center of gravity. b. Simulate rigging and moving materials and equipment. 	<p>Teaching:</p> <ul style="list-style-type: none"> • Discuss procedures for handling a load. Provide the proper hand signals for moving the load. Provide the correct procedures to move a rig and move materials and equipment. Utilize activities in Contren Core Text Basic Rigging Unit.^{A1, E3, E8} <p>Assessment:</p> <ul style="list-style-type: none"> • Assess the discussion using teacher observation to monitor the activity. • Assess the Contren activities from the materials provided.

STANDARDS

Contren Learning Series Best Practices

Core Curriculum Best Practices

- RIG1 Identify and describe the use of slings and common rigging hardware.
- RIG2 Describe the basic inspection techniques and rejection criteria used for slings and hardware.
- RIG3 Describe the basic hitch configurations and their proper connections.
- RIG4 Describe basic load-handling safety practices.
- RIG5 Demonstrate proper use of American National Standards Institute (ANSI) hand signals.

Academic Standards

- A1 Recognize, classify, and use real numbers and their properties.
- A2 Recognize, create, extend, and apply patterns, relations, and functions and their applications.
- A3 Simplify algebraic expressions, solve and graph equations, inequalities and systems in one and two variables.
- E1 Produce writing which reflects increasing proficiency through planning, writing, revising, and editing and which is specific to audience and purpose.
- E2 Communicate ideas for a variety of school and other life situations through listening, speaking, and reading aloud.
- E3 Read, evaluate, and use print, non-print, and technological sources to research issues and problems, to present information, and to complete projects.
- E4 Work individually and as a member of a team to analyze and interpret information, to make decisions, to solve problems, and to reflect, using increasingly complex and abstract thinking.
- E5 Complete oral and written presentations which exhibit interaction and consensus within a group.
- E8 Read, discuss, analyze, and evaluate literature from various genres and other written material.
- E9 Sustain progress toward fluent control of grammar, mechanics, and usage of standard English in the context of writing and speaking.
- E10 Use language and critical thinking strategies to serve as tools for learning.

Workplace Skills for the 21st Century

- WP2 Acquires, evaluates, organizes and maintains, and interprets/communicates information, including the use of computers.
- WP3 Practices interpersonal skills related to careers including team member participation, teaching other people, serving clients/customers, exercising leadership, negotiation, and working with culturally diverse.

- WP4 Applies systems concept including basic understanding, monitoring and correction system performance, and designing and improving systems.
- WP5 Selects, applies, and maintains/troubleshoots technology.
- WP6 Employs thinking skills including creative thinking, decision making, problem solving, reasoning, and knowing how to learn.
- WP7 Basic Skills: Employs basic academic skills including reading, writing, arithmetic and mathematics, speaking, and listening.
- WP8 Personal Qualities: Practices work ethics related to individual responsibility, integrity, honesty, and personal management.

National Educational Technology Standards for Students

- T1 Basic operations and concepts
- T3 Technology productivity tools
- T6 Technology problem-solving and decision-making tools

Suggested References

National Center for Construction Education and Research. (2004). *Core curriculum*. Upper Saddle River, NJ: Pearson Prentice Hall.

Heating and Air Conditioning I

Unit 7: Manifold Gauges and Refrigerant Cylinder

(25 hours)

Competencies and Suggested Objectives	Suggested Strategies for Competencies
<p>1. Explain and apply the basic principles in the use of manifold gauges and refrigerant cylinders.</p> <p>a. Explain the safety precautions and purpose of working with manifold gauges and refrigerant cylinders.</p> <p>b. Connect a set of refrigeration manifold gauges to a system.</p> <p>c. Identify the methods of charging a refrigeration system.</p> <p>d. Charge the refrigeration system from the low side or high side.</p>	<p>Teaching:</p> <ul style="list-style-type: none"> Discuss the safety precautions to be used in working with refrigerant cylinders and manifold gauges. Demonstrate the proper procedures for connecting the manifold gauge to the cylinder and explain the purpose of the gauge. Each student will properly connect the gauge to a cylinder. Divide students into groups and provide a scenario for gauge uses to each group. The group will present to the class. ^{A1, E2, E3, E4, E8, E10} Discuss the methods of charging a system using high side or low side methods. Demonstrate the methods of charging a system. The students will perform the methods of charging a system. ^{A1, E2, E3, E4, E8, E10} <p>Assessment:</p> <ul style="list-style-type: none"> The connection procedures will be assessed by using a checklist and the presentation will be assessed with a rubric. Assessment will be using a checklist for the performance activity.

STANDARDS

Contren Learning Series Best Practices

Level II

LDE8 Identify the service equipment used for charging refrigerant into a system, and explain why each item of equipment is used.

LDE9 Demonstrate skill in charging refrigerant into a system.

Academic Standards

A1 Recognize, classify, and use real numbers and their properties.

E2 Communicate ideas for a variety of school and other life situations through listening, speaking, and reading aloud.

- E3 Read, evaluate, and use print, non-print, and technological sources to research issues and problems, to present information, and to complete projects.
- E4 Work individually and as a member of a team to analyze and interpret information, to make decisions, to solve problems, and to reflect, using increasingly complex and abstract thinking.
- E8 Read, discuss, analyze, and evaluate literature from various genres and other written material.
- E10 Use language and critical thinking strategies to serve as tools for learning.

Workplace Skills for the 21st Century

- WP2 Acquires, evaluates, organizes and maintains, and interprets/communicates information, including the use of computers.
- WP3 Practices interpersonal skills related to careers including team member participation, teaching other people, serving clients/customers, exercising leadership, negotiation, and working with culturally diverse.
- WP4 Applies systems concept including basic understanding, monitoring and correction system performance, and designing and improving systems.
- WP6 Employs thinking skills including creative thinking, decision making, problem solving, reasoning, and knowing how to learn.
- WP7 Basic Skills: Employs basic academic skills including reading, writing, arithmetic and mathematics, speaking, and listening.
- WP8 Personal Qualities: Practices work ethics related to individual responsibility, integrity, honesty, and personal management.

National Educational Technology Standards for Students

- T1 Basic operations and concepts
- T3 Technology productivity tools
- T6 Technology problem-solving and decision-making tools

Suggested References

- Jeffus, L. (2004). *Refrigeration and air conditioning*. Upper Saddle River, NJ: Pearson Prentice Hall.
- National Center for Construction Education and Research. (2004). *HVAC level II*. Upper Saddle River, NJ: Pearson Prentice Hall.
- Silberstein, E. (2005). *Residential construction academy: HVAC*. Albany, NY: Delmar.
- Whitman, W., Johnson, W., & Tomczyk, J. (2005). *Refrigeration and air conditioning technology*. Albany, NY: Delmar.

Heating and Air Conditioning I

Unit 8: Leak Detection and Vacuum Pump/Recovery Service Operations

(38 hours)

Competencies and Suggested Objectives	Suggested Strategies for Competencies
<p>1. Describe leaks in a refrigerant system.</p> <ol style="list-style-type: none"> a. Describe the safety precautions. b. Discuss the features and benefits of refrigerant leak detectors. 	<p>Teaching:</p> <ul style="list-style-type: none"> • Utilize Contren or other materials to describe safety precautions regarding leaks in a refrigerant system. The students will participate in a discussion and written activity to describe these precautions. ^{E1, E2, E3, E4, E5, E9, E10} • Provide the students with a list of features and benefits of leak detectors (i.e., soap bubbles, electronic detector, halide torch). Students will research the benefits of each detector covered using Contren materials, resource materials, or the Internet. A short summary of the benefits will be written and presented in a class discussion. ^{E1, E2, E3, E4, E5, E9, E10} <p>Assessment:</p> <ul style="list-style-type: none"> • The summary will be assessed using teacher observation, summary grade (grammar, punctuation, and content accuracy), and class participation.
<p>2. Locate leaks in a refrigerant system using the various methods.</p>	<p>Teaching</p> <ul style="list-style-type: none"> • Discuss the methods of locating leaks in refrigerant systems. Demonstrate the methods of locating leaks and have the students perform at least one method of locating a leak in a system. <p>Assessment:</p> <ul style="list-style-type: none"> • The activity will be assessed using a checklist for the performance activity.
<p>3. Identify/install a basic vacuum pump service operation.</p> <ol style="list-style-type: none"> a. Describe safety procedures using a vacuum pump. b. Install a vacuum pump on a system. 	<p>Teaching:</p> <ul style="list-style-type: none"> • Discuss the safety precautions to be used in working with a vacuum pump. Demonstrate the proper procedures for installing the vacuum pump. Each student will properly install the vacuum pumps. ^{E2, E3, E4, E10} <p>Assessment:</p> <ul style="list-style-type: none"> • The installation procedures will be assessed by using a checklist.

Competencies and Suggested Objectives	Suggested Strategies for Competencies
<p>4. Provide basic recovery system service operations.</p> <p>a. Describe the effects of refrigerant and fluorocarbons on the atmosphere.</p> <p>b. Use a refrigerant recovery system to reclaim refrigerant.</p>	<p>Teaching:</p> <ul style="list-style-type: none"> Utilize resource materials or the Internet and have the students research the effects of refrigerants and fluorocarbons on the atmosphere. Students should write a summary of these effects and present the results in class. <small>A1, E1, E2, E3, E4, E5, E9, E10</small> Discuss and demonstrate the proper procedure for recovering refrigerants. Students will properly perform these procedures. <p>Assessment:</p> <ul style="list-style-type: none"> The summary will be assessed using teacher observation, summary grade (grammar, punctuation, and content accuracy), and class participation. The recovery procedures will be assessed using a checklist.

STANDARDS

Contren Learning Series Best Practices

Level II

- LDE1 Identify the common types of leak detectors and explain how each is used.
- LDE2 Demonstrate skill in performing leak detection tests.
- LDE3 Identify the service equipment used for evacuating a system and explain why each item of equipment is used.
- LDE4 Demonstrate skill in performing system evacuation and dehydration.
- LDE5 Identify the service equipment used for recovering refrigerant from a system and for recycling the recovered refrigerant, and explain why each item of equipment is used.
- LDE6 Demonstrate skill in performing refrigerant recovery.

Academic Standards

- A1 Recognize, classify, and use real numbers and their properties.
- E1 Produce writing which reflects increasing proficiency through planning, writing, revising, and editing and which is specific to audience and purpose.
- E2 Communicate ideas for a variety of school and other life situations through listening, speaking, and reading aloud.
- E3 Read, evaluate, and use print, non-print, and technological sources to research issues and problems, to present information, and to complete projects.

- E4 Work individually and as a member of a team to analyze and interpret information, to make decisions, to solve problems, and to reflect, using increasingly complex and abstract thinking.
- E5 Complete oral and written presentations which exhibit interaction and consensus within a group.
- E8 Read, discuss, analyze, and evaluate literature from various genres and other written material.
- E9 Sustain progress toward fluent control of grammar, mechanics, and usage of standard English in the context of writing and speaking.
- E10 Use language and critical thinking strategies to serve as tools for learning.

Workplace Skills for the 21st Century

- WP2 Acquires, evaluates, organizes and maintains, and interprets/communicates information, including the use of computers.
- WP3 Practices interpersonal skills related to careers including team member participation, teaching other people, serving clients/customers, exercising leadership, negotiation, and working with culturally diverse.
- WP4 Applies systems concept including basic understanding, monitoring and correction system performance, and designing and improving systems.
- WP6 Employs thinking skills including creative thinking, decision making, problem solving, reasoning, and knowing how to learn.
- WP7 Basic Skills: Employs basic academic skills including reading, writing, arithmetic and mathematics, speaking, and listening.
- WP8 Personal Qualities: Practices work ethics related to individual responsibility, integrity, honesty, and personal management.

National Educational Technology Standards for Students

- T1 Basic operations and concepts
- T3 Technology productivity tools
- T5 Technology research tools
- T6 Technology problem-solving and decision-making tools

Suggested References

- Jeffus, L. (2004). *Refrigeration and air conditioning*. Upper Saddle River, NJ: Pearson Prentice Hall.
- National Center for Construction Education and Research. (2004). *HVAC level II*. Upper Saddle River, NJ: Pearson Prentice Hall.
- Silberstein, E. (2005). *Residential construction academy: HVAC*. Albany, NY: Delmar.

Whitman, W., Johnson, W., & Tomczyk, J. (2005). *Refrigeration and air conditioning technology*. Albany, NY: Delmar.

Heating and Air Conditioning I
Unit 9: Copper and Plastic Tubing Practices

(40 hours)

Competencies and Suggested Objectives	Suggested Strategies for Competencies
<p>1. Identify and demonstrate precautions and procedures when installing refrigerant piping.</p> <ul style="list-style-type: none"> a. Identify safety procedures when installing copper and plastic tubing. b. Identify sizes and types of copper and plastic tubing. c. Lay out and construct copper and plastic tubing in a refrigeration system. 	<p>Teaching:</p> <ul style="list-style-type: none"> • Utilize Contren Level I Copper and Plastic Piping Unit to read and discuss the safety precautions and procedures when installing copper and plastic. Have students perform the Contren activity.^{A1, E2, E3, E4, E10} • Provide the students with the types and sizes of copper and plastic tubing from the Contren Level I Copper and Plastic Piping Unit. The students will complete the Contren or a teacher-made activity.^{E2, E3, E4, E10} • Discuss and demonstrate the procedures used to cut, flare, and bend copper tubing. The students will perform these procedures according to specifications.^{A1, E2, E3, E4, E10} • Discuss and demonstrate the procedures used to cut and lay out plastic piping. The students will perform these procedures according to specifications.^{E2, E3, E4, E10} <p>Assessment:</p> <ul style="list-style-type: none"> • Assess the activity using the Contren materials. • Assess the activity using the Contren materials or teacher made assessment. • The performance activity will be assessed using a checklist. • The performance activity will be assessed using a checklist.

STANDARDS

Contren Learning Series Best Practices

Level I

- CPP1 State the precautions that must be taken when installing refrigerant piping.
- CPP2 Select the right tubing for the job.
- CPP3 Cut and bend tubing
- CPP4 Safely join tubing by using flare and compression fittings.
- CPP5 Determine the kinds of hangers and supports needed for refrigerant piping.

CPP6 State the basic requirements for pressure testing a system once it has been installed.

Academic Standards

- A1 Recognize, classify, and use real numbers and their properties.
- E2 Communicate ideas for a variety of school and other life situations through listening, speaking, and reading aloud.
- E3 Read, evaluate, and use print, non-print, and technological sources to research issues and problems, to present information, and to complete projects.
- E4 Work individually and as a member of a team to analyze and interpret information, to make decisions, to solve problems, and to reflect, using increasingly complex and abstract thinking.
- E8 Read, discuss, analyze, and evaluate literature from various genres and other written material.
- E9 Sustain progress toward fluent control of grammar, mechanics, and usage of standard English in the context of writing and speaking.

Workplace Skills for the 21st Century

- WP2 Acquires, evaluates, organizes and maintains, and interprets/communicates information, including the use of computers.
- WP3 Practices interpersonal skills related to careers including team member participation, teaching other people, serving clients/customers, exercising leadership, negotiation, and working with culturally diverse.
- WP4 Applies systems concept including basic understanding, monitoring and correction system performance, and designing and improving systems.
- WP6 Employs thinking skills including creative thinking, decision making, problem solving, reasoning, and knowing how to learn.
- WP7 Basic Skills: Employs basic academic skills including reading, writing, arithmetic and mathematics, speaking, and listening.
- WP8 Personal Qualities: Practices work ethics related to individual responsibility, integrity, honesty, and personal management

National Educational Technology Standards for Students

- T1 Basic operations and concepts
- T3 Technology productivity tools
- T4 Technology communications tools
- T5 Technology research tools
- T6 Technology problem-solving and decision-making tools

Suggested References

Jeffus, L. (2004). *Refrigeration and air conditioning*. Upper Saddle River, NJ: Pearson Prentice Hall.

National Center for Construction Education and Research. (2004). *HVAC Level I*. Upper Saddle River, NJ: Pearson Prentice Hall.

Silberstein, E. (2005). *Residential construction academy: HVAC*. Albany, NY: Delmar.

Whitman, W., Johnson, W., & Tomczyk, J. (2005). *Refrigeration and air conditioning technology*. Albany, NY: Delmar.

**Heating and Air Conditioning I
Unit 10: Soldering and Brazing Procedures**

(40 hours)

Competencies and Suggested Objectives	Suggested Strategies for Competencies
<p>1. Discuss and demonstrate procedures for soldering and brazing safely.</p> <ul style="list-style-type: none"> a. Identify purposes and use of solder, filler metal, and fluxes. b. Solder and braze copper tubing and fittings. 	<p>Teaching:</p> <ul style="list-style-type: none"> • Utilize the Contren Level I Soldering and Brazing Unit activities to explain safety procedures for soldering and brazing. Explain the purposes and use of solder, filler metal and fluxes. Have the student complete the Contren activity. Discuss and demonstrate the procedures for assembly and operation of an oxy-acetylene torch. Following the demonstration the students will solder copper tubing and fittings according to specifications. ^{A1, E2, E3, E4, E10} <p>Assessment:</p> <ul style="list-style-type: none"> • Assessment for the activity will use the Contren material and checklist or rubric for the performance activity.

STANDARDS

Contren Learning Series Best Practices

Level I

- SBR1 Assemble and operate the tools used for soldering.
- SBR2 Prepare tubing and fittings for soldering.
- SBR3 Identify the purposes and uses of solder and solder fluxes.
- SBR4 Solder copper tubing and fittings.
- SBR5 Assemble and operate the tools used for brazing.
- SBR6 Prepare tubing and fittings for brazing.
- SBR7 Identify the purposes and uses of filler metals and fluxes used for brazing.
- SBR8 Braze copper tubing and fittings.
- SBR9 Identify the inert gases that can safely be used to purge tubing when brazing.

Academic Standards

- A1 Recognize, classify, and use real numbers and their properties.
- E2 Communicate ideas for a variety of school and other life situations through listening, speaking, and reading aloud.
- E3 Read, evaluate, and use print, non-print, and technological sources to research issues and problems, to present information, and to complete projects.

- E4 Work individually and as a member of a team to analyze and interpret information, to make decisions, to solve problems, and to reflect, using increasingly complex and abstract thinking.
- E8 Read, discuss, analyze, and evaluate literature from various genres and other written material.
- E10 Use language and critical thinking strategies to serve as tools for learning.

Workplace Skills for the 21st Century

- WP2 Acquires, evaluates, organizes and maintains, and interprets/communicates information, including the use of computers.
- WP3 Practices interpersonal skills related to careers including team member participation, teaching other people, serving clients/customers, exercising leadership, negotiation, and working with culturally diverse.
- WP4 Applies systems concept including basic understanding, monitoring and correction system performance, and designing and improving systems.
- WP6 Employs thinking skills including creative thinking, decision making, problem solving, reasoning, and knowing how to learn. WP1 Allocates resources (time, money, materials and facilities, and human resources).
- WP7 Basic Skills: Employs basic academic skills including reading, writing, arithmetic and mathematics, speaking, and listening.
- WP8 Personal Qualities: Practices work ethics related to individual responsibility, integrity, honesty, and personal management.

National Educational Technology Standards for Students

- T1 Basic operations and concepts
- T3 Technology productivity tools
- T6 Technology problem-solving and decision-making tools

Suggested References

- Jeffus, L. (2004). *Refrigeration and air conditioning*. Upper Saddle River, NJ: Pearson Prentice Hall.
- National Center for Construction Education and Research. (2004). *HVAC level I*. Upper Saddle River, NJ: Pearson Prentice Hall.
- Silberstein, E. (2005). *Residential construction academy: HVAC*. Albany, NY: Delmar.
- Whitman, W., Johnson, W., & Tomczyk, J. (2005). *Refrigeration and air conditioning technology*. Albany, NY: Delmar.

Heating and Air Conditioning II
Unit 1: Orientation Review

(12 hours)

Competencies and Suggested Objectives	Suggested Strategies for Competencies
<p>1. Review local program and vocational center policies and procedures.</p> <p>a. Describe local program and vocational center policies and procedures including dress code, attendance, academic requirements, discipline, and transportation regulations.</p>	<p>Teaching:</p> <ul style="list-style-type: none"> • Present local program and vocational center policies and procedures. • Students will read the handbook to become aware of what is expected of them in relation to the policies and procedures of the school. This will include dress code, attendance, academic requirements, discipline, and transportation regulations. Students will work together in pairs. A student with a higher reading ability will team up with a student with a lower reading ability to get a better understanding of the school’s program policies and procedures.^{E1, E2, E3, E4, E8, E9, E10} <p>Assessment:</p> <ul style="list-style-type: none"> • Students will have a test on applicable policies and procedures. • Students will submit written report on rules and regulations. • Explanation of local student handbook requirements. • Exercises to identify equipment and functions found in the school lab. • Assess student orientation knowledge through teacher observations and written unit test. File completed test to document student mastery of the school and program policies and procedures.
<p>2. Review employment opportunities and responsibilities.</p> <p>a. Describe employment opportunities including potential earnings, employee benefits, job availability, place of employment, working conditions, and educational requirements.</p> <p>b. Describe basic employee responsibilities.</p>	<p>Teaching:</p> <ul style="list-style-type: none"> • Use the Contren Series Core Text, Basic Employability Skills Unit to define trade terms related to basic employability skills. Discuss the chapter and perform the related activities to promote awareness of employability skills.^{E2} • Students will use career software, such as Choices, to measure their aptitudes and abilities for particular careers.^{E3, E8} • Students will use the Internet to research a list of careers for which they will be qualified upon program completion.^{E2, E3, E4,}

	<p>E5, E10</p> <ul style="list-style-type: none"> • Students will use available resources (college catalogs, college websites) to research information about postsecondary educational opportunities. ^{E2, E3, E4, E5, E10} • Students will select a career in the field and outline educational and skill requirements, expected job growth, and entry-level salaries. ^{E1, E3, E8, E9} • Discuss the parts of a resume and cover letter, and/or job application and provide each student a written sample. • Have each student use the Internet or newspapers to choose a job for which they are qualified and prepare a resume and cover letter that can be used to apply for the selected job. ^{E1, E2, E4, E10} <p>Assessment:</p> <ul style="list-style-type: none"> • Assessment will be determined by matching test for definitions and the level of success regarding the Contren activities. Lessons involving writing and math skills will be integrated with the appropriate department. • Use a checklist to evaluate the resume and cover letter. • Use a checklist to evaluate the presentation. • Review career software printout to assess student aptitudes and abilities.
<p>3. Review leadership skills and personal development opportunities provided students by student organizations to include SkillsUSA.</p> <ol style="list-style-type: none"> a. Demonstrate effective teambuilding and leadership skills. b. Practice appropriate work ethics. 	<p>Teaching:</p> <ul style="list-style-type: none"> • Discuss the role of a team member and leader. Assign the students roles within a team and have them role play a situation in which there is a conflict which must be resolved. Utilize the lessons from SkillsUSA, Contren Tools for Success, or other resources to provide additional training. ^{E3, E8} • Discuss appropriate work ethics standards. Have the students list what they believe to be the most common problems within the HVAC profession. <p>Assessment:</p> <ul style="list-style-type: none"> • Assess the role play using a checklist for documentation. • Lessons from other resources should be

	<p>assessed according to the recommended resource guide.</p>
<p>4. Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations.</p>	<p>Teaching:</p> <ul style="list-style-type: none"> Have the students perform an activity involving verbal instructions. Divide the students into groups and have one team be the customer and the other be the contractor. The customer will describe the project and the contractor will have to provide a brief plan for the construction of the project. Have the groups switch roles and the customer will provide the contractor with a written plan and blueprint. The contractor will describe the procedure for construction of the project.^{E2, E3, E4, E8} <p>Assessment:</p> <ul style="list-style-type: none"> The lesson will be assessed using a rubric and a checklist for the written projects and presentations.

STANDARDS

Contren Learning Series Best Practices

Core Curriculum Best Practices

- COM1 Demonstrate the ability to understand information and instructions that are presented in both written and verbal form.
- COM2 Demonstrate the ability to communicate effectively in on-the-job situations using written and verbal skills.
- EMP1 Explain the construction industry, the role of the companies that make up the industry, and the role of individual professionals in the industry.
- EMP2 Demonstrate critical thinking skills and the ability to solve problems using those skills.
- EMP3 Demonstrate knowledge of computer systems and explain common uses for computers in the construction industry.
- EMP4 Demonstrate effective relationship skills with teammates and supervisors, exhibit the ability to work on a team, and demonstrate appropriate leadership skills.
- EMP5 Be aware of workplace issues such as sexual harassment, stress, and substance abuse.

Academic Standards

- A5 Utilize various formulas in problem-solving situations.
- E1 Produce writing which reflects increasing proficiency through planning, writing, revising, and editing and which is specific to audience and purpose.
- E2 Communicate ideas for a variety of school and other life situations through listening, speaking, and reading aloud.
- E3 Read, evaluate, and use print, non-print, and technological sources to research issues and problems, to present information, and to complete projects.
- E4 Work individually and as a member of a team to analyze and interpret information, to make decisions, to solve problems, and to reflect, using increasingly complex and abstract thinking.
- E5 Complete oral and written presentations which exhibit interaction and consensus within a group.
- E9 Sustain progress toward fluent control of grammar, mechanics, and usage of standard English in the context of writing and speaking.
- E10 Use language and critical thinking strategies to serve as tools for learning.

Workplace Skills for the 21st Century

- WP2 Acquires, evaluates, organizes and maintains, and interprets/communicates information, including the use of computers.
- WP3 Practices interpersonal skills related to careers including team member participation, teaching other people, serving clients/customers, exercising leadership, negotiation, and working with culturally diverse.
- WP6 Employs thinking skills including creative thinking, decision making, problem solving, reasoning, and knowing how to learn.
- WP7 Basic Skills: Employs basic academic skills including reading, writing, arithmetic and mathematics, speaking, and listening.
- WP8 Personal Qualities: Practices work ethics related to individual responsibility, integrity, honesty, and personal management

National Educational Technology Standards for Students

- T1 Basic operations and concepts
- T3 Technology productivity tools

Suggested References

Choices [Computer software]. (n.d.). Ogdensburg, NY: Careerware, IMS Information Systems Management.

Davies, D. (1997). *Grammar? No problem!* Mission, KS: SkillPath.

Gould, M. C. (2002). *Developing literacy & workplace skills*. Bloomington, IN: National Education Service.

Jeffus, L. (2004). *Refrigeration and air conditioning*. Upper Saddle River, NJ: Pearson Prentice Hall.

Local District Policy Handbook

National Center for Construction Education and Research. (2004). *Core curriculum*. Upper Saddle River, NJ: Pearson Prentice Hall.

National Center for Construction Education and Research. (2004). *Tools for success*. Upper Saddle River, NJ: Pearson Prentice Hall.

SkillsUSA. (2002). *Leadership and competition curricula*. Tinley Park, IL: Goodheart-Wilcox.

Heating and Air Conditioning II
Unit 2: Basic Safety (Review and Reinforcement)

(18 hours)

Competencies and Suggested Objectives	Suggested Strategies for Competencies
<p>1. Describe general safety rules for working in a shop/lab and industry.</p> <ol style="list-style-type: none"> Describe how to avoid on-site accidents. Explain the relationship between housekeeping and safety. Explain the importance of following all safety rules and company safety policies. Explain the importance of reporting all on-the-job injuries, accidents, and near misses. Explain the need for evacuation policies and the importance of following them. Explain the employer’s substances abuse policy and how it relates to safety. Explain the safety procedures when working near pressurized or high temperature. 	<p>Teaching: This can be used for the entire unit.</p> <ul style="list-style-type: none"> Identify, discuss and demonstrate terms, rules, and procedures related to shop/lab and industry safety. (Contren Core Text Basic Safety Unit)^{E3, E8} Required written tests will follow each section of guidelines for safety rules and procedures. Provide the students with a list of terms and have them define the terms. Pair the students to quiz each other on the definitions in preparation for a written exam.^{E2, E3, E8} Use the guidelines provided for personal safety (i.e., clothing, jewelry, hair, eyes, and ears). Divide the students into pairs and assign each pair one of the guidelines. Each pair will demonstrate the “do’s and don’ts” of the guideline.^{E2} Have an industry speaker present to the class the necessity of safety in the work environment. The students will write a summary of the presentation.^{E2, E9} Divide the students into teams and have them develop scenarios of hazards and accidents using the Contren Series Core Text, Basic Safety Unit, publications, and the Internet. This will include tools, spills, working around welding, improper use of barriers, ladders or scaffolds, use of MSDS information, fires, and electrical situations. In a game type situation, one team will read a scenario and the other teams will compete to be the first to provide the proper safety measures which should have been used to prevent the hazardous situation or accident. Points will be awarded to the teams with the correct answers.^{E2, E4} Required written tests will follow each section of guidelines for safety rules and procedures.
<p>2. Identify and apply safety around welding operations.</p> <ol style="list-style-type: none"> Use proper safety practices when welding or working around welding operations. Use proper safety practices when welding in or near trenches and excavations. Explain the term <i>proximity work</i>. 	
<p>3. Identify and explain use of various barriers and confinements.</p> <ol style="list-style-type: none"> Explain the safety requirements for working in confined areas. Explain and practice lockout/tagout procedures. Explain the different barriers and barricades and how they are used. Recognize and explain personal protective equipment. Inspect and care for personal protective equipment. 	

<p>4. Explain lifting and the use of ladders and scaffolds.</p> <p>a. Identify and explain the procedures for lifting heavy objects.</p> <p>b. Inspect and safely work with various ladders and scaffolds.</p>	<p>• NOTE: SAFETY IS TO BE TAUGHT AS AN ONGOING PART OF THE COURSE THROUGHOUT THE YEAR.</p> <p>Assessment:</p> <ul style="list-style-type: none"> • Student participation will be monitored by the teacher and the written exam will be graded. • The “do’s and don’ts” exercise will be critiqued with a peer review. • The summary of the speaker’s presentation will be critiqued using a rubric. • The teams will be rewarded according to the points earned from the game. This could be extra points, classroom privileges, etc. • Written exams will be graded.
<p>5. Explain the Material Safety Data Sheet (MSDS).</p> <p>a. Explain the function of the MSDS.</p> <p>b. Interpret the requirements of the MSDS.</p>	
<p>6. Explain fires.</p> <p>a. Explain the process by which fires start.</p> <p>b. Explain fire prevention of various flammable liquids.</p> <p>c. Explain the classes of fire and the types of extinguishers.</p>	
<p>7. Explain safety in and around electrical situations.</p> <p>a. Explain injuries when electrical contact occurs.</p> <p>b. Explain safety around electrical hazards.</p> <p>c. Explain action to take when an electrical shock occurs.</p>	

STANDARDS

Contren Learning Series Best Practices

Core Curriculum Best Practices

- SAF1 Identify the responsibilities and personal characteristics of a professional craftsperson.
- SAF2 Explain the role that safety plays in the construction crafts.
- SAF3 Describe what job-site safety means.
- SAF4 Explain the appropriate safety precautions around common job-site hazards.
- SAF5 Demonstrate the use and care of appropriate personal protective equipment.
- SAF5 Follow safe procedures for lifting heavy objects.
- SAF6 Describe safe behavior on and around ladders and scaffolds.
- SAF7 Explain the importance of the HazCom (Hazard Communication Standard) requirement and MSDSs (Material Safety Data Sheets).
- SAF8 Describe fire prevention and fire fighting techniques.
- SAF9 Define safe work procedures around electrical hazards.

Academic Standards

- A5 Utilize various formulas in problem-solving situations.
- E1 Produce writing which reflects increasing proficiency through planning, writing, revising, and editing and which is specific to audience and purpose.
- E2 Communicate ideas for a variety of school and other life situations through listening, speaking, and reading aloud.
- E3 Read, evaluate, and use print, non-print, and technological sources to research issues and problems, to present information, and to complete projects.
- E4 Work individually and as a member of a team to analyze and interpret information, to make decisions, to solve problems, and to reflect, using increasingly complex and abstract thinking.
- E5 Complete oral and written presentations which exhibit interaction and consensus within a group.
- E9 Sustain progress toward fluent control of grammar, mechanics, and usage of standard English in the context of writing and speaking.
- E10 Use language and critical thinking strategies to serve as tools for learning.

Workplace Skills for the 21st Century

- WP2 Acquires, evaluates, organizes and maintains, and interprets/communicates information, including the use of computers.
- WP3 Practices interpersonal skills related to careers including team member participation, teaching other people, serving clients/customers, exercising leadership, negotiation, and working with culturally diverse.
- WP6 Employs thinking skills including creative thinking, decision making, problem solving, reasoning, and knowing how to learn.
- WP7 Basic Skills: Employs basic academic skills including reading, writing, arithmetic and mathematics, speaking, and listening.
- WP8 Personal Qualities: Practices work ethics related to individual responsibility, integrity, honesty, and personal management

National Educational Technology Standards for Students

- T1 Basic operations and concepts
- T3 Technology productivity tools

Suggested References

- Jeffus, L. (2004). *Refrigeration and air conditioning*. Upper Saddle River, NJ: Pearson Prentice Hall.
- National Center for Construction Education and Research. (2004). *Core curriculum*. Upper Saddle River, NJ: Pearson Prentice Hall.

Silberstein, E. (2005). *Residential construction academy: HVAC*. Albany, NY: Delmar.

Whitman, W., Johnson, W., & Tomczyk, J. (2005). *Refrigeration and air conditioning technology*. Albany, NY: Delmar.

Heating and Air Conditioning II
Unit 3: Basic Electricity

(40 hours)

Competencies and Suggested Objectives	Suggested Strategies for Competencies
<p>1. Describe/identify basic electricity.</p> <ol style="list-style-type: none"> a. State how electrical power is generated and distributed. b. Describe how voltage, current, resistance, and power are related. c. Explain the different types of meters used to measure voltage, current, and resistance. d. Use Ohm’s Law to calculate the current, voltage, and resistance in a circuit. e. Calculate how much power is consumed by a circuit using the power formula. f. Describe the differences between series and parallel circuits. 	<p>Teaching:</p> <ul style="list-style-type: none"> • Discuss the process of generating electrical power from origin to actual usage. Utilize a chart, diagram, or flow chart to trace the generation of power from the atom to the power plant to industrial buildings and residential areas. Students will be able to trace this process by labeling an example of the process. ^{E2, E3, E5, E8,} • Using Contren Level I, Basic Electricity Unit or other resources, define and discuss the terms related to electricity. The students will match terms with the definitions. ^{E2, E3, E8, E10} • Discuss and demonstrate the various types of meters and their uses. Students will be given a specific reading and must identify the correct meter. ^{E2, E3, E8, E10} • Given the formula for Ohm’s Law, the students will calculate current, resistance, and voltage. ^{A1, A3, A5} • Given the power equation, students will perform calculations to find the power consumed in a circuit or load. ^{A1, A3, A5} • Discuss the difference between a series circuit and a parallel circuit. The students should be able to draw a diagram of a series/parallel circuit. ^{E2, E3, E8, E10} <p>Assessment:</p> <ul style="list-style-type: none"> • The labeling exercise will be assessed by using a checklist. • The matching activity will be assessed with an answer key. • Assessment of the activity will use an identification checklist and reading chart. • The problems will be assessed with an answer key. • The problems will be assessed with an answer key. • The diagram will be assessed using rubric or checklist.

<p>2. Interpret wiring diagrams.</p>	<p>Teaching:</p> <ul style="list-style-type: none"> Review wiring diagrams to include types of diagrams, symbols, and sequence of operation. The students will be given a wiring diagram to interpret. ^{E2, E3, E8, E10} <p>Assessment:</p> <ul style="list-style-type: none"> The project will be assessed according to teacher observation and a wiring checklist.
<p>3. Demonstrate the ability to wire basic circuits.</p> <ol style="list-style-type: none"> Explain the difference between AC and DC currents. Explain the difference between conductors and insulators. Describe the differences between series and parallel circuits. 	<p>Teaching:</p> <ul style="list-style-type: none"> Utilize the Contren Level I, Basic Electricity Unit or other resources to discuss the difference between AC currents and DC currents. Have the students discuss the material and perform the activities provided. ^{E2, E3, E8, E10} Utilize the Contren Level I, Basic Electricity Unit or other resources to discuss the difference between conductors and insulators. Have the students discuss the material and perform the activities provided. ^{E2, E3, E4, E8, E10} Discuss the difference between a series circuit and a parallel circuit. The students should be able to draw a diagram of a series/parallel circuit. ^{E2, E3, E8, E10} <p>Assessment:</p> <ul style="list-style-type: none"> The assessment for the activities is provided in the Contren Level I Instructors Guide. The assessment for the activities is provided in the Contren Level I Instructor's Guide.

STANDARDS

Contren Learning Series Best Practices

Level I

- BEL1 State how electrical power is generated and distributed.
- BEL2 Describe how voltage, current, resistance, and power are related.
- BEL3 Use Ohm's law to calculate the current, voltage, and resistance in a circuit.
- BEL4 Use the power formula to calculate how much power is consumed by a circuit.
- BEL5 Describe the differences between series and parallel circuits.
- BEL6 Recognize and describe the purpose and operation of the various electrical components used in HVAC equipment.

- BEL7 State and demonstrate the safety precautions that must be followed when working on electrical equipment.
- BEL8 Make voltage, current, and resistance measurements using electrical test equipment.

Academic Standards

- A1 Recognize, classify, and use real numbers and their properties.
- A3 Simplify algebraic expressions, solve and graph equations, inequalities and systems in one and two variables.
- A5 Utilize various formulas in problem-solving situations.
- E2 Communicate ideas for a variety of school and other life situations through listening, speaking, and reading aloud.
- E3 Read, evaluate, and use print, non-print, and technological sources to research issues and problems, to present information, and to complete projects.
- E4 Work individually and as a member of a team to analyze and interpret information, to make decisions, to solve problems, and to reflect, using increasingly complex and abstract thinking.
- E8 Read, discuss, analyze, and evaluate literature from various genres and other written material.
- E10 Use language and critical thinking strategies to serve as tools for learning.

Workplace Skills for the 21st Century

- WP2 Acquires, evaluates, organizes and maintains, and interprets/communicates information, including the use of computers.
- WP3 Practices interpersonal skills related to careers including team member participation, teaching other people, serving clients/customers, exercising leadership, negotiation, and working with culturally diverse.
- WP4 Applies systems concept including basic understanding, monitoring and correction system performance, and designing and improving systems.
- WP6 Employs thinking skills including creative thinking, decision making, problem solving, reasoning, and knowing how to learn.
- WP7 Basic Skills: Employs basic academic skills including reading, writing, arithmetic and mathematics, speaking, and listening.
- WP8 Personal Qualities: Practices work ethics related to individual responsibility, integrity, honesty, and personal management.

National Educational Technology Standards for Students

- T1 Basic operations and concepts
- T2 Social, ethical, and human issues
- T3 Technology productivity tools
- T4 Technology communications tools
- T5 Technology research tools
- T6 Technology problem-solving and decision-making tools

Suggested References

Jeffus, L. (2004). *Refrigeration and air conditioning*. Upper Saddle River, NJ: Pearson Prentice Hall.

Herman, S., & Sparkman, B. (2001). *Electricity and controls for HVAC/R*. Albany, NY: Delmar.

National Center for Construction Education and Research. (2004). *HVAC level I*. Upper Saddle River, NJ: Pearson Prentice Hall.

Silberstein, E. (2005). *Residential construction academy: HVAC*. Albany, NY: Delmar.

Whitman, W., Johnson, W., & Tomczyk, J. (2005). *Refrigeration and air conditioning technology*. Albany, NY: Delmar.

Heating and Air Conditioning II
Unit 4: Introduction to Heating

(61 hours)

Competencies and Suggested Objectives	Suggested Strategies for Competencies
<p>1. Identify/explain a maintenance schedule.</p>	<p>Teaching:</p> <ul style="list-style-type: none"> Provide students with terms, definitions, and sample schedules. The students will utilize the above information to discuss and develop a maintenance schedule. <small>E2, E3, E4, E8, E10</small> <p>Assessment:</p> <ul style="list-style-type: none"> The activity will be assessed by class participation and using a rubric for the schedule project.
<p>2. Explore the various types of fuels, systems, and methods of transfer.</p> <ol style="list-style-type: none"> Identify and explain the three methods by which heat is transferred. Describe how combustion occurs. Identify the various type of fuels used in heating. 	<p>Teaching:</p> <ul style="list-style-type: none"> Utilize the Contren Level I Introduction to Heating to read and discuss information concerning fuels, systems, and methods of transfer. The students will research the byproducts of combustion and write a brief summary of the information obtained. The students will also compare the various types of fuels used in heating. Provide the students with a scenario for the student to compare fuel sources to be used in a new of existing construction. <small>A1, E1, E2, E3, E4, E5, E8, E9, E10</small> <p>Assessment:</p> <ul style="list-style-type: none"> Assess the research summary and the scenario with a checklist or rubric.
<p>3. Perform maintenance on a heating system.</p> <ol style="list-style-type: none"> Identify the major components of heating systems. 	<p>Teaching:</p> <ul style="list-style-type: none"> Utilize the Contren Level I Introduction to Heating to discuss and identify the major components of various heating systems (electric, gas, etc.). Have students research emerging technologies in heating systems and fuels and write a brief summary of the research found. <small>A1, E1, E2, E3, E4, E5, E8, E9, E10</small> Discuss and demonstrate actual heating system maintenance and procedures. Have the students perform or simulate maintenance on a specified heating system. <small>A1, E2, E3, E4, E8, E10</small> <p>Assessment:</p> <ul style="list-style-type: none"> Assessment for the summary will be a checklist.

	<ul style="list-style-type: none"> Assessment for the performance activity will be teacher observation and a checklist.
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STANDARDS

Contren Learning Series Best Practices

Level I

- ITH1 Explain the three methods by which heat is transferred and give an example of each.
- ITH2 Describe how combustion occurs and identify the by-products of combustion.
- ITH3 Identify the various types of fuels used in heating.
- ITH4 Identify the major components and accessories of a forced-air furnace and explain the function of each component.
- ITH5 State the factors that must be considered when installing a furnace.
- ITH6 Identify the major components of a gas furnace and describe how each works.
- ITH7 With supervision, use a manometer to measure and adjust manifold pressure on a gas furnace.
- ITH8 Identify the major components of an oil furnace and describe how each works.
- ITH9 Describe how an electric furnace works.
- ITH10 With supervision, perform basic furnace preventive maintenance procedures such as cleaning and filter replacement.

Academic Standards

- A1 Recognize, classify, and use real numbers and their properties.
- E2 Communicate ideas for a variety of school and other life situations through listening, speaking, and reading aloud.
- E3 Read, evaluate, and use print, non-print, and technological sources to research issues and problems, to present information, and to complete projects.
- E4 Work individually and as a member of a team to analyze and interpret information, to make decisions, to solve problems, and to reflect, using increasingly complex and abstract thinking.
- E8 Read, discuss, analyze, and evaluate literature from various genres and other written material.
- E10 Use language and critical thinking strategies to serve as tools for learning.

Workplace Skills for the 21st Century

- WP2 Acquires, evaluates, organizes and maintains, and interprets/communicates information, including the use of computers.
- WP3 Practices interpersonal skills related to careers including team member participation, teaching other people, serving clients/customers, exercising leadership, negotiation, and working with culturally diverse.

- WP4 Applies systems concept including basic understanding, monitoring and correction system performance, and designing and improving systems.
- WP6 Employs thinking skills including creative thinking, decision making, problem solving, reasoning, and knowing how to learn.
- WP7 Basic Skills: Employs basic academic skills including reading, writing, arithmetic and mathematics, speaking, and listening.
- WP8 Personal Qualities: Practices work ethics related to individual responsibility, integrity, honesty, and personal management.

National Educational Technology Standards for Students

- T1 Basic operations and concepts
- T3 Technology productivity tools
- T6 Technology problem-solving and decision-making tools

Suggested References

- Jeffus, L. (2004). *Refrigeration and air conditioning*. Upper Saddle River, NJ: Pearson Prentice Hall.
- National Center for Construction Education and Research. (2004). *HVAC level I*. Upper Saddle River, NJ: Pearson Prentice Hall.
- Silberstein, E. (2005). *Residential construction academy: HVAC*. Albany, NY: Delmar.
- Whitman, W., Johnson, W., & Tomczyk, J. (2005). *Refrigeration and air conditioning technology*. Albany, NY: Delmar.

Heating and Air Conditioning II
Unit 5: Introduction to Air Conditioning

(66 hours)

Competencies and Suggested Objectives	Suggested Strategies for Competencies
<p>1. Identify and perform a maintenance schedule.</p>	<p>Teaching:</p> <ul style="list-style-type: none"> • Provide students with terms, definitions, and sample schedules. The students will utilize the above information to discuss and develop a maintenance schedule. ^{E2, E3, E4, E8, E10} • Discuss and demonstrate the procedures for performing maintenance on various cooling systems (air conditioner, refrigerator, ice machine, etc.). The students will perform the maintenance procedures on assigned cooling systems. ^{E2, E3, E4, E8, E10} <p>Assessment:</p> <ul style="list-style-type: none"> • The activity will be assessed by class participation and using a rubric for the schedule project. • The performance activity will be assessed using a checklist.
<p>2. Identify and discuss the major components of a cooling system.</p> <ol style="list-style-type: none"> Explain how heat transfer occurs in a cooling system. Calculate the temperature and pressure relationships at key points. Use temperature and pressure measuring instruments to make readings at key points. Identify refrigerants and demonstrate the procedures for handling. 	<p>Teaching:</p> <ul style="list-style-type: none"> • (Utilize Contren, Level I Introduction to Cooling.) Provide the students with a vocabulary list and have them define terms. Read and discuss the material relating to heat transfer, pressure or temperature, refrigerants, components, and accessories. Explain the process, charts and diagrams, and calculation processes. Discuss and demonstrate the function of major components of a cooling system. Have the students complete a project in which a scenario is given. The students will utilize all procedures to troubleshoot the problem and complete the repair. (This project will include written summary of problem solution, calculation of necessary data, charting the process of troubleshooting the problem, and simulation or real work completion of project.) ^{A1, A3, A5, E1, E2, E3, E4, E5, E8, E9, E10} <p>Assessment:</p> <ul style="list-style-type: none"> • The vocabulary and discussion will be assessed by teacher observation and written

	test. The project will be assessed by teacher observation and a checklist.
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STANDARDS

Contren Learning Series Best Practices

Level I

- ITC1 Explain how heat transfer occurs in a cooling system, demonstrating an understanding of the terms and concepts used in the refrigeration cycle.
- ITC2 Calculate the temperature and pressure relationships at key points in the refrigeration cycle.
- ITC3 Under supervision, use temperature-and pressure-measuring instruments to make readings at key points in the refrigeration cycle.
- ITC4 Identify commonly used refrigerants and demonstrate the procedures for handling these refrigerants.
- ITC5 Identify the major components of a cooling system and explain how each type works.
- ITC6 Identify the major accessories available for cooling systems and explain how each type works.
- ITC7 Identify the control devices used in cooling systems and explain how each type works.
- ITC8 State the correct methods to be used when piping a refrigeration system.

Academic Standards

- A1 Recognize, classify, and use real numbers and their properties.
- A3 Simplify algebraic expressions, solve and graph equations, inequalities and systems in one and two variables.
- A5 Utilize various formulas in problem-solving situations.
- E1 Produce writing which reflects increasing proficiency through planning, writing, revising, and editing and which is specific to audience and purpose.
- E2 Communicate ideas for a variety of school and other life situations through listening, speaking, and reading aloud.
- E3 Read, evaluate, and use print, non-print, and technological sources to research issues and problems, to present information, and to complete projects.
- E4 Work individually and as a member of a team to analyze and interpret information, to make decisions, to solve problems, and to reflect, using increasingly complex and abstract thinking.
- E5 Complete oral and written presentations which exhibit interaction and consensus within a group.
- E8 Read, discuss, analyze, and evaluate literature from various genres and other written material.
- E9 Sustain progress toward fluent control of grammar, mechanics, and usage of standard English in the context of writing and speaking.
- E10 Use language and critical thinking strategies to serve as tools for learning.

Workplace Skills for the 21st Century

- WP1 Allocates resources (time, money, materials and facilities, and human resources).
- WP2 Acquires, evaluates, organizes and maintains, and interprets/communicates information, including the use of computers.
- WP3 Practices interpersonal skills related to careers including team member participation, teaching other people, serving clients/customers, exercising leadership, negotiation, and working with culturally diverse.
- WP4 Applies systems concept including basic understanding, monitoring and correction system performance, and designing and improving systems.
- WP5 Selects, applies, and maintains/troubleshoots technology.
- WP6 Employs thinking skills including creative thinking, decision making, problem solving, reasoning, and knowing how to learn.
- WP7 Basic Skills: Employs basic academic skills including reading, writing, arithmetic and mathematics, speaking, and listening.
- WP8 Personal Qualities: Practices work ethics related to individual responsibility, integrity, honesty, and personal management.

National Educational Technology Standards for Students

- T1 Basic operations and concepts
- T3 Technology productivity tools
- T4 Technology communications tools
- T6 Technology problem-solving and decision-making tools

Suggested References

- Jeffus, L. (2004). *Refrigeration and air conditioning*. Upper Saddle River, NJ: Pearson Prentice Hall.
- National Center for Construction Education and Research. (2004). *HVAC level I*. Upper Saddle River, NJ: Pearson Prentice Hall.
- Silberstein, E. (2005). *Residential construction academy: HVAC*. Albany, NY: Delmar.
- Whitman, W., Johnson, W., & Tomczyk, J. (2005). *Refrigeration and air conditioning technology*. Albany, NY: Delmar.

Recommended Tools and Equipment

CAPITALIZED ITEMS

1. Computer file server with network software (1)
2. Computer with operating software with multimedia kit (6-8)
3. Internet access
4. Networkable laser printer
5. Recovery/recycling equipment (1)
6. Commercial/Industrial ice machine (1)
7. A/C split (gas) (1)
8. Residential package heating (Dual purpose—for heating and cooling instruction) (1)
9. Air-to-air heat pump (with electrical backup heat) (1)

NON-CAPITALIZED ITEMS

Tools

1. Acetylene B-tank (8)
2. Acetylene regulator-hose and tips (turbo)—tip with halide leak detector (4)
3. Bench/metal top with metal vise (10)
4. C clamps, assorted sets—6", 8", 10" (3)
5. Divider set (1)
6. Drill, 3/8" and 1/2" electric (1)
7. 7" pedestal grinder, commercial (1)
8. 220v kit quick start (1)
9. 110v kit quick start (1)
10. Electronic leak detector (2)
11. Pop rivet gun set (1)
12. Service valve kit (2)
13. Snips: straight, left, right (3)
14. Soldering station (1)
15. Combination squares (2)
16. Tap and die set (1 metric and 1 SAE)
17. 25 ft. tape measure (2)
18. Three-foot metal rules (2)
19. Universal appliance truck (1)
20. Vacuum (wet or dry)(1)
21. Oxyfuel welding units (2)
22. Pipe wrench set
23. Chisel set (2)
24. Combination wrench sets (1 metric and 1 SAE)
25. Diagonal cutters (4)
26. Reciprocating saw (1)
27. Grinder, side (4" and 7") (1)
28. File set (1)

29. Flare/swage sets (5)
30. Nitrogen tank and recycling regulator and relief valve (1)
31. First aid kit (1)
32. Schrader valve core removal tool (1)
33. Low loss fittings (3)
34. Industrial flashlight (1)
35. Fuse puller (1)
36. Hack saws (2)
37. Ball peen hammer sets (2)
38. Set, refrigeration flare nut wrench (7/16"-1") (1)
39. Nut driver sets (4)
40. Pinch off tool (1)
41. Pliers (slip joint/needle nose/linesman locking) (4)
42. Scratch awls (2)
43. Screwdriver sets (straight and Phillips) (4)
44. Sockets and ratchet set—2" and 3/8" drive, 1/4" drive (1 metric and 1 SAE)
45. Tubing bender set (1)
46. Tubing cutter kits (5)
47. Wire strippers (5)
48. Allen wrenches sets (2)
49. Wire end crimpers (2)
50. Sanitation cabinet with 1 pair of safety glasses per person (1)
51. 8 ft. fiberglass ladder (1)
52. Cordless drills, 3/8" and 2" (1 each))
53. Four wheel cart (1)
54. Appliance lift (1)
55. Torpedo levels - 9" (2)
56. Spirit level, 36" (1)
57. Claw hammers (2)
58. Stainless steel brush (2)
59. Stainless steel wire brush (toothbrush) (2)
60. Adjustable wrenches 6" - 8" - 10" (2 ea)
61. Open end—box end wrench sets—1/4" through 1" (2)
62. Pipe vise with tripod (1)
63. Pipe die set, 3/8" through 1 1/4" (1)
64. Pipe reamer (1)
65. High speed drill bit set with 2" shank 1/16" through 2" (1)
66. Eyewash station (1)
67. Analog multi-meters (6)
68. Digital multi-meter (6)
69. PCV cutters—3/8" through 1" (3)
70. Pump sprayer (2)

Equipment

1. A/C window unit (1)
2. Residential refrigerator (1)
3. Clamp-on ammeters (4)
4. Hermetic analyzer (1)
5. Capacitor analyzer (1)
6. Set of recording ammeter and voltmeter (1)
7. Electronic thermometer (1)
8. Electronic charging scale (1)
9. Micron vacuum gauge (1)
10. Manifold gauge sets (6)
12. Bimetal (digital) thermometers (6)
13. Temperature recorder (1)
14. Psychrometer (dry and wet bulb) (2)
15. Vacuum pumps (2)
16. Refrigerant identifier (1)
17. Storage tanks (3)
18. Hand oil pump (1)
19. Combustion test kit (1)
20. U-tube manometer (1)
21. Carbon monoxide tester (1)
22. Velocity meter (Dual purpose—for heating and cooling instruction) (1)

RECOMMENDED INSTRUCTIONAL AIDS

It is recommended that instructors have access to the following items:

1. Scientific calculator (1)
2. VCR/DVD Player (1)
3. Cart, AV (for VCR/DVD and data projector) (1)
4. Data projector (1)
5. Laptop computer (1)
6. Laser printer
7. Digital camera
8. Digital scanner with Optical Character Recognition (OCR)

Student Competency Profile for Heating and Air Conditioning I

Student: _____

This record is intended to serve as a method of noting student achievement of the competencies in each unit. It can be duplicated for each student and serve as a cumulative record of competencies achieved in the course.

In the blank before each competency, place the date on which the student mastered the competency.

Unit 1: Introduction and Orientation

- ____ 1. Describe local program and vocational center policies and procedures.
- ____ 2. Describe employment opportunities and responsibilities.
- ____ 3. Explore leadership skills and personal development opportunities provided students by student organizations to include SkillsUSA.
- ____ 4. Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations.
- ____ 5. Discuss the basic principles of heating, ventilation, and air conditioning to include materials and techniques.

Unit 2: Basic Safety

- ____ 1. Describe general safety rules for working in a shop/lab and industry.
- ____ 2. Identify and apply safety around welding operations.
- ____ 3. Identify and explain use of various barriers and confinements.
- ____ 4. Explain lifting and the use of ladders and scaffolds.
- ____ 5. Explain the Material Safety Data Sheet (MSDS).
- ____ 6. Explain fires.
- ____ 7. Explain safety in and around electrical situations.

Unit 3: Basic Math

- ____ 1. Apply the four basic math skills with whole numbers, fractions, and percent.
- ____ 2. Use the metric system.
- ____ 3. Apply basic mathematics for heating, ventilation, and air conditioning.

Unit 4: Hand and Power Tools

- ____ 1. Demonstrate the use and maintenance of hand and power tools.

Unit 5: Introduction to Blueprints

- ____ 1. Read, analyze, and design a blueprint.

Unit 6: Basic Rigging

- _____ 1. Explain and identify safe rigging and equipment.
- _____ 2. Discuss the proper use of load-handling and signaling practices.

Unit 7: Manifold Gauges and Refrigerant Cylinder

- _____ 1. Explain and apply the basic principles in the use of manifold gauges and refrigerant cylinders.

Unit 8: Leak Detection and Vacuum Pump/Recovery Service Operations

- _____ 1. Describe leaks in a refrigerant system.
- _____ 2. Locate leaks in a refrigerant system using the various methods.
- _____ 3. Identify/install a basic vacuum pump service operation.
- _____ 4. Provide basic recovery system service operations.

Unit 9: Copper and Plastic Tubing Practices

- _____ 1. Identify and demonstrate precautions and procedures when installing refrigerant piping.

Unit 10: Soldering and Brazing Procedures

- _____ 1. Discuss and demonstrate procedures for soldering and brazing safely.

Student Competency Profile for Heating and Air Conditioning II

Student: _____

This record is intended to serve as a method of noting student achievement of the competencies in each unit. It can be duplicated for each student and serve as a cumulative record of competencies achieved in the course.

In the blank before each competency, place the date on which the student mastered the competency.

Unit 1: Orientation Review

- _____ 1. Review local program and vocational center policies and procedures.
- _____ 2. Review employment opportunities and responsibilities.
- _____ 3. Review leadership skills and personal development opportunities provided students by student organizations to include SkillsUSA.
- _____ 4. Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations.

Unit 2: Basic Safety (Review and Reinforcement)

- _____ 1. Describe general safety rules for working in a shop/lab and industry.
- _____ 2. Identify and apply safety around welding operations.
- _____ 3. Identify and explain use of various barriers and confinements.
- _____ 4. Explain lifting and the use of ladders and scaffolds.
- _____ 5. Explain the Material Safety Data Sheet (MSDS).
- _____ 6. Explain fires.
- _____ 7. Explain safety in and around electrical situations.

Unit 3: Basic Electricity

- _____ 1. Describe/identify basic electricity.
- _____ 2. Interpret wiring diagrams.
- _____ 3. Demonstrate the ability to wire basic circuits.

Unit 4: Introduction to Heating

- _____ 1. Identify/explain a maintenance schedule.
- _____ 2. Explore the various types of fuels, systems, and methods of transfer.
- _____ 3. Perform maintenance on a heating system.

Unit 5: Introduction to Air Conditioning

- _____ 1. Identify and perform a maintenance schedule.
- _____ 2. Identify and discuss the major components of a cooling system.

Appendix A: Contren Learning Series Best Practices¹

CORE CURRICULUM BEST PRACTICES

BASIC SAFETY

- SAF1 Identify the responsibilities and personal characteristics of a professional craftsperson.
- SAF2 Explain the role that safety plays in the construction crafts.
- SAF3 Describe what job-site safety means.
- SAF4 Explain the appropriate safety precautions around common job-site hazards.
- SAF5 Demonstrate the use and care of appropriate personal protective equipment.
- SAF5 Follow safe procedures for lifting heavy objects.
- SAF6 Describe safe behavior on and around ladders and scaffolds.
- SAF7 Explain the importance of the HazCom (Hazard Communication Standard) requirement and MSDSs (Material Safety Data Sheets).
- SAF8 Describe fire prevention and fire fighting techniques.
- SAF9 Define safe work procedures around electrical hazards.

INTRODUCTION TO CONSTRUCTION MATH

- MAT1 Add, subtract, multiply, and divide whole numbers, with and without a calculator.
- MAT2 Use a standard ruler and a metric ruler to measure.
- MAT3 Add, subtract, multiply, and divide fractions.
- MAT4 Add, subtract, multiply, and divide decimals, with and without a calculator.
- MAT5 Convert decimals to percents and percents to decimals.
- MAT6 Convert fractions to decimals and decimals to fractions.
- MAT7 Explain what the metric system is and how it is important in the construction trade.
- MAT8 Recognize and use metric units of length, weight, volume, and temperature.
- MAT9 Recognize some of the basic shapes used in the construction industry and apply basic geometry to measure them.

INTRODUCTION TO HAND TOOLS

- HTO1 Recognize and identify some of the basic hand tools used in the construction trade.
- HTO2 Use these tools safely.
- HTO3 Describe the basic procedures for taking care of these tools.

INTRODUCTION TO POWER TOOLS

- PTO1 Identify commonly used power tools of the construction trade.
- PTO2 Use power tools safely.
- PTO3 Explain how to maintain power tools properly.

¹ Contren learning series. Retrieved October 7, 2004, from <http://www.nccer.org/>

INTRODUCTION TO BLUEPRINTS

- BLU1 Recognize and identify basic blueprint terms, components, and symbols.
- BLU2 Relate information on blueprints to actual locations on the print.
- BLU3 Recognize different classifications of drawings.
- BLU4 Interpret and use drawing dimensions.

BASIC RIGGING

- RIG1 Identify and describe the use of slings and common rigging hardware.
- RIG2 Describe the basic inspection techniques and rejection criteria used for slings and hardware.
- RIG3 Describe the basic hitch configurations and their proper connections.
- RIG4 Describe basic load-handling safety practices.
- RIG5 Demonstrate proper use of American National Standards Institute (ANSI) hand signals.

COMMUNICATION SKILLS

- COM1 Demonstrate the ability to understand information and instructions that are presented in both written and verbal form.
- COM2 Demonstrate the ability to communicate effectively in on-the-job situations using written and verbal skills.

EMPLOYABILITY SKILLS

- EMP1 Explain the construction industry, the role of the companies that make up the industry, and the role of individual professionals in the industry.
- EMP2 Demonstrate critical thinking skills and the ability to solve problems using those skills.
- EMP3 Demonstrate knowledge of computer systems and explain common uses for computers in the construction industry.
- EMP4 Demonstrate effective relationship skills with teammates and supervisors, exhibit the ability to work on a team, and demonstrate appropriate leadership skills.
- EMP5 Be aware of workplace issues such as sexual harassment, stress, and substance abuse.

LEVEL I**INTRODUCTION TO HVAC**

- INT1 Explain the basic principles of heating, ventilation, and air conditioning.
- INT2 Identify career opportunities available to people in the HVAC trade.
- INT3 Explain the purpose and objectives of an apprentice training program.
- INT4 Describe how certified apprentice training can start in high school.
- INT5 Describe what the Clean Air Act means to the HVAC trade

TRADE MATHEMATICS

- TMA1 Identify similar units of measurement in both the inch-pound (English) and metric systems and know which units are larger.

TMA2 Convert measured values in the inch-pound system to equivalent metric values and vice versa.

TMA3 Express numbers as powers of ten.

TMA4 Determine the powers and roots of numbers.

TMA5 Solve basic algebraic equations.

TMA6 Recognize various geometric figures.

TMA7 Use the Pythagorean theorem to make calculations involving right triangles.

TMA7 Convert decimal feet to feet and inches and vice versa.

TOOLS OF THE TRADE

TOT1 Identify and state the use of the following tools:

- ⟨Pipe wrenches
- ⟨Torque wrenches
- ⟨Tinner's and soft-faced hammers
- ⟨Hand cutting snips
- ⟨Hand and power hacksaws
- ⟨Drill press
- ⟨Measuring tools

TOT2 Describe the general procedures for maintenance of most hand and power tools.

TOT3 Describe or demonstrate the general safety precautions that must be followed when using most hand and power tools.

COPPER AND PLASTIC PIPING

CPP1 State the precautions that must be taken when installing refrigerant piping.

CPP2 Select the right tubing for the job.

CPP3 Cut and bend tubing

CPP4 Safely join tubing by using flare and compression fittings.

CPP5 Determine the kinds of hangers and supports needed for refrigerant piping.

CPP6 State the basic requirements for pressure testing a system once it has been installed.

SOLDERING AND BRAZING

SBR1 Assemble and operate the tools used for soldering.

SBR2 Prepare tubing and fittings for soldering.

SBR3 Identify the purposes and uses of solder and solder fluxes.

SBR4 Solder copper tubing and fittings.

SBR5 Assemble and operate the tools used for brazing.

SBR6 Prepare tubing and fittings for brazing.

SBR7 Identify the purposes and uses of filler metals and fluxes used for brazing.

SBR8 Braze copper tubing and fittings.

SBR9 Identify the inert gases that can safely be used to purge tubing when brazing.

BASIC ELECTRICITY

BEL1 State how electrical power is generated and distributed.

- BEL2 Describe how voltage, current, resistance, and power are related.
- BEL3 Use Ohm's law to calculate the current, voltage, and resistance in a circuit.
- BEL4 Use the power formula to calculate how much power is consumed by a circuit.
- BEL5 Describe the differences between series and parallel circuits.
- BEL6 Recognize and describe the purpose and operation of the various electrical components used in HVAC equipment.
- BEL7 State and demonstrate the safety precautions that must be followed when working on electrical equipment.
- BEL8 Make voltage, current, and resistance measurements using electrical test equipment.

INTRODUCTION TO COOLING

- ITC1 Explain how heat transfer occurs in a cooling system, demonstrating an understanding of the terms and concepts used in the refrigeration cycle.
- ITC2 Calculate the temperature and pressure relationships at key points in the refrigeration cycle.
- ITC3 Under supervision, use temperature-and pressure-measuring instruments to make readings at key points in the refrigeration cycle.
- ITC4 Identify commonly used refrigerants and demonstrate the procedures for handling these refrigerants.
- ITC5 Identify the major components of a cooling system and explain how each type works.
- ITC6 Identify the major accessories available for cooling systems and explain how each type works.
- ITC7 Identify the control devices used in cooling systems and explain how each type works.
- ITC8 State the correct methods to be used when piping a refrigeration system.

INTRODUCTION TO HEATING

- ITH1 Explain the three methods by which heat is transferred and give an example of each.
- ITH2 Describe how combustion occurs and identify the by-products of combustion.
- ITH3 Identify the various types of fuels used in heating.
- ITH4 Identify the major components and accessories of a forced-air furnace and explain the function of each component.
- ITH5 State the factors that must be considered when installing a furnace.
- ITH6 Identify the major components of a gas furnace and describe how each works.
- ITH7 With supervision, use a manometer to measure and adjust manifold pressure on a gas furnace.
- ITH8 Identify the major components of an oil furnace and describe how each works.
- ITH9 Describe how an electric furnace works.
- ITH10 With supervision, perform basic furnace preventive maintenance procedures such as cleaning and filter replacement.

LEVEL II

LEAK DETECTION, EVACUATION, RECOVERY, AND CHARGING

- LDE1 Identify the common types of leak detectors and explain how each is used.
- LDE2 Demonstrate skill in performing leak detection tests.

- LDE3 Identify the service equipment used for evacuating a system and explain why each item of equipment is used.
- LDE4 Demonstrate skill in performing system evacuation and dehydration.
- LDE5 Identify the service equipment used for recovering refrigerant from a system and for recycling the recovered refrigerant, and explain why each item of equipment is used.
- LDE6 Demonstrate skill in performing refrigerant recovery.
- LDE7 Demonstrate or explain how to use a recycle unit.
- LDE8 Identify the service equipment used for charging refrigerant into a system, and explain why each item of equipment is used.
- LDE9 Demonstrate skill in charging refrigerant into a system.

Appendix B: Academic Standards

Algebra I²

Competencies and Suggested Objective(s)

- A1 Recognize, classify, and use real numbers and their properties.
- Describe the real number system using a diagram to show the relationships of component sets of numbers that compose the set of real numbers.
 - Model properties and equivalence relationships of real numbers.
 - Demonstrate and apply properties of real numbers to algebraic expressions.
 - Perform basic operations on square roots excluding rationalizing denominators.
- A2 Recognize, create, extend, and apply patterns, relations, and functions and their applications.
- Analyze relationships between two variables, identify domain and range, and determine whether a relation is a function.
 - Explain and illustrate how change in one variable may result in a change in another variable.
 - Determine the rule that describes a pattern and determine the pattern given the rule.
 - Apply patterns to graphs and use appropriate technology.
- A3 Simplify algebraic expressions, solve and graph equations, inequalities and systems in one and two variables.
- Solve, check, and graph linear equations and inequalities in one variable, including rational coefficients.
 - Graph and check linear equations and inequalities in two variables.
 - Solve and graph absolute value equations and inequalities in one variable.
 - Use algebraic and graphical methods to solve systems of linear equations and inequalities.
 - Translate problem-solving situations into algebraic sentences and determine solutions.
- A4 Explore and communicate the characteristics and operations of polynomials.
- Classify polynomials and determine the degree.
 - Add, subtract, multiply, and divide polynomial expressions.
 - Factor polynomials using algebraic methods and geometric models.
 - Investigate and apply real-number solutions to quadratic equations algebraically and graphically.
 - Use convincing arguments to justify unfactorable polynomials.
 - Apply polynomial operations to problems involving perimeter and area.
- A5 Utilize various formulas in problem-solving situations.
- Evaluate and apply formulas (e.g., circumference, perimeter, area, volume, Pythagorean Theorem, interest, distance, rate, and time).
 - Reinforce formulas experimentally to verify solutions.
 - Given a literal equation, solve for any variable of degree one.

² *Mississippi mathematics framework—Algebra I*. (2003). Retrieved September 10, 2003, from http://marcopolo.mde.k12.ms.us/frameworks/mathematics/ma_algebra_i.html

- d. Using the appropriate formula, determine the length, midpoint, and slope of a segment in a coordinate plane.
 - e. Use formulas (e.g., point-slope and slope-intercept) to write equations of lines.
- A6 Communicate using the language of algebra.
- a. Recognize and demonstrate the appropriate use of terms, symbols, and notations.
 - b. Distinguish between linear and non-linear equations.
 - c. Translate between verbal expressions and algebraic expressions.
 - d. Apply the operations of addition, subtraction, and scalar multiplication to matrices.
 - e. Use scientific notation to solve problems.
 - f. Use appropriate algebraic language to justify solutions and processes used in solving problems.
- A7 Interpret and apply slope as a rate of change.
- a. Define slope as a rate of change using algebraic and geometric representations.
 - b. Interpret and apply slope as a rate of change in problem-solving situations.
 - c. Use ratio and proportion to solve problems including direct variation ($y=kx$).
 - d. Apply the concept of slope to parallel and perpendicular lines.
- A8 Analyze data and apply concepts of probability.
- a. Collect, organize, graph, and interpret data sets, draw conclusions, and make predictions from the analysis of data.
 - b. Define event and sample spaces and apply to simple probability problems.
 - c. Use counting techniques, permutations, and combinations to solve probability problems.

Biology I³

Competencies and Suggested Objective(s)

- B1 Utilize critical thinking and scientific problem solving in designing and performing biological research and experimentation.
- a. Demonstrate the proper use and care for scientific equipment used in biology.
 - b. Observe and practice safe procedures in the classroom and laboratory.
 - c. Apply the components of scientific processes and methods in the classroom and laboratory investigations.
 - d. Communicate results of scientific investigations in oral, written, and graphic form.
- B2 Investigate the biochemical basis of life.
- a. Identify the characteristics of living things.
 - b. Describe and differentiate between covalent and ionic bonds using examples of each.
 - c. Describe the unique bonding and characteristics of water that makes it an essential component of living systems.
 - d. Classify solutions using the pH scale and relate the importance of pH to organism survival.

³ *Mississippi science framework—Biology I*. (2003). Retrieved September 10, 2003, from http://marcopolo.mde.k12.ms.us/frameworks/science/sci_biology_I.html

- e. Compare the structure, properties and functions of carbohydrates, lipids, proteins and nucleic acids in living organisms.
 - f. Explain how enzymes work and identify factors that can affect enzyme action.
- B3 Investigate cell structures, functions, and methods of reproduction.
- a. Differentiate between prokaryotic and eukaryotic cells.
 - b. Distinguish between plant and animal (eukaryotic) cell structures.
 - c. Identify and describe the structure and basic functions of the major eukaryotic organelles.
 - d. Describe the way in which cells are organized in multicellular organisms.
 - e. Relate cell membrane structure to its function in passive and active transport.
 - f. Describe the main events in the cell cycle and cell mitosis including differences in plant and animal cell divisions.
 - g. Relate the importance of meiosis to sexual reproduction and the maintenance of chromosome number.
 - h. Identify and distinguish among forms of asexual and sexual reproduction.
- B4 Investigate the transfer of energy from the sun to living systems.
- a. Describe the structure of ATP and its importance in life processes.
 - b. Examine, compare, and contrast the basic processes of photosynthesis and cellular respiration.
 - c. Compare and contrast aerobic and anaerobic respiration.
- B5 Investigate the principles, mechanisms, and methodology of classical and molecular genetics.
- a. Compare and contrast the molecular structures of DNA and RNA as they relate to replication, transcription, and translation.
 - b. Identify and illustrate how changes in DNA cause mutations and evaluate the significance of these changes.
 - c. Analyze the applications of DNA technology (forensics, medicine, agriculture).
 - d. Discuss the significant contributions of well-known scientists to the historical progression of classical and molecular genetics.
 - e. Apply genetic principles to solve simple inheritance problems including monohybrid crosses, sex linkage, multiple alleles, incomplete dominance, and codominance.
 - f. Examine inheritance patterns using current technology (gel electrophoresis, pedigrees, karyotypes).
- B6 Investigate concepts of natural selection as they relate to diversity of life.
- a. Analyze how organisms are classified into a hierarchy of groups and subgroups based on similarities and differences.
 - b. Identify characteristics of kingdoms including monerans, protists, fungi, plants and animals.
 - c. Differentiate among major divisions of the plant and animal kingdoms (vascular/non-vascular; vertebrate/invertebrate).
 - d. Compare the structures and functions of viruses and bacteria relating their impact on other living organisms.
 - e. Identify evidence of change in species using fossils, DNA sequences, anatomical and physiological similarities, and embryology.

- f. Analyze the results of natural selection in speciation, diversity, adaptation, behavior and extinction.
- B7 Investigate the interdependence and interactions that occur within an ecosystem.
 - a. Analyze the flow of energy and matter through various cycles including carbon, oxygen, nitrogen and water cycles.
 - b. Interpret interactions among organisms in an ecosystem (producer/consumer/decomposer, predator/prey, symbiotic relationships and competitive relationships).
 - c. Compare variations, tolerances, and adaptations of plants and animals in major biomes.
 - d. Investigate and explain the transfer of energy in an ecosystem including food chains, food webs, and food pyramids.
 - e. Examine long and short-term changes to the environment as a result of natural events and human actions.

English II⁴

Competencies and Suggested Objective(s)

- E1 Produce writing which reflects increasing proficiency through planning, writing, revising, and editing and which is specific to audience and purpose.
 - a. Produce individual and/or group compositions and/or projects to persuade, tell a story, describe, create an effect, explain or justify an action or event, inform, entertain, etc.
 - b. Produce writing typically used in the workplace such as social, business, and technical correspondence; explanation of procedures; status reports; research findings; narratives for graphs; justification of decisions, actions, or expenses; etc.
 - c. Write a response, reaction, interpretation, analysis, summary, etc., of literature, other reading matter, or orally presented material.
 - d. Revise to ensure effective introductions, details, wording, topic sentences, and conclusions.
- E2 Communicate ideas for a variety of school and other life situations through listening, speaking, and reading aloud.
 - a. Listen to determine the main idea and supporting details, to distinguish fact from opinion, and to determine a speaker's purpose or bias.
 - b. Speak with appropriate intonation, articulation, gestures, and facial expression.
 - c. Speak effectively to explain and justify ideas to peers, to inform, to summarize, to persuade, to entertain, to describe, etc.
- E3 Read, evaluate, and use print, non-print, and technological sources to research issues and problems, to present information, and to complete projects.
 - a. Read, view, and listen to distinguish fact from opinions and to recognize persuasive and manipulative techniques.
 - b. Access both print and non-print sources to produce an I-Search paper, research paper, or project.

⁴ *Mississippi language arts framework—English II*. (2003). Retrieved September 10, 2003, from http://marcopolo.mde.k12.ms.us/frameworks/language_arts/la_10.html

- c. Use computers and audio-visual technology to access and organize information for purposes such as resumes, career search projects, and analytical writings, etc.
 - d. Use reference sources, indices, electronic card catalog, and appropriate research procedures to gather and synthesize information.
- E4 Work individually and as a member of a team to analyze and interpret information, to make decisions, to solve problems, and to reflect, using increasingly complex and abstract thinking.
- a. Interact with peers to examine real world and literary issues and ideas.
 - b. Show growth in critical thinking, leadership skills, consensus building, and self-confidence by assuming a role in a group, negotiating compromise, and reflecting on individual or group work.
- E5 Complete oral and written presentations which exhibit interaction and consensus within a group.
- a. Share, critique, and evaluate works in progress and completed works through a process approach.
 - b. Communicate effectively in a group to present completed projects and/or compositions.
 - c. Edit oral and written presentations to reflect correct grammar, usage, and mechanics.
- E6 Explore cultural contributions to the history of the English language and its literature.
- a. Explore a variety of works from various historical periods, geographical locations, and cultures, recognizing their influence on language and literature.
 - b. Identify instances of dialectal differences which create stereotypes, perceptions, and identities.
 - c. Recognize root words, prefixes, suffixes, and cognates.
 - d. Relate how vocabulary and spelling have changed over time.
- E7 Discover the power and effect of language by reading and listening to selections from various literary genres.
- a. Listen to and read aloud selected works to recognize and respond to the rhythm and power of language to convey a message.
 - b. Read aloud with fluency and expression.
 - c. Analyze the stylistic devices, such as alliteration, assonance, word order, rhyme, onomatopoeia, etc., that make a passage achieve a certain effect.
 - d. Demonstrate how the use of language can confuse or inform, repel or persuade, or inspire or enrage.
 - e. Analyze how grammatical structure or style helps to create a certain effect.
- E8 Read, discuss, analyze, and evaluate literature from various genres and other written material.
- a. Read and explore increasingly complete works, both classic and contemporary, for oral discussion and written analysis.
 - b. Read, discuss, and interpret literature to make connections to life.
 - c. Read from a variety of genres to understand how the literary elements contribute to the overall quality of the work.
 - d. Identify qualities in increasingly complex literature that have produced a lasting impact on society.

- e. Read for enjoyment, appreciation, and comprehension of plot, style, vocabulary, etc.
- E9 Sustain progress toward fluent control of grammar, mechanics, and usage of standard English in the context of writing and speaking.
 - a. Infuse the study of grammar and vocabulary into written and oral communication.
 - b. Demonstrate, in the context of their own writing, proficient use of the conventions of standard English, including, but not limited to, the following: complete sentences, subject-verb agreement, plurals, spellings, homophones, possessives, verb forms, punctuation, capitalization, pronouns, pronoun-antecedent agreement, parallel structure, and dangling and misplaced modifiers.
 - c. Give oral presentations to reinforce the use of standard English.
 - d. Employ increasingly proficient editing skills to identify and solve problems in grammar, usage, and structure.
- E10 Use language and critical thinking strategies to serve as tools for learning.
 - a. Use language to facilitate continuous learning, to record observations, to clarify thought, to synthesize information, and to analyze and evaluate language.
 - b. Interpret visual material orally and in writing.

U. S. History from 1877⁵

Competencies and Suggested Objective(s)

- H1 Explain how geography, economics, and politics have influenced the historical development of the United States in the global community.
 - a. Apply economic concepts and reasoning when evaluating historical and contemporary social developments and issues (e.g., gold standard, free coinage of silver, tariff issue, laissez faire, deficit spending, etc.).
 - b. Explain the emergence of modern America from a domestic perspective (e.g., frontier experience, Industrial Revolution and organized labor, reform movements of Populism and Progressivism, Women’s Movement, Civil Rights Movement, the New Deal, etc.).
 - c. Explain the changing role of the United States in world affairs since 1877 through wars, conflicts, and foreign policy (e.g., Spanish-American War, Korean conflict, containment policy, etc.).
 - d. Trace the expansion of the United States and its acquisition of territory from 1877 (e.g., expansionism and imperialism).
- H2 Describe the impact of science and technology on the historical development of the United States in the global community.
 - a. Analyze the impact of inventions on the United States (e.g., telephone, light bulb, etc.).
 - b. Examine the continuing impact of the Industrial Revolution on the development of our nation (e.g., mass production, computer operations, etc.).
 - c. Describe the effects of transportation and communication advances since 1877.
- H3 Describe the relationship of people, places, and environments through time.

⁵ *Mississippi social studies framework—U.S. History from 1877*. (2003). Retrieved September 10, 2003, from http://marcopolo.mde.k12.ms.us/frameworks/social_studies/ss_us_history.html

- a. Analyze human migration patterns since 1877 (e.g., rural to urban, the Great Migration, etc.).
 - b. Analyze how changing human, physical, geographic characteristics can alter a regional landscape (e.g., urbanization, Dust Bowl, etc.).
- H4 Demonstrate the ability to use social studies tools (e.g., timelines, maps, globes, resources, graphs, a compass, technology, etc.).
- a. Interpret special purpose maps, primary/secondary sources, and political cartoons.
 - b. Analyze technological information on graphs, charts, and timelines.
 - c. Locate areas of international conflict (e.g., Caribbean, Southeast Asia, Europe, etc.).
- H5 Analyze the contributions of Americans to the ongoing democratic process to include civic responsibilities.
- a. Examine various reform movements (e.g., Civil Rights, Women's Movement, etc.).
 - b. Examine the government's role in various movements (e.g., arbitration, 26th Amendment, etc.).
 - c. Examine the role of government in the preservation of citizens' rights (e.g., 19th Amendment, Civil Rights Act of 1964).
 - d. Examine individuals' duties and responsibilities in a democratic society (e.g., voting, volunteerism, etc.).

Appendix C: Workplace Skills for the 21st Century⁶

- WP1 Allocates resources (time, money, materials and facilities, and human resources).
- WP2 Acquires, evaluates, organizes and maintains, and interprets/communicates information, including the use of computers.
- WP3 Practices interpersonal skills related to careers including team member participation, teaching other people, serving clients/customers, exercising leadership, negotiation, and working with culturally diverse.
- WP4 Applies systems concept including basic understanding, monitoring and correction system performance, and designing and improving systems.
- WP5 Selects, applies, and maintains/troubleshoots technology.
- WP6 Employs thinking skills including creative thinking, decision making, problem solving, reasoning, and knowing how to learn.
- WP7 Basic Skills: Employs basic academic skills including reading, writing, arithmetic and mathematics, speaking, and listening.
- WP8 Personal Qualities: Practices work ethics related to individual responsibility, integrity, honesty, and personal management.

⁶ Secretary's commission on achieving necessary skills. Retrieved July 13, 2004, from <http://wdr.doleta.gov/SCANS/>

Appendix D: National Educational Technology Standards for Students⁷

- T1 Basic operations and concepts
- Students demonstrate a sound understanding of the nature and operation of technology systems.
 - Students are proficient in the use of technology.
- T2 Social, ethical, and human issues
- Students understand the ethical, cultural, and societal issues related to technology.
 - Students practice responsible use of technology systems, information, and software.
 - Students develop positive attitudes toward technology uses that support lifelong learning, collaboration, personal pursuits, and productivity.
- T3 Technology productivity tools
- Students use technology tools to enhance learning, increase productivity, and promote creativity.
 - Students use productivity tools to collaborate in constructing technology-enhanced models, prepare publications, and produce other creative works.
- T4 Technology communications tools
- Students use telecommunications to collaborate, publish, and interact with peers, experts, and other audiences.
 - Students use a variety of media and formats to communicate information and ideas effectively to multiple audiences.
- T5 Technology research tools
- Students use technology to locate, evaluate, and collect information from a variety of sources.
 - Students use technology tools to process data and report results.
 - Students evaluate and select new information resources and technological innovations based on the appropriateness for specific tasks.
- T6 Technology problem-solving and decision-making tools
- Students use technology resources for solving problems and making informed decisions.
 - Students employ technology in the development of strategies for solving problems in the real world.

⁷ ISTE: National educational technology standards (NETS). Retrieved July 13, 2004, from <http://cnets.iste.org/>