

Review of Competencies for HVAC Excellence

Cengage Learning

Refrigeration & Air Conditioning Technology 9th Edition

ISBN: 9780357122273

RESIDENTIAL AIR CONDITIONING

HVAC Standard	Whitman, 9E Unit, Page Number
<i>Students should have knowledge of Air Conditioning components and be able to demonstrate proficiency in:</i>	
The three states of matter	Unit 1, p. 17-19
The laws of Thermodynamics	Unit 1, p. 18-20
Heat transfer Convection, Conduction, and Radiation	Unit 1, p. 20-22
Atmospheric pressure and the effect of altitude	Unit 1, p. 17, 26
Absolute and gauge pressures	Unit 1, p. 27-28
Psychrometrics	Unit 35, p. 1036-1058
Refrigerant charging methods	Unit 10, p. 254-269
Refrigerant piping	Unit 38, p. 1145, 1147-1153
Soldering and brazing	Unit 7, p. 153-156, 162-169
Refrigerant leak detection and types of leak detectors	Unit 8, p. 182-196
Recovery and recycling processes	Unit 8, p. 200-206; Unit 9, p. 237-251
Defining enthalpy and entropy	Unit 3, p. 61-74; Unit 35, p. 1044-1050
Change of state between liquids, vapor, and solids	Unit 1, p. 22-24
Describing and defining the following; conduction, convection and radiant heat transfer	Unit 1, p. 20-22
Describing, defining, and converting the following temperature measurements; Fahrenheit, Celsius, Rankine, and Kelvin	Unit 1, p. 17-18

Condensation of a vapor, and its effect on heat	Unit 1, p. 22
Vaporization of a liquid, and its effect on heat	Unit 1, p. 22
Describing the thermodynamics of refrigerants	Unit 9, p. 242-244, 249-251
Describing and defining the following; BTU, latent heat, sensible heat	Unit 1, p. 18-20, 22-24
Describing and defining the following; subcooled liquid, superheated vapor	Unit 3, p. 48-49, 52-57, 63-74 Unit 21, p. 497-498
Describing the state of refrigerant, and explain what occurs in each major component during normal operation	Unit 3, p. 43-47
Using saturation tables	Unit 3, p. 47
Identifying and defining the following types of blends; Binary, Ternary, Azeotropic, and Near Azeotropic	Unit 3, p. 57-59; Unit 9, p. 228; Unit 10, p. 268-269
Identifying and defining; CFC's, HCFC's, HFC's, HFO's & HC's	Unit 9, p. 218-224
Describing temperature glide	Unit 3, p. 48-49, 52-57; Unit 9, p. 228-237; Unit 10, p. 261-269
Describing fractionation and its causes	Unit 9, p. 228-237; Unit 10, p. 266-269
Describing and defining the following; wet bulb temperature, dry bulb temperature, and dew point	Unit 35, p. 1038-1041, 1043-1044
Measuring wet and dry-bulb temperatures	Unit 35, p. 1038-1041, 1043-1044
Defining wet bulb depression	Unit 35, p. 1043-1045
Describing the principles of dehumidification and humidification	Unit 3, p. 55; Unit 21, p. 488-489
Describing, explaining the function, evaluating, cleaning, and replacing (when feasible) of the following components:	
<ul style="list-style-type: none"> • <i>Compressors (reciprocating, scroll, rotary, and screw)</i> 	Unit 23, p. 543-576
<ul style="list-style-type: none"> • <i>Compressor capacity control methods and operation</i> 	Unit 23, p. 559-572
<ul style="list-style-type: none"> • <i>Condensers air cooled</i> 	Unit 22, p. 524-527
<ul style="list-style-type: none"> • <i>Condensers water cooled</i> 	Unit 22, p. 509-524
<ul style="list-style-type: none"> • <i>Metering devices (capillary tube, thermostatic expansion valve, automatic expansion valve, electronic expansion valve)</i> 	Unit 24, p. 578-603

• <i>Evaporators</i>	Unit 21, p. 486-507
• <i>Receivers</i>	Unit 22 ,p. 514-517; Unit 26, p. 659, 661, 666-668
• <i>Discharge line</i>	Unit 3, p. 50-54
• <i>Liquid line</i>	Unit 43, p. 1279-1280, 1281-1284
• <i>Suction line</i>	Unit 8, p. 186-188, 191-193, 212, 212-215
• <i>Liquid line filter/driver</i>	Unit 8, p. 212-215
• <i>Sight glass</i>	Unit 8, p. 186-188, 191-193, 212-215; Unit 25, p. 638-642
• <i>Suction line filter</i>	Unit 8, p. 212-215
• <i>Accumulator</i>	Unit 25, p. 633-637, 639-643
• <i>Head pressure controls</i>	Unit 25, p. 617-620
• <i>Low pressure controls</i>	Unit 25, p. 621-628
• <i>Pump down solenoid</i>	Unit 25, p. 628
Plotting the refrigeration cycle on a pressure enthalpy chart	Unit 21, p. 495-497
Defining SEER and EER	Unit 43, p. 1299-1303
Describing the operation and use of a gauge manifold assembly	Unit 1, p. 16; Unit 8, p. 188, 197-212
Identifying and differentiate between the various types of service valves	Unit 49, p. 1533-1536, 1539-1542
Obtaining gauge pressure using compound gauges and convert to absolute	Unit 23, p. 543-545
Defining vacuum and vacuum levels as required in the HVACR industry	Unit 8, p. 191-206
Identifying the types of micron gauges and how they should be connected to measure evacuation levels	Unit 8, p. 194-206
Explaining vacuum pump selection	Unit 8, p. 194-206
Evacuating and measuring system evacuation level	Unit 8, p. 194-206
Describing the triple evacuation method	Unit 8, p. 200-206

Soldering and brazing using correct techniques	Unit 7, p. 153-156, 162-169
Demonstrating the triple evacuation method	Unit 8, p. 202-206
Calculating and demonstrating the weigh-in charging method	Unit 10, p. 272-273
Demonstrating charging using the superheat method	Unit 10, p. 267, 274-276, 280
Demonstrating charging using the subcooling method	Unit 10, p. 267, 274-275, 278
Identifying proper charging of a blended refrigerant into an operating system	Unit 10, p. 268-269
Identifying proper charging a blended refrigerant by weight into an empty system	Unit 10, p. 268-269
Demonstrating charging using the manufacturers literature	Unit 10, p. 261-264
Demonstrating charging a mini-split system with two or more evaporators	Unit 10, p. 256-266
Describing the following oils and their applications; Mineral, Alkylbenzene, Glycols, and Esters	Unit 9, p. 235-237
Select the proper refrigerant oil and add it to an operating system	Unit 9, p. 235-237
Defining compression ratio	Unit 23, p. 543, 545, 564-566
Describing and performing a compressor efficiency test	Unit 23, p. 574-576
Determine superheat and subcooling on an operating system	Unit 3, p. 48-49, 52-57, 62-74
Identifying proper charging of a compound refrigerant into an empty system	Unit 10, p. 268-269
Identifying proper charging of a compound refrigerant into an operating system	Unit 10, p. 268-269
Describing the six types of leak detectors and demonstrating the proper use	Unit 8, p. 184-193
Explaining the proper use of each type of leak detector and their applicability	Unit 8, p. 184-193
Explaining the method for and pinpointing a leak	Unit 8, p. 184-193
Explaining the proper use and handling of nitrogen in the leak detection process	Unit 8, p. 184-193
Defining and demonstrating refrigerant recovery	Unit 8, p. 200-206; Unit 9, p. 237-242
Defining and demonstrating refrigerant recycling	Unit 8, p. 200-206; Unit 9, p. 237-242
Defining reclaim	Unit 8, p. 200-206
Installing an air handler	Unit 38, p. 1139-1141, 1145-1149

Installing a condensing unit	Unit 38, p. 1149-1154
Adjusting blower fan speed	Unit 38, p. 1154-1156
Select the proper refrigerant oil and add it to an operating system	Unit 9, p. 235-237
Perform a compressor efficiency test	Unit 23, p. 574-576

HVAC Standard	Whitman, 9E Unit, Page Number
<i>Students should have knowledge of and be able to describe and demonstrate the following safety requirements:</i>	
Ladder and fall protection safety procedures	Unit 4, p. 87
Lock Out and Tag Out procedures	Unit 4, p. 82
Proper and safe handling of refrigerants	Unit 4, p. 79-82
Proper PPE requirements	Unit 4, p. 79-82
Emergency First Aid procedures	Unit 4, p. 86-87, 93
Proper use of hand tools	Unit 5, p. 97-115

HVAC Standard	Whitman, 9E Unit, Page Number
<i>Air Conditioning troubleshooting and problem solving:</i>	
Troubleshooting and Problem Solving involve diagnostic procedures requiring the use of test equipment, manufacturers' _installation and start up procedures, and data plate information.	Unit 29, p. 753, 775-776; Unit 41, p. 1221-1246

HVAC Standard	Whitman, 9E Unit, Page Number
<i>Knowledge of the following test instruments and/or tools is required:</i>	

Thermometers (wet and dry)	Unit 35, p. 1043-1046, 1046; Unit 41, p. 1231-1234
Gauge manifold assembly	Unit 1, p. 16; Unit 8, p. 188, 196-199, 207, 209-210, 212
Refrigerant throttling valve	Unit 10, p. 256-264
Charging scale and charging cylinder	Unit 10, p. 260
Soldering and brazing equipment	Unit 7, p. 153-156, 162-170
Flaring tool/ tubing cutters	Unit 5, p. 106-107
Tubing benders	Unit 5, p. 107-108
Nitrogen Cylinder	Unit 8, p. 183-184, 188-191
Leak detector	Unit 8, p. 182-193
Valve Core removal tool	Unit 8, p. 193-200
Micron gauge	Unit 8, p. 194-206
Vacuum pump	Unit 8, p. 194-206
Recovery equipment	Unit 8, p. 200-206; Unit 9, p. 237-251

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COMMERCIAL REFRIGERATION

HVAC Standard	Whitman, 9E Unit, Page Number
<i>Students should have prior knowledge of:</i>	
The laws of Thermodynamics	Unit 1, p. 18-20
Recovery and recycling processes	Unit 8, p. 199, 214-215; Unit 9, p. 237-251
Refrigerant leak detection and types of leak detectors	Unit 8, p. 182-206
Refrigerant piping	Unit 38, p. 1045-1154
Soldering and brazing	Unit 7, p. 153-156, 162-169
Refrigerant types	Unit 9, p. 220-237
Leak detectors	Unit 8, p. 182-206

HVAC Standard	Whitman, 9E Unit, Page Number
<i>Students must have knowledge of light commercial refrigeration systems, their components, and be able to demonstrate proficiency in:</i>	
Defining enthalpy and entropy	Unit 3, p. 63-74; Unit 35, p. 1044-1050
Change of state between liquids, vapor, and solids	Unit 1, p. 22-24
Describing and defining the following; conduction, convection and radiant heat transfer	Unit 1, p. 20-22
Describing, defining, and converting the following temperature measurements; Fahrenheit, Celsius, Rankine, and Kelvin	Unit 1, p. 17-18

Condensation of a vapor, and its effect on heat	Unit 1, p. 22
Vaporization of a liquid, and its effect on heat	Unit 1, p. 22
Describing the thermodynamics of refrigerants	Unit 9, p. 245
Define Cryogenics	Not Available
Define and state the applications of High, Medium, and Low temperature refrigeration	Unit 21, p. 487; Unit 26, p. 652-685
Define "Expendable Refrigerant"	Unit 28, p. 733-739
Describing and defining the following; BTU, latent heat, sensible heat	Unit 1, p. 18-20, 22-24
Describing and defining the following; subcooled liquid, superheated vapor	Unit 3, p. 49, 52-57, 66-67, 70; Unit 21, p. 498
Describing the state of refrigerant, and explain what occurs in each major component during normal operation	Unit 3, p. 43-47
Using saturation tables	Unit 3, p. 45-47
Identifying and defining the following types of blends; Binary, Ternary, Azeotropic, and Near Azeotropic	Unit 3, p. 57-59; Unit 9, p. 228; Unit 10, p. 266-268
Identifying and defining; CFC's, HCFC's, HFC's, HFO's & HC's	Unit 9, p. 218-227
Describing temperature glide	Unit 3, p. 45, 53, 57-58; Unit 9, p. 228-235; Unit 10, p. 262, 266-269
Describing fractionation and its causes	Unit 9, p. 228-234; Unit 10, p. 266, 268
Explain the procedures to retrofit a system from a CFC to an HFC, & an HCFC to an HFC	Not Available
Describing and defining the following; wet bulb temperature, dry bulb temperature, and dew point	Unit 35, p. 1038-1044
Defining wet bulb depression	Unit 35, p. 1038-1044
Measuring wet and dry-bulb temperatures	Unit 35, p. 1038-1044
Describing the principles of dehumidification and humidification	Unit 3, p. 55; Unit 21, p. 488
Define and explain the use of high humidity evaporator coils	Not Available
Describing, explaining the function, evaluating, cleaning, and replacing (when feasible) of the following components:	

<ul style="list-style-type: none"> • <i>Compressors (reciprocating, scroll, rotary, and screw)</i> 	Unit 23, p. 543-545; p. 574-576
<ul style="list-style-type: none"> • <i>Condensers air cooled</i> 	Unit 22, p. 524-527
<ul style="list-style-type: none"> • <i>Condensers water cooled</i> 	Unit 22, p. 509-524
<ul style="list-style-type: none"> • <i>Metering devices (capillary tube, thermostatic expansion valve, automatic expansion valve, electronic expansion valve)</i> 	Unit 24, p. 578-603
<ul style="list-style-type: none"> • <i>Refrigerant distributors and feeder tubes</i> 	Unit 21, p. 487-507
<ul style="list-style-type: none"> • <i>Evaporators</i> 	Unit 22 ,p. 514-517; Unit 26, p. 659, 662, 665-667
<ul style="list-style-type: none"> • <i>Receivers</i> 	Unit 3, p. 50-54
<ul style="list-style-type: none"> • <i>Discharge line</i> 	Unit 43, p. 1279-1284
<ul style="list-style-type: none"> • <i>Liquid line</i> 	Unit 8, p. 186-1883, 192, 212, 214
<ul style="list-style-type: none"> • <i>Suction line</i> 	Unit 8, p. 214-215
<ul style="list-style-type: none"> • <i>Liquid line filter</i> 	Unit 8, p. 214-215
<ul style="list-style-type: none"> • <i>Sight glass</i> 	Unit 8, p. 186-187, 201, 213-215; Unit 25, p. 640
<ul style="list-style-type: none"> • <i>Suction line filter</i> 	Unit 8, p. 186-188, 197, 218, 220
<ul style="list-style-type: none"> • <i>Vibration eliminator</i> 	Unit 25, p. 644-649
<ul style="list-style-type: none"> • <i>Accumulator</i> 	Unit 25, p. 641-643
<ul style="list-style-type: none"> • <i>Head pressure controls</i> 	Unit 25, p. 617-620
<ul style="list-style-type: none"> • <i>Low pressure controls</i> 	Unit 25, p. 621-628
<ul style="list-style-type: none"> • <i>Pump down solenoid</i> 	Unit 25, p. 628
<ul style="list-style-type: none"> • <i>Oil separator</i> 	Unit 25, p. 644-648
<ul style="list-style-type: none"> • <i>Crankcase heater</i> 	Unit 25, p. 644-648
<ul style="list-style-type: none"> • <i>Economizer</i> 	Unit 50, p. 1563-1569
<ul style="list-style-type: none"> • <i>Lockout relay</i> 	Not Available
<ul style="list-style-type: none"> • <i>Thermostat</i> 	Unit 43, p. 1295-1299

• <i>Oil pressure safety control</i>	Unit 25, p. 624-627
• <i>Current start relay</i>	Not Available
• <i>Defrost heater</i>	Unit 15, 366-373
• <i>Defrost terminator</i>	Unit 15, 366-373
• <i>Mechanical or electronic defrost timer</i>	Unit 45, p. 1384, 1386
• <i>Crankcase pressure regulator (CPR)</i>	Unit 25, p. 610-617
• <i>Liquid line solenoid valve</i>	Unit 25, p. 637-643; Unit 43, p. 1283-1284
• <i>Evaporator pressure regulator (EPR)</i>	Unit 25, p. 606-610
• <i>Pressure regulator (OPR)</i>	Unit 25, p. 606-620
• <i>Ambient temperature controls</i>	Unit 25, p. 617-630
• <i>Water regulating valve</i>	Unit 22, p. 509-524
Plotting the refrigeration cycle on a pressure enthalpy chart	Unit 21, p. 498
Defining SEER and EER	Unit 43, p. 1299-1303
Describing a cascade system its application and operation	Unit 28, p. 743
Describing the purpose and applicability of a defrost cycle	Unit 43, p. 1299-1303
Describing defrost cycle initiation and termination	Unit 43, p. 1299-1306
Describing the basic cycles and operation of ice makers	Unit 27, p. 688-713
Describing a Head Master and its operation	Unit 22, p 530-541
Describing the function, selection and installation of auxiliary heat exchangers	Unit 25, p. 641
Select the proper refrigerant oil add to an operating system	Unit 9, p. 235-237
Adjusting blower fan speed	Unit 38, p. 1154-1156
Sizing, designing, and installing refrigerant lines	Unit 38, p. 1150-1154
Describing a service valve and its operation	Unit 49, p. 1533-1536, 1539-1542
Determine refrigerant line pressure drop and explain the effects of pressure drop on a system	Not Available

Describing proper soldering and brazing techniques	Unit 7, p. 153-156, 162-169
Describing the function, selection and installation of a vibration eliminator	Unit 25, p. 644-649
Describing the design structure, function, operation, and selection of refrigerant distributors and feeder tubes	Unit 25, p. 637-643
Installing a medium temperature condensing unit	Unit 26, p. 677; Unit 38, p. 1149-1154
Installing a low temperature evaporator with electric defrost	Unit 21, p. 502-503
Describing the required CFM for evaporator operation and calculate air flow	Unit 37, p. 1088-1089
Installing a condensate drain for a low temperature system	Unit 38, p. 1145-1149
Describing a drain and drain pan heater and their operation	Unit 26, p. 681-683
Defining reclaim	Unit 8, p. 202-206
Defining and demonstrating refrigerant recycling	Unit 8, p. 202-206; Unit 9, p. 237-251
Defining and demonstrating refrigerant recovery	Unit 8, p. 206-210; Unit 9, p. 237-251
Explaining the proper use and handling of nitrogen in the leak detection process	Unit 8, p. 184-193
Explaining the method for and pinpointing a leak	Unit 8, p. 184-193
Explaining the proper use of each type of leak detector and their applicability	Unit 8, p. 184-193
Describing the six types of leak detectors and demonstrating the proper use	Unit 8, p. 184-193
Identifying proper charging of a compound refrigerant into an operating system	Unit 10, p. 264-266
Identifying proper charging of a compound refrigerant into an empty system	Unit 10, p. 264-266
Determine superheat and subcooling on an operating system	Unit 3, p. 49, 52-54, 57, 66-67, 71-74, 77-79
Describing and performing a compressor efficiency test	Unit 23, p. 590-592
Select the proper refrigerant oil and add it to an operating system	Unit 9, p. 235-238
Describing the following oils and their applications; Mineral, Alkylbenzene, Glycols, and Esters	Unit 9, p. 235-238
Demonstrating charging a mini-split system with two or more evaporators	Unit 10, p. 258-265
Demonstrating charging using the manufacturers literature	Unit 10, p. 261-264

Identifying proper charging a blended refrigerant by weight into an empty system	Unit 10, p. 268-269
Identifying proper charging of a blended refrigerant into an operating system	Unit 10, p. 268-269
Demonstrating charging using the subcooling method	Unit 10, p. 254-265
Describing the proper procedure for measuring and adjusting evaporator superheat	Unit 10, p. 254-267
Stating the reason why capillary tube systems require a critical charge	Unit 29, p. 764
Describing a capillary / distributor tube sizing and selection procedure	Unit 10, p. 261-264
Calculating and demonstrating the weigh-in charging method	Unit 10, p. 259-260
Describing the triple evacuation method	Unit 8, p. 202-206
Demonstrating the triple evacuation method	Unit 8, p. 202-206
Soldering and brazing using correct techniques	Unit 7, p. 153-156, 162-169
Evacuating and measuring system evacuation level	Unit 8, p. 195, 199-202
Explaining vacuum pump selection	Unit 8, p. 194-202
Identifying the types of micron gauges and how they should be connected to measure evacuation levels	Unit 8, p. 195, 198-204
Obtaining gauge pressure using compound gauges and convert to absolute	Unit 1, p. 27-28
Describing the operation and use of a gauge manifold assembly	Unit 1, p. 16; Unit 8, p. 188, 197-199, 207-210, 212
Identifying and differentiate between the various types of service valves	Unit 49, p. 1533-1536, 1539-1542
Defining compression ratio	Unit 23, p. 558, 560, 581-582
Describing the automatic pump-down system and its operation	Unit 21, p. 506
Describing an air cooled condenser, its function, and operating parameters	Unit 22, p. 524-527
Installing water cooled system and adjusting a water regulating valve	Unit 22, p. 509-524
Describing the function of, and install a lockout relay in a circuit	Not Available
Describing the operation of and install a contactor	Unit 19, p. 458-460; Unit 30, p. 813

Describing, test, and install a run and start capacitor	Unit 12, p. 297-298; Unit 17, p. 427-428, 434; Unit 20, p. 476-480
Describing and install a compressor potential start relay	Not Available
Describing the operation of and test a high pressure switch	Unit 25, p. 621
Describing the operation of and test a low pressure switch	Unit 25, p. 621
Install and adjust a low pressure switch used for temperature control	Unit 43, p. 1295-1299
Describing and wire the terminal connections of a thermostat temperature control	Unit 12, p. 304-309
Describing and test thermistor type temperature sensors (PTC & NTC)	Unit 25, p. 628-632
Describing the function, check the operation, and wire an oil pressure safety control	Unit 25, p. 617-630
Installing and adjusting a low ambient temperature control	Unit 20, p. 467, 476; Unit 38, p. 1154-1156
Test a blower or fan motor and its circuit	Unit 25, p. 618-619
Describing the operation of and testing a hot gas bypass valve	Unit 25, p. 606-610
Describing the operation of and adjust an inline, and pilot operated evaporator pressure regulator	Unit 25, p. 637-643; Unit 43, p. 1283-1284
Describing and installing a replaceable core liquid line drier	Unit 8, p. 212-215; Unit 25, p. 640-644
Describing and install a replaceable core suction line filter drier	Unit 21, p. 487-507
Describing dry type evaporators and their operation	Unit 21, p. 487-507
Describing the piping configuration for a multiple evaporator systems	Unit 23, p. 559-572
Describing the function and purpose of a multiple compressor system	Unit 23, p. 559-572
Compressor capacity control methods and operation	Unit 47, p. 1452-1494
Describing a chilled water system and its operation	Unit 48, p. 1498-1524
Describing cooling towers and their operating limitations	Unit 21, p. 487-507
Describing the operation and function of a flooded evaporator and its metering device	Unit 21, p. 506

HVAC Standard	Whitman, 9E Unit, Page Number
<i>Students must have knowledge of and be able to demonstrate the following safety requirements:</i>	
Describe and perform "Lock out and Tag" procedures	Unit 4, p. 82
System leak-test pressures and nitrogen regulator installation and adjustment	Unit 8, p. 184-193
Explain and demonstrate the proper method of connecting a micron gauge to the system	Unit 8, p. 195, 198-204

HVAC Standard	Whitman, 9E Unit, Page Number
<i>Commercial Refrigeration troubleshooting and problem solving:</i>	
Troubleshooting and Problem Solving involves diagnostic procedures requiring the use of test equipment, manufacturers' installation and start up procedures, and data plate information.	Unit 29, p. 753, 775-776; Unit 41, p. 1221-1246
<i>Knowledge of the following test instruments and/or tools is required</i>	
Ammeter	Unit 11, p. 276-278
Oil pressure gauge	Unit 25, p. 628-633
Ohmmeter	Unit 11, p. 276-278
Oil pump	Unit 25, p. 628-633
Voltmeter	Not Available
Nitrogen Cylinder	Unit 8, p. 183, 188-189
Micron gauge	Unit 8, p. 195, 198-204
Vacuum pump	Unit 8, p. 193-204
Sling Psychrometer	Unit 5, p. 126
Refrigerant throttling valve	Unit 10, p. 258-261
Thermometers (wet and dry)	Unit 35, p. 1044-1045; Unit 41, p. 1231-1234

Recovery equipment	Unit 8, p. 204-206; Unit 9, p. 237-251
Leak detector	Unit 8, p. 182-194
Charging scale and charging cylinder	Unit 10, p. 260
Gauge manifold assembly	Unit 1, p. 16; Unit 8, p. 193, 205, 212, 214-217
Soldering and brazing equipment	Unit 7, p. 153-156, 162-169

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CORE COMPETENCIES

Mathematics for HVACR

HVAC Standard	Whitman, 9E Unit, Page Number
<i>Students should have knowledge of and be able to demonstrate proficiency in the following:</i>	
Adding, subtracting, multiplying, and dividing decimal numbers including negative numbers	Not Available
Adding, subtracting, multiplying, and dividing fractions	Not Available
Adding, subtracting, multiplying, and dividing whole numbers including negative numbers	Not Available
Calculating ΔT	Unit 30, p. 813; Unit 31, p. 837
Calculating squares, cubes, and roots for area and volume	Not Available
Converting English measurements to Metric measurements and Metric to English	Unit 1, p. 17-18
Converting fractions to decimals, and decimals to fractions	Not Available
Measure length, area, and volume using both inch pound (English) and SI (metric) measurements	Not Available
Solving basic equations	Not Available
Manipulate ratios and proportions as they relate to various equipment and components such as:	
<ul style="list-style-type: none">Compressors	Unit 23, p. 543-545; p. 574-576
<ul style="list-style-type: none">Pumps	Unit 23, p. 543-545; p. 574-576

<ul style="list-style-type: none"> • Drive Systems 	Unit 18, p. 450-454
<ul style="list-style-type: none"> • Fans 	Unit 18, p. 450-454; Unit 37, p. 1089-1092

HVACR General Studies

HVAC Standard	Whitman, 9E Unit, Page Number
<i>Students should have knowledge of and be able to demonstrate proficiency in:</i>	
HVACR industry organizations	Preface, p. xiii; Introduction, p. 6-10;
Energy resources	Unit 2, p. 35-38
Energy efficiency ratings	Unit 31, p. 853-857; Unit 39, p. 1199-1200, 1204, 1216,
Defining and differentiating between Renewable and Sustainable energy	Unit 1, p. 5-7
Life Cycle cost Analysis	Not Available
The meaning of the follow acronyms BIM, CBECS, ECM, EIA, EER, SEER, AFUE, HSPF, COP,	Unit 31, p. 857; Unit 40, p. 1209, 1216; Unit 43, p. 1287-1288, 1288-1292; BIM and EIC Not Available.
Energy auditing	Unit 39, p. 1158-1172
The thermodynamics of air and water vapor	Unit 35, p. 1037, 1041-1058
The water vapor cycle in the Earth's atmosphere	Not Available
Standard air volume and density	Unit 35, p. 1038, 1041-1042, 1046-1049,
Psychrometrics	Unit 35, p. 1038-1041, 1043, 1044-1050, 1052-1058
The properties of each line on a psychrometric chart	Unit 35, p. 1046-1050
Plotting any two basic points on the psychrometric chart and evaluating the data	Unit 35, p. 1046-1050
Describing the eight processes of air conditioning and how to plot each on a psychrometric chart	Unit 35, p. 1046-1055
Defining and use the Process Triangle on the psychrometric chart to calculate, sensible heat, latent heat and total heat	Unit 35, p. 1046-1058

Explaining the comfort zone and the different temperatures and relative humidity's effect on human comfort	Unit 35, p. 1038-1041
Explaining sensible heat ratio	Unit 35, p. 1049-1058
Calculating mixed air problems for infiltration and ventilation	Unit 35, p. 1055-1058
Calculating residential structure heat loss and gain	Unit 42, 1255-1256
Calculating duct sizing, using duct sizing formulas	Unit 37, p. 1122-126
Developing critical thinking skills including analysis, evaluation, calculations, and the use of computer technology	Unit 39, p. 1159-1160, 1166, 1186, 1189, 1199-1202; Unit 41, p. 1225-1226

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ELECTRICAL

HVAC Standard	Whitman, 9E Unit, Page Number
<i>Students should have knowledge of and be able to demonstrate proficiency in the following:</i>	
Electrical Safety	Unit 4, p. 82-85
The structure of an Atom	Unit 12, p. 284-285
Direct current	Unit 12, p. 288, 298
Alternating current	Unit 12, p. 288, 302
Positive and negative charged atoms	Unit 12, p. 284-286
Potential difference	Unit 12, p. 287-295
Current flow	Unit 12, p. 285-295
Ohm's Law and solving problems applying to Ohm's Law	Unit 11, p. 276-278; Unit 12, p. 288-292
Watts Law	Unit 2, p. 37-38
Series and Parallel circuit rules	Unit 12, p. 292-293
The effects of voltage drop, amps, and resistance in a series circuit	Unit 12, p. 292-293; Unit 15, p. 366
The effects of voltage, amps, and resistance in a parallel circuit	Unit 12, p. 292-293; Unit 15, p. 366
The effects of voltage, amps, and resistance in a combination series-parallel circuit	Unit 12, p. 292-293
Impedance and how it effects a circuits	Unit 12, p. 298

Interpreting Electrical Diagrams	Unit 30, p. 803-815
Calculating and measuring the voltage output of a transformer using the number of turns on the primary vs. the secondary sides	Unit 12, p. 295-297; Unit 15, p. 363-365, 367-368
Defining and identifying conductors	Unit 12, p. 286-287
Describing and identifying insulators	Unit 12, p. 286-287
Describing and identifying semi-conductors	Unit 12, p. 307-312
Identifying the types and describing the proper application and use of "Circuit Protectors"	Unit 12, p. 305-307
Overload protectors construction and function	Unit 12, p. 305-307; Unit 13, p. 316-317; Unit 41, p. 1239-1240
Evaluating, replacing, and describing the function, application and wiring of a start capacitor	Unit 12, p. 297-298; Unit 17, p. 426-428, 434; Unit 20, p. 488-491
Evaluating, replacing and describing the function, application and wiring of a run capacitor	Unit 12, p. 297-298; Unit 17, p. 427-428, 434; Unit 20, p. 476-480
The fundamentals of single phase and three phase motors	Unit 17, p. 412, 417-419
Defining and measuring Locked Rotor Amps, and Full Load Amps	Unit 17, p. 409, 412-413
Demonstrating and explaining the purpose of checking the resistance of motor windings	Unit 20, p. 471-476
Describing a dual voltage three phase motor	Unit 17, p. 425-426; Unit 18, 443-445
Describing a dual voltage three phase motor and demonstrating the wiring configurations	Unit 17, p. 425-426; Unit 18, p. 443-445
Describing a permanent split capacitor motor, capacitor start induction run motor, and a multi speed motor	Unit 17, p. 414-417
Describing the operation and characteristics of motor speed drives	Unit 17, p. 420-425
Describing and demonstrating setup and adjustment of a Variable Frequency Drive (VFD)	Unit 17, p. 431-434
Describing and demonstrating setup and adjustment of a Variable Speed Drive (VSD)	Unit 17, p. 431-434
Describing and demonstrating the method used to change rotation direction in a three phase motor	Unit 17, p. 417-419

Describing and explaining motor construction, speed, rotation for single phase motors	Unit 17, p. 412
Describing the operation and characteristics of an Electronically Commutated Motor (ECM)	Unit 17, p. 434-435
Disassembling, assembling, and describing the function of the parts of an induction motor	Unit 17, p. 409, 417
Explaining the difference between a Wye and Delta three phase motor	Unit 47, p. 1489-1491
Describing the differences between a "Pictorial", a "Ladder Diagram", and a "Schematic"	Unit 15, p. 373-375; Unit 30, p. 806-808
Cleaning evaluating and installing different types of motors (Shaded pole, split phase, PSC, CSR, and ECM)	Unit 17, p. 412, 415-417, 422-423, 434-435
Evaluating and installing a run and start capacitor	Unit 12, p. 297-298; Unit 17, p. 426-429; Unit 20, p. 476-480
Determining the sequence of operation using schematic wiring diagrams	Unit 30, p. 803-813
Drawing and interpreting electrical diagrams for the purpose of troubleshooting	Unit 41, p. 1238-1243
Installing and evaluating a transformer.	Unit 12, p. 295-297, 313
Installing and evaluating a contactor	Unit 19, p. 458-460; Unit 30, p. 830
Installing and evaluating a control relay	Unit 19, p. 457-458
Installing and evaluating a defrost timer	Unit 45, p. 1387-1389
Installing and evaluating a digital thermostat	Unit 15, p. 363-365; Unit 14, p. 331-334
Installing and evaluating a line starter	Unit 19, p. 456, 460-461
Installing and evaluating a solenoid valve	Unit 12, p. 295; Unit 25, p. 617-620; Unit 27, p. 694
Installing and evaluating start relays (current, potential, and solid state)	Not Available
Installing and evaluating temperature coefficient thermistors	Unit 12, p. 308-312
Identifying electrical symbols used in HVACR schematics	Unit 12, p. 291-292
Identifying inoperative/defective components using schematic wiring diagrams	Not Available

Identifying voltage between two points using schematic wiring diagrams	Unit 12, p. 298-302
Installing and evaluating a communications thermostat	Unit 14, p. 331-334
Installing, evaluating and servicing a dual stage thermostat	Unit 16, p. 398-402
Servicing and installing equipment control circuits	Unit 38, p. 1139-1142
Servicing and installing equipment power supply	Unit 38, p. 1139-1141
Identifying the types and describing the proper application and use of common switches use in HVACR	Unit 17, p. 412; Unit 25, p. 320-321, Unit 31, p. 840-843; Unit 32, p. 927
Identifying the types and describing the proper application and use of a Positive temperature coefficient thermistors (PTC)	Unit 12, p. 310-3123
Describing and demonstrating the proper solder, flux, and procedures for soldering electrical wiring	Not Available

HVAC Standard	Whitman, 9E Unit, Page Number
<i>Students should have knowledge of and be able to describe and demonstrate the following safety requirements:</i>	
Ladder safety procedures	Unit 4, p. 87
Describe and perform "Lock out and Tag" procedures	Unit 4, p. 82
Identifying the safety ground	Unit 4, p. 82-85
Identifying the "Hot" conductor	Unit 4, p. 82-85
Identifying "Neutral" conductor	Unit 4, p. 82-85
Electrical Shock, prevention and first aid	Unit 4, p. 82-85
Electrical Burns, prevention and first aid	Unit 4, p. 82-85
Describe and demonstrate emergency first aid procedures	Unit 4, p. 82-85, 94

HVAC Standard	Whitman, 9E Unit, Page Number
<i>Knowledge of the following test instruments and/or tools is required:</i>	

Ohmmeter	Unit 11, p. 276-276
Multimeter	Unit 11, p. 271
Ammeter	Unit 11, p. 276-278
Voltmeter	Unit 11, p. 276-278
Wattmeter	Not Available
Hermetic compressor analyzer	Unit 5, p. 114
Relay tester	Not Available
Megger meter	Not Available
Capacitor analyzer	Not Available

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ELECTRICAL HEAT

HVAC Standard	Whitman, 9E Unit, Page Number
<i>Students should have knowledge of and be able to demonstrate proficiency in:</i>	
Electrical Safety	Unit 30, p. 800, 803, 806-808, 815-817
Electric Heat Theory	Unit 30, p. 800
Identifying system Components	Unit 30, p. 800-813
Calculating Watts	Unit 30, p. 813
Describing how electric heating elements are rated	Unit 30, p. 810-812
Describing types and how a sequencer controls heating elements and blower operation	Unit 37, p. 1092
Defining and calculating furnace BTU output	Unit 30, p. 813
Defining Coefficient of performance	Unit 43, p. 1287-1288
Describing sensible and latent heat	Unit 35, p. 1043-1046
Identifying the formula for sensible heat	Unit 35, p. 1043-1046
Describing the principles of dehumidification and humidification	Unit 3, p. 55; Unit 21, p. 488-489
Differentiating between a resistive and inductive load	Unit 12, p. 287-295
Identifying the material used to construct electric heater elements	Unit 30, p. 800-813
Describing the insulating properties of mica and ceramics and their application	Unit 30, p. 801-803
Describing the operation and purpose of, and evaluate/replace a fan interlock switch	Not Available

Describing snap discs and their sequence of operation	Unit 13, p. 319
Describing the operation of, and evaluate/replace a limit switch	Unit 31, p. 823, 841-843
Evaluating, describing its operation, installing, and setting a pressure differential switch	Unit 31, p. 852-854, 862-865
Describing the effects of relative humidity on comfort and health	Unit 35, p. 1038-1041
Explaining and measuring temperature rise	Unit 30, p. 813
Identifying the various types of motor mounts used on residential furnace blower assemblies	Unit 18, p. 448-450
Identifying the NEC code requirements for residential thermostat wiring	Unit 38, p. 1139-1141
Describing and calculate wire sizing as it applies to voltage drop and length of wiring run	Unit 38, p. 1139-1141
Describing voltage tolerances	Unit 20, p. 471
Demonstrating the measurement of and determining the amp draw of electric heating element	Unit 30, p. 810-817
Describing and demonstrating the method of wiring heating elements in a single-phase-system	Unit 30, p. 800-813
Describing and determine the maximum allowable voltage imbalance in a three phase circuit	Unit 47, p. 1494
Measuring the voltage imbalance in a three phase circuit	Unit 47, p. 1494
Setting the heat anticipation or cycling rate for an electric furnace thermostat	Not Available
Identifying the proper location for and install a conventional thermostat	Unit 30, p. 803-806; Unit 14, p. 341-343
Explaining the detailed wiring and operation of a setback programmable thermostat	Unit 30, p. 806-809
Describing "R" values and application of various duct insulation materials	Unit 38, p. 1137-1138
Determine system maximum allowable operating static pressure	Unit 37, p. 1087
Describing and demonstrating the method of measuring static pressure	Unit 37, p. 1087
Explain the procedures for determining CFM	Unit 37, p. 1088-1089
Stating the recommended air velocities throughout the supply and return duct system	Unit 37, p. 1087-1089, 1093-1097, 1109-1112, 1114, 118-1120, 1126-1130

Stating the recommended air velocities through the return air grilles	Unit 37, p. 1087-1089, 1093-1097, 1109-1112, 1114, 118-1120, 1126-1130
Measure air velocities throughout the supply and return duct system	Unit 37, p. 1087-1089, 1093-1097, 1109-1112, 1114, 118-1120, 1126-1130
Describing the effects of static pressure on air flow	Unit 37, p. 1087
Measure the effects of static pressure on air flow	Unit 37, p. 1087
Demonstrating the procedure for finding CFM using an anemometer	Unit 37, p. 1088-1089
Demonstrating the procedure for finding CFM using temperature rise	Unit 37, p. 1088-1089
Stating the typical operating characteristics of a direct drive blower	Unit 37, p. 1092-1093
Performing blower airflow adjustments	Unit 37, p. 1092-1093, 1110-11123, 1118, 1126
Choosing and installing the proper bearings for a residential belt driven blower assembly	Unit 37, p. 1092
Describing and demonstrating the method of wiring heating elements in a three-phase system (wye or delta)	Not Available
Choosing and using the proper lubricant for residential blower motor maintenance	Unit 18, p. 446-448

HVAC Standard	Whitman, 9E Unit, Page Number
<i>Students should have knowledge of and be able to demonstrate proficiency in:</i>	
Describing and demonstrating the procedure to replace the belt and adjust air flow on a belt driven	Unit 37, p. 1092
Describing, fabricating and install various types of duct connectors	Unit 38, p. 1135
Describing the application of and preform the installation of turning vanes	Unit 37, p. 1107-1108, 1118, 1128-1130
Describing the construction and efficiencies of varying filtering media and systems	Unit 34, p. 1011-1013, 1013-1025
Electric Heat Troubleshooting and Problem Solving	Unit 30, p. 803
Evaluating and replacing a heating element and a sequencer	Unit 37, p. 1092
Describing installation and service procedures for central heating system	Unit 30, p. 821-828

Stating the minimum required clearances for service and safety of an electric furnace	Unit 30, p. 803-813
Evaluating, describing its operation, and install a duct heater	Unit 30, p. 803
Describing procedures for retrofit of a system to electric heat	Not Available

HVAC Standard	Whitman, 9E Unit, Page Number
<i>Students should have knowledge of and be able to describe and demonstrate the following safety requirements:</i>	
Ladder safety procedures	Unit 4, p. 87
Describe and perform "Lock out and Tag" procedures	Unit 4, p. 82
Identifying the safety ground	Unit 4, p. 82-85
Identifying the "Hot" conductor	Unit 4, p. 82-85
Identifying "Neutral" conductor	Unit 4, p. 82-85
Describe and install a GFCI circuit breaker	Unit 4, p. 84
Describe and demonstrate safety grounding procedures for electric motors	Unit 4, p. 84
Describe the application of and test a fusible link	Not Available
Electrical Shock, prevention and first aid	Unit 4, p. 82-85
Electrical Burns, prevention and first aid	Unit 4, p. 82-85
Describe and demonstrate emergency first aid procedures	Unit 4, p. 82-85, 94

HVAC Standard	Whitman, 9E Unit, Page Number
<i>Electric Heat troubleshooting and problem solving:</i>	
Troubleshooting and Problem Solving involves diagnostic procedures requiring the use of test instruments, data plate information, and wiring diagrams. All of the HVACR electric furnace system components, circuits, air distribution system, and/or power supply should be	Unit 30, p. 803

part of the Troubleshooting and Problem Solving question area.	
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HVAC Standard	Whitman, 9E Unit, Page Number
<i>Knowledge of the following test instruments and/or tools is required</i>	
Ohmmeter	Unit 11, p. 276-278
Multimeter	Unit 11, p. 276-278
Ammeter	Unit 5, p. 109; Unit 11, p. 276-278
Voltmeter	Not Available
Wattmeter	Not Available
Megger meter	Not Available
Capacitor analyzer	Not Available

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GAS HEAT

HVAC Standard	Whitman, 9E Unit, Page Number
<i>Students must have knowledge of heating systems, their components, and be able to demonstrate proficiency in:</i>	
Describing and explaining the function of upflow, downflow, and horizontal furnaces	Unit 31, p. 821-823
Explaining combustion Theory and Heating Fuels	Unit 31, p. 823-827
Explaining the Properties of Heating Fuels	Unit 31, p. 823-827
Define BTU	Unit 1, p. 18-20, 22-24
Define AFUE	Unit 31, p. 853-857
Describing and using the formula for sensible heat	Unit 35, p. 1043-4046
Describing the principles of humidification	Unit 3, p. 55
Describing the principles of dehumidification	Unit 21, p. 488-489
Explaining the BTU content of natural gas and propane gas	Unit 1, p. 18-20, 22-24
Describing the fuel pressures in natural gas and liquefied petroleum (LP) gas piping	Unit 31, p. 823-825
Describing and measuring operating fuel pressures in natural gas and liquefied petroleum (LP) furnaces	Unit 31, p. 823-825
Describing the typical flue gas temperatures of gas-fired furnaces	Unit 31, p. 823, 826-827, 837, 855-857
Describing the chemical names of natural gas and propane gas	Unit 31, p. 823-825
Determining the quantity of combustion air required to burn 1 cubic foot of natural gas and propane gas	Unit 31, p. 852-857, 865-867

Defining and differentiating between primary air and excess air	Unit 31, p. 825-827, 835
Stating the maximum percentage of Carbon Dioxide produced by the perfect combustion of natural gas	Unit 31, p. 825-827
Stating the maximum percentage of Carbon Dioxide produced by the perfect combustion of propane gas	Unit 31, p. 825-827
Explaining the ignition temperatures of natural gas and propane gas	Unit 31, p. 825-827
Describing and stating the causes of burner "Flashback"	Not Available
Describing and stating the causes of a lifting flame.	Unit 31, p. 881-883
Stating the reason for appropriate polarity wiring on solid state circuits	Not Available
Stating the generally accepted standard gas manifold pressure for a residential furnace	Unit 31, p. 825
Describing, explaining the function, evaluating, cleaning, and replacing (when feasible) of the following components:	
<ul style="list-style-type: none"> • <i>Gas valves used with residential furnaces</i> 	Unit 31, p. 827-835
<ul style="list-style-type: none"> • <i>Gas pressure regulating valves</i> 	Unit 31, p. 827-835
<ul style="list-style-type: none"> • <i>Orifice</i> 	Unit 31, p. 835
<ul style="list-style-type: none"> • <i>In-shot burner</i> 	Unit 31, p. 835
<ul style="list-style-type: none"> • <i>Pilot burner</i> 	Unit 31, p. 835
<ul style="list-style-type: none"> • <i>Heat exchanger</i> 	Unit 31, 835-840
<ul style="list-style-type: none"> • <i>Flue baffles</i> 	Unit 31, p. 852
<ul style="list-style-type: none"> • <i>Residential gas shutoff valve</i> 	Unit 31, p. 857-860
<ul style="list-style-type: none"> • <i>Thermocouple</i> 	Unit 31, p. 843-846
<ul style="list-style-type: none"> • <i>Thermopile</i> 	Unit 31, p. 843-846
<ul style="list-style-type: none"> • <i>Ignition module</i> 	Unit 31, p. 857-865
<ul style="list-style-type: none"> • <i>Spark igniter</i> 	Unit 31, p. 846-848, 863
<ul style="list-style-type: none"> • <i>Hot surface igniter</i> 	Unit 31, p. 846-848
<ul style="list-style-type: none"> • <i>Flame sensor</i> 	Unit 31, p. 846-852

<ul style="list-style-type: none"> • <i>Combination fan and limit switch</i> 	Unit 31, p. 823, 840-843
<ul style="list-style-type: none"> • <i>Door safety switch</i> 	Not Available
<ul style="list-style-type: none"> • <i>Blower motor relay</i> 	Unit 31, p. 840, 859-861
<ul style="list-style-type: none"> • <i>Vent blower motor</i> 	Unit 31, p. 821-823, 828-830
<ul style="list-style-type: none"> • <i>Vent pressure switch</i> 	Unit 31, p. 865-866
<ul style="list-style-type: none"> • <i>Vent motor relay</i> 	Unit 31, p. 821-823, 828-830
Describing, explaining the function, evaluating, cleaning, and replacing (when feasible) of the following components:	
<ul style="list-style-type: none"> • <i>Single stage thermostat</i> 	Unit 14, p. 331-334; Unit 30, p. 803-806
<ul style="list-style-type: none"> • <i>Dual stage thermostat</i> 	Unit 16, p. 398-402
<ul style="list-style-type: none"> • <i>Run and start capacitor</i> 	Unit 12, p. 297-298; Unit 17, p. 414-417; Unit 20, p. 476-480
<ul style="list-style-type: none"> • <i>Gas piping drip-leg</i> 	Unit 31, p. 868-870
Describing a blower housing cut-off plate	Not Available
Identifying the different types of venting systems	Unit 31, p. 865-868
Sizing and installing the vent systems	Unit 31, p. 865-868
Properly sizing, cutting, threading, and connecting gas piping	Unit 31, p. 868-870
Installing a fire-stop support plate	Not Available
Adjusting blower fan speed for proper temperature rise	Unit 38, p. 1154-1156
Describing the procedure to measure static pressure	Unit 37, p. 1087
Sizing wire with regards to voltage drop and length of wiring run	Unit 12, p. 292; Unit 15, p. 366
Describing and demonstrating proper soldering procedures for electrical wiring	Not Available
Setting the heat anticipation or cycling rate for a furnace thermostat	Unit 14, p. 330-334
Describing and demonstrating proper installation of a single and two stage thermostats	Unit 30, p. 803-806; Unit 14, p. 330-334; Unit 16, p. 398-402
Describing and demonstrating proper installation of a communication type thermostat	Unit 14, p. 330-334

Adjusting airflow on a belt-driven blower assembly	Unit 37, p. 1092-1093, 1111, 1118, 1126
Describing the procedure to de-rate a gas furnace at altitudes of 2,000 feet and above	Not Available
Describing and demonstrating proper use of a Combustion analyzer	Unit 5, p. 126-127; Unit 32, p. 904-905
Identifying the different types of conduit used for power	Not Available
Installing duct connectors and hangers	Unit 37, p. 1099, 1101
Describing and demonstrating proper installation of a duct mounted Carbon Monoxide detector	Unit 39, p. 1186

HVAC Standard	Whitman, 9E Unit, Page Number
<i>Gas Heat troubleshooting and problem solving:</i>	
Troubleshooting and problem solving involves diagnostic procedures requiring the use of test instruments, data plate information, and wiring diagrams. All of the gas furnace system components, circuits, air distribution system, and/or power supply should be part of troubleshooting and problem solving.	Unit 31, p. 843, 846-852, 857-865, 870-877

HVAC Standard	Whitman, 9E Unit, Page Number
<i>Students must have knowledge of and be able to demonstrate the following safety requirements:</i>	
Ladder safety procedures	Unit 4, p. 87
Clearances to combustibles for venting materials	Unit 31, p. 865-868
Maximum level of Carbon monoxide in ppm in a flue gas sample	Unit 31, p. 825-827
Proper safety procedures to follow on discovery of a gas leak	Not Available

HVAC Standard	Whitman, 9E Unit, Page Number
<i>Knowledge of the following test instruments and/or tools is required</i>	

Combustion analyzer	Unit 5, p. 126-127; Unit 32, p. 904-905
Ohmmeter	Unit 11, p. 276-278
Combustible gas detector	Unit 5, p. 128
Voltmeter	Unit 11, p. 278
Carbon Monoxide detector	Unit 39, p. 1186
Manometer	Unit 5, p. 125-126
Pipe Reamers	Unit 7, p. 172-176
Velometer	Unit 37, p. 1087-1088
Ammeter	Unit 11, p. 276-278
Pipe tap and die set	Unit 7, p. 167-169
Pipe cutter	Unit 7, p. 172-176
Pipe Reamers	Unit 7, p. 172-175

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HEAT PUMP

HVAC Standard	Whitman, 9E Unit, Page Number
<i>Students should have prior knowledge of:</i>	
Refrigerant thermodynamics	Unit 9, p. 244-246, 249-251
Psychrometrics	Unit 35, p. 1038-1041, 1043, 1044-1058
Residential air conditioning and electric heating systems	Unit 30, p. 800-816; Unit 36, p. 1072-1091
Refrigerant charging	Unit 10, p. 254-269
Refrigerant recovery	Unit 8, p. 200-206; Unit 9, p. 237-251
Soldering and brazing techniques.	Unit 7, p. 153-156, 162-169
Refrigerant recycling	Unit 8, p. 200-206; Unit 9, p. 237-251
Refrigerant reclamation	Unit 8, p. 200-206; Unit 9, p. 237-251

HVAC Standard	Whitman, 9E Unit, Page Number
<i>Students must have knowledge of Heat Pump system components and be able to demonstrate proficiency in:</i>	
Describing a heat pump's design, configuration for both the heating and cooling cycle	Unit 43, p. 1274-1287
Define SEER, HSPF, and COP	Unit 31, p. 857; Unit 43, p. 1287-1288, 1291-1292, 1299-1303,
Identifying and differentiate between the various types of service valves	Unit 49, p. 1533-1536, 1540-1542

Differentiate between a compressor designed for use in a heat pump and one that is designed for use in a cooling only air conditioner	Unit 43, p. 1274-1283
Demonstrating the proper connection and use of a gauge manifold assembly	Unit 1, p. 16; Unit 8, p. 193, 205, 212, 214-217
Describing the operation of a reversing valve.	Unit 43, p. 1274-1279
Describing the procedures for testing the operation of a reversing valve	Unit 43, p. 1274-1279
Perform a reversing valve replacement	Unit 43, p. 1306-1307
State the purpose of an accumulator and how it is constructed	Unit 25, p. 621-633; Unit 43, p. 1281, 1311
Evaluate and replace a accumulator	Unit 25, p. 633-643
Describing the principle of operation of a capillary tubes as used on a heat pump	Unit 24, p. 578-580, 583-584, 600-603
Describing the principle of operation of a fixed orifice as used on a heat pump	Unit 10, p. 261-264; Unit 41, p. 1235; Unit 43, p. 1283
Describing the principle of operation of a thermostatic expansion valve used with and with out check valves	Unit 10, p. 261; Unit 24, p. 578-594; Unit 43, p. 1281-1283
Describing the principle of operation of an electronic expansion valve	Unit 24, p. 595-597; Unit 43, p. 1283
Evaluating and replacing a capillary tube	Unit 24, p. 600-603; Unit 43, p. 1281-1283
Servicing, selecting, and installing a fixed orifice	Unit 10, p. 261-264; Unit 41, p. 1235; Unit 43, p. 1283
Servicing, selecting, and installing a thermostatic expansion valve	Unit 10, p. 261; Unit 24, p. 578-594; Unit 43, p. 1281-1283
Servicing, selecting, and installing an electronic expansion valve	Unit 24, p. 578-580; Unit 43, p. 1283
Describing a check valve, its function and operation	Unit 25, p. 608-610, 637-649
Evaluating and replacing a check valve	Unit 25, p. 608-610, 637-649
Describing the operation of a heat/cool relay	Unit 15, p. 360-375
Describing the operation of the following defrost controls, mechanical, time/temperature, and solid state	Unit 43, p. 299-1303, 1309, 1313
Describing the function of and testing	Not available

method for an outdoor thermostat	
Describing the sequence of the defrost cycle	Unit 43, p. 1299-1303
Describing the sequence of operation and the testing methods for a defrost relay	Unit 43, p. 1299-1303, 1306
Install a solid state defrost control	Unit 43, p. 1299-1303
Stating the purpose of and testing method for a bimetal outdoor coil temperature sensor	Unit 43, p. 1296-1299
Evaluate and replace a defrost board	Unit 43, p. 1299-1303, 1311-1312
Servicing and installing a thermistor type temperature sensor (PTC & NTC)	Unit 12, p. 311; Unit 13, p. 324-325
Replacing a printed circuit control board (PC) the indoor and outdoor units	Unit 43, p. 1299-1303, 1311-1312
Describing crankcase heating methods and how they operate	Unit 25, p. 644-649
Describing a heat pump thermostat with emergency heat feature	Unit 43, p. 1292
Describing the function of and the testing method for a control circuit fuse	Unit 12, p. 298-302; Unit 19, p. 460-462; Unit 41, p. 1238, 1244-1246
Explain how the set points for outdoor thermostats are established	Not Available
Describing the function and the control methods used by an indoor electronic thermostat	Unit 43, p. 1295-1299
Measure system air flow	Unit 37, p. 1087, 1089-1090, 1111
Explain the function of a liquid line bi-flow drier	Unit 25, p. 637-640
Installing and evaluating a liquid line bi-flow drier	Unit 25, p. 637-640; Unit 43, p. 1283-1284
Installing and evaluating a liquid line drier	Unit 25, p. 637-640; Unit 43, p. 1283-1284
Explain the function of a suction line filter drier	Unit 8, p. 212-215; Unit 25, p. 643-645
Installing and evaluating a suction line filter drier	Unit 8, p. 212-215; Unit 25, p. 643-645
Identifying the types of micron gauges	Unit 8, p. 194-206
Explain the method for connecting a micron gauge to the system	Unit 8, p. 194-206
Describing and performing the triple evacuation method	Unit 8, p. 200-204
Describing heat pump charging procedures	Unit 43, p. 1306, 1309, 1318-1320

Explain charging using the manufacturers literature	Unit 10, p. 261-266
Calculating and demonstrating the weigh-in charging method	Unit 10, p. 259-260
Determine required superheat and subcooling for an operating system	Unit 3, p. 48-49, 52-54, 56-57, 61-74
Explain charging using the superheat method	Unit 10, p. 254, 261-264, 266-269
Select the proper refrigerant oil for an operating system	Unit 9, p. 235-237
Explain charging using the subcooling method	Unit 10, p. 254, 261-264, 264-266
Demonstrating charging using the manufacturers literature	Unit 10, p. 261-266
Demonstrating proper charging of HCFC and HFC refrigerants into an operating system	Unit 9, p. 218-227
Demonstrating proper charging of HCFC and HFC refrigerants into an empty system	Unit 9, p. 218-227
Describing the operation of and the testing method for a high pressure switch	Unit 25, p. 621
Describing the operation of and the testing method for a low pressure switch	Unit 25, p. 624
Describing the procedure to perform a compressor efficiency test	Unit 23, p. 574-576

HVAC Standard	Whitman, 9E Unit, Page Number
<i>Students should have knowledge of & be able to describe & demonstrate the following safety requirements</i>	
Ladder safety procedures	Unit 4, p. 87
Fall prevention procedures	Unit 4, p. 83-85
Refrigerant handling	Unit 4, p. 79-82
Nitrogen handling procedures	Unit 8, p. 184-193

HVAC Standard	Whitman, 9E Unit, Page Number
<i>Heat Pump troubleshooting & problem solving</i>	
Troubleshooting and Problem Solving involves diagnostic procedures requiring the use of test equipment, manufacturers	Unit 43, p. 1304-1310

installation and start up procedures, and data plate information.	
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HVAC Standard	Whitman, 9E Unit, Page Number
<i>Knowledge of the following test instruments and/or tools is required</i>	
Anemometer	Unit 37, p. 1087-1088
Thermometers (wet and dry)	Unit 35, p. 1043-1046, 1059; Unit 41, p. 1231-1234
Gauge manifold assembly	Unit 1, p. 16; Unit 8, p. 188, 194-212
Recovery equipment	Unit 8, p. 194-206; Unit 9, p. 237-251
Vacuum pump	Unit 8, p. 193-206
Micron gauge	Unit 8, p. 194-206
Leak detector	Unit 8, p. 182-195
Nitrogen Cylinder	Unit 8, p. 182-184, 188-191
Soldering and brazing equipment	Unit 7, p. 153-156, 162-169
Charging scale and Charging cylinder	Unit 10, p. 260
Refrigerant throttling valve	Unit 10, p. 259, 269
Ohmmeter	Unit 11, p. 276-278
Ammeter	Unit 11, p. 276-278
Voltmeter	Unit 11, p. 288-289
Valve Core removal tool	Unit 8, p. 193, 194-200
Flaring tool/ tubing cutters	Unit 5, p. 112-114
Tubing benders	Unit 5, p. 106-107
Sling Psychrometer	Unit 5, p. 126

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LIGHT COMMERCIAL AIR CONDITIONING

HVAC Standard	Whitman, 9E Unit, Page Number
<i>Students should have prior knowledge of:</i>	
Leak detectors	Unit 8, p. 187-200
The laws of Thermodynamics	Unit 1, p. 18-20
Recovery and recycling processes	Unit 8, p. 194-206; Unit 9, p. 237-251
Refrigerant leak detection and types of leak detectors	Unit 8, p. 182-195
Refrigerant piping	Unit 38, p. 1145, 1147-1153
Soldering and brazing	Unit 7, p. 155-156, 162-168
Refrigerant types	Unit 9, p. 220-235
System components such as:	
• Metering devices	Unit 24, p. 578-603
• Receivers	Unit 22 ,p. 514-517; Unit 26, p. 659, 561, 666-668
• Pressure controls	Unit 25, p. 617-628
• Suction accumulators	Unit 25, p. 634-643
• Refrigerant flow and control valves	Unit 24, p. 589, 593, 600
• Evacuation methods and equipment	Unit 8, p. 194-206
• Refrigerant charging methods	Unit 10, p. 254-269

HVAC Standard	Whitman, 9E Unit, Page Number
<i>Students must have knowledge of light commercial air conditioning systems, their components, and be able to demonstrate proficiency in:</i>	
Defining enthalpy and entropy	Unit 3, p. 63-74, 70-74; Unit 35, p. 1044-1050
Change of state between liquids, vapor, and solids	Unit 1, p. 22-24
Describing and defining the following; conduction, convection and radiant heat transfer	Unit 1, p. 20-22
Describing, defining, and converting the following temperature measurements; Fahrenheit, Celsius, Rankine, and Kelvin	Unit 1, p. 17-18
Condensation of a vapor, and its effect on heat	Unit 1, p. 22
Vaporization of a liquid, and its effect on heat	Unit 1, p. 22
Describing the thermodynamics of refrigerants	Unit 9, p. 242-244, 249-251
Describing and defining the following; BTU, latent heat, sensible heat	Unit 1, p. 18-20, 22-24
Describing and defining the following; subcooled liquid, superheated vapor	Unit 3, p. 48-49, 52-57, 63-74; Unit 21, p. 498
Describing the state of refrigerant, and explain what occurs in each major component during normal operation	Unit 3, p. 43-47
Using saturation tables	Unit 3, p. 44-47
Identifying and defining the following types of blends; Binary, Ternary, Azeotropic, and Near Azeotropic	Unit 3, p. 57-59; Unit 9, p. 228; Unit 10, p. 268
Identifying and defining; CFC's, HCFC's, HFC's, HFO's & HC's	Unit 9, p. 217-227
Describing temperature glide	Unit 3, p. 44-46, 52-53, 57-59; Unit 9, p. 228-235; Unit 10, p. 261-268
Describing fractionation and its causes	Unit 9, p. 228-237; Unit 10, p. 268-268
Explain the procedures to retrofit a system from a CFC to an HFC, & an HCFC to an HFC	Unit 9, p. 217-227
Describing and defining the following; wet bulb temperature, dry bulb temperature, and dew point	Unit 35, p. 1038-1051

Defining wet bulb depression	Unit 35, p. 1043-1044
Measuring wet and dry-bulb temperatures	Unit 35, p. 1038-1041, 1043-1044
Describing the principles of dehumidification and humidification	Unit 3, p. 55; Unit 21, p. 488

Plotting the refrigeration cycle on a pressure enthalpy chart	Unit 21, p. 495-497
Defining SEER and EER	Unit 43, p. 1299-1302
Describing a Head Master and its operation	Unit 22, p. 530-541
Describing the function, selection and installation of auxiliary heat exchangers	Unit 25, p. 641
Select the proper refrigerant oil add to an operating system	Unit 9, p. 235-237
Adjusting blower fan speed	Unit 38, p. 1154-1156
Sizing, designing, and installing refrigerant lines	Unit 38, p. 1150-1154
Installing a condensing unit	Unit 38, p. 1149-1154
Installing an air handler	Unit 38, p. 1139-1141, 1145-1149
Describing the required CFM for system operation and calculate air flow	Unit 37, p. 1088-1089
Installing a condensate drain	Unit 38, p. 1145-1149
Defining reclaim	Unit 8, p. 200-206
Defining and demonstrating refrigerant recycling	Unit 8, p. 200-206; Unit 9, p. 237-251
Defining and demonstrating refrigerant recovery	Unit 8, p. 200-206; Unit 9, p. 237-251
Explaining the proper use and handling of nitrogen in the leak detection process	Unit 8, p. 184-193
Explaining the method for and pinpointing a leak	Unit 8, p. 184-193
Explaining the proper use of each type of leak detector and their applicability	Unit 8, p. 182-195
Describing the six types of leak detectors and demonstrating the proper use	Unit 8, p. 182-195
Identifying proper charging of a compound refrigerant into an operating system	Unit 10, p. 267-269
Identifying proper charging of a compound refrigerant into an empty system	Unit 10, p. 2267-269

Determine superheat and subcooling on an operating system	Unit 3, p. 49, 52-54, 57, 63-74
Describing and performing a compressor efficiency test	Unit 23, p. 574-576
Select the proper refrigerant oil and add it to an operating system	Unit 9, p. 235-237
Describing the following oils and their applications; Mineral, Alkylbenzene, Glycols, and Esters	Unit 9, p. 235-237
Demonstrating charging a mini-split system with two or more evaporators	Unit 10, p. 256-266
Demonstrating charging using the manufacturers literature	Unit 10, p. 261-264
Identifying proper charging a blended refrigerant by weight into an empty system	Unit 10, p. 268-269
Identifying proper charging of a blended refrigerant into an operating system	Unit 10, p. 268-269
Demonstrating charging using the subcooling method	Unit 10, p. 254-266
Demonstrating charging using the superheat method	Unit 10, p. 254-267
Stating the reason why capillary tube systems require a critical charge	Unit 29, p. 764
Describing a capillary / distributor tube sizing and selection procedure	Unit 10, p. 261-264
Calculating and demonstrating the weigh-in charging method	Unit 10, p. 259-260
Describing the triple evacuation method	Unit 8, p. 200-206
Demonstrating the triple evacuation method	Unit 8, p. 200-206
Soldering and brazing using correct techniques	Unit 7, p. 153-156, 163-169
Evacuating and measuring system evacuation level	Unit 8, p. 200-206
Explaining vacuum pump selection	Unit 8, p. 200-206
Identifying the types of micron gauges and how they should be connected to measure evacuation	Unit 8, p. 194-206
Defining vacuum and vacuum levels as required in the HVACR industry	Unit 8, p. 191-206
Obtaining gauge pressure using compound gauges and convert to absolute	Unit 1, p. 27-28
Describing the operation and use of a gauge manifold assembly	Unit 1, p. 16; Unit 8, p. 188, 196-197, 199, 207, 209-212

Identifying and differentiate between the various types of service valves	Unit 49, p. 1533-1536, 1539-1542
Defining compression ratio	Unit 23, p. 543, 545, 564-566
Describing the automatic pump-down system and its operation	Unit 21, p. 506-507
Describing an air cooled condenser, its function, and operating parameters	Unit 22, p. 524-527
Installing water cooled system and adjusting a water regulating valve	Unit 22, p. 509-524
Describing the function of, and install a lockout relay in a circuit	Not Available
Describing the operation of and install a contactor	Unit 19, p. 458-460; Unit 30, p. 813
Describing, test, and install a run and start capacitor	Unit 12, p. 297-298; Unit 17, p. 414-417, 422; Unit 20, p. 476-480
Describing and install a compressor potential start relay	Not Available
Describing the operation of and test a high pressure switch	Unit 25, p. 620-621
Describing the operation of and test a low pressure switch	Unit 25, p. 620-621
Describing and wire the terminal connections of a thermostat temperature control	Unit 43, p. 1296-1299
Describing and test thermistor type temperature sensors (PTC & NTC)	Unit 12, p. 308-312
Describing the function, check the operation, and wire an oil pressure safety control	Unit 25, p. 628-632
Installing and adjusting a low ambient temperature control	Unit 25, p. 617-620, 617-630
Test a blower or fan motor and its circuit	Unit 20, p. 467, 476; Unit 38, p. 1154-1156
Describing the operation of and test a hot gas bypass valve	Unit 25, p. 637-640
Describing the operation of and adjust an inline, and pilot operated evaporator pressure regulator	Unit 25, p. 606-610
Describing and installing a replaceable core liquid line drier	Unit 25, p. 637-640; Unit 43, p. 1283-1284
Describing and install a replaceable core suction line filter drier	Unit 8, p. 212-215; Unit 25, p. 640-643
Describing dry type evaporators and their operation	Unit 21, p. 487-507
Describing the piping configuration for a multiple evaporator systems	Unit 21, p. 487-507

Describing the function and purpose of a multiple compressor system	Unit 23, p. 559-562, 564-572
Compressor capacity control methods and operation	Unit 23, p. 559-562, 563-572
Describing a chilled water system and its operation	Unit 47, p. 1452-1494
Describing cooling towers and their operating limitations	Unit 48, p. 1498-1524
Describing the operation and function of a flooded evaporator and its metering device	Unit 21, p. 487-507
Describing the function, check the operation, and wire a demand ventilation control	Unit 50, p. 1570-1571
Describing the function, check the operation, and wire communications type thermostat	Unit 14, p. 331-334
Describing the function, check the operation, and install a variable volume air handler	Unit 50, p. 1571
Describing the function, check the operation, and install a variable air volume (VAV) unit	Unit 50, p. 1571

HVAC Standard	Whitman, 9E Unit, Page Number
<i>Students must have knowledge of and be able to demonstrate the following safety requirements:</i>	
Describe and perform "Lock out and Tag" procedures	Unit 4, p. 82
System leak-test pressures and nitrogen regulator installation and adjustment	Unit 8, p. 182-184
Explain and demonstrate the proper method of connecting a micron gauge to the system	Unit 8, p. 194-206

HVAC Standard	Whitman, 9E Unit, Page Number
<i>Light Commercial Air Conditioning troubleshooting and problem solving:</i>	
Troubleshooting and Problem Solving involves diagnostic procedures requiring the use of test equipment, manufacturers' installation and start up procedures, and data plate information.	Unit 29, p. 753, 775-776; Unit 41, p. 1221-1246

HVAC Standard	Whitman, 9E Unit, Page Number
<i>Knowledge of the following test instruments and/or tools is required</i>	
Ammeter	Unit 11, p. 276-277
Oil pressure gauge	Unit 25, p. 628-632
Ohmmeter	Unit 11, p. 276-278
Oil pump	Unit 25, p. 628-632
Voltmeter	Not Available
Nitrogen Cylinder	Unit 8, p. 183, 188-191
Micron gauge	Unit 8, p. 194-206
Vacuum pump	Unit 8, p. 194-206
Sling Psychrometer	Unit 5, p. 115-116
Refrigerant throttling valve	Unit 10, p. 258-262
Thermometers (wet and dry)	Unit 35, p. 1043-1046; Unit 41, p. 1230-1234
Recovery equipment	Unit 8, p. 206-210; Unit 9, p. 237-251
Leak detector	Unit 8, p. 182-195
Charging scale and charging cylinder	Unit 10, p. 260
Gauge manifold assembly	Unit 1, p. 16; Unit 8, p. 188-212
Anemometer	Unit 37, p. 1087-1088
Soldering and brazing equipment	Unit 7, p. 153-156, 162-169
Valve Core removal tool	Unit 8, p. 194-206
Flaring tool/ tubing cutters	Unit 5, p. 106-107
Tubing benders	Unit 5, p. 107-108

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OIL HEAT

HVAC Standard	Whitman, 9E Unit, Page Number
<i>Students must have knowledge of oil heating systems, their components, and be able to demonstrate proficiency in:</i>	
Describing and explaining the function of upflow, downflow, and horizontal furnaces	Unit 31, p. 821-823
Explaining combustion Theory and Heating Fuels	Unit 31, p. 823-827
Explaining the Properties of Various Heating Fuels	Unit 31, p. 823-827
Define BTU	Unit 1, p. 18-20, 22-24
Define AFUE	Unit 31, p. 853-857
Describing and using the sensible heat formula	Unit 35, p. 1052-1054
Describing the principles of humidification	Unit 3, p. 55
Describing the principles of dehumidification	Unit 21, p. 488-489
Explaining the BTU content and specific gravities of various fuel oils	Unit 1, p. 18-20, 22-24
Describing the oil pressures (and vacuum levels) on an operating oil-fired heating system	Unit 32, p. 904, 908-912, 938-940, 946
Measuring the oil pressures (and vacuum levels) on an operating oil-fired heating system	Unit 32, p. 904, 908-912, 938-940, 946
Measuring the flue gas temperatures of furnaces	Unit 31, p. 823, 826-827, 837, 856-857
Determining the amount of combustion air required to safely burn oil in a furnace	Unit 32, p. 894, 905, 944-945
Defining primary and secondary air	Unit 31, p. 825-827, 835

Differentiating between primary air and excess air	Unit 31, p. 825-827, 835
Describing the causes of burner "Flashback"	Not Available
Describing the causes of a lifting flame.	Unit 31, p. 880-881
Stating the reason for appropriate polarity wiring on solid state circuits	Not Available
Stating the generally accepted standard oil pressure for a residential furnace	Unit 32, p. 901-902, 909-912
Describing, explaining the function, evaluating, cleaning, and replacing (when feasible) of the following components:	
<ul style="list-style-type: none"> Oil valves used with residential furnaces 	Unit 32, p. 922, 927-928
<ul style="list-style-type: none"> oil pressure regulating valves 	Unit 32, p. 922, 927-928
<ul style="list-style-type: none"> Orifice 	Unit 32, p. 910-911, 914-917
<ul style="list-style-type: none"> Heat exchanger 	Unit 32, p. 893-894, 910, 920, 922, 924, 933-935, 937-938, 943-945, 947
<ul style="list-style-type: none"> Flue baffles 	Unit 31, p. 852
<ul style="list-style-type: none"> Fuel oil pump 	Unit 32, p. 908-911
<ul style="list-style-type: none"> Cadmium sulfide cell 	Unit 32, p. 920-922
<ul style="list-style-type: none"> Burner primary safety control 	Unit 32, p. 927-928
<ul style="list-style-type: none"> Ignition module 	Unit 32, p. 896-897, 905, 917-920
<ul style="list-style-type: none"> Spark igniter 	Unit 32, p. 914-920
<ul style="list-style-type: none"> High voltage ignition transformer 	Unit 32, p. 914-920
<ul style="list-style-type: none"> Flame sensor 	Unit 31, p. 846-848-852
<ul style="list-style-type: none"> Combination fan and limit switch 	Unit 31, p. 823, 840-843
<ul style="list-style-type: none"> Door safety switch 	Not Available
<ul style="list-style-type: none"> Blower motor relay 	Unit 31, p. 840, 857-863
<ul style="list-style-type: none"> Vent blower motor 	Unit 31, p. 821-823, 828-830
<ul style="list-style-type: none"> Vent pressure switch 	Unit 31, p. 865-866
<ul style="list-style-type: none"> Vent motor relay 	Unit 31, p. 821-823, 828-830

<ul style="list-style-type: none"> • Single stage thermostat 	Unit 30, p. 803-806; Unit 14, p. 331-334
<ul style="list-style-type: none"> • Dual stage thermostat 	Unit 16, p. 398-402
<ul style="list-style-type: none"> • Run and start capacitor 	Unit 12, p. 297-298; Unit 17, p. 414-417; Unit 20, p. 476-480
Describing a blower housing cut-off plate	Not Available
Identifying the different types of venting systems	Unit 31, p. 865-868
Sizing and installing the venting systems	Unit 31, p. 865-868
Installing fuel lines	Unit 32, p. 904
Describing the purpose and operation of delayed action solenoid valve	Unit 32, p. 922
Describing the function of a barometric draft control	Unit 39, p. 1196-1197
Describing the testing and adjustment procedure of a barometric draft control	Unit 39, p. 1196-1197
Describing the function of and the testing method for a fuel unit cut-off	Unit 32, p. 915-916, 939-940
Describing the procedure to perform a smoke test on an oil furnace	Unit 32, p. 942-945
Installing a fire-stop support plate	Appendix A, p. 1610-1611
Adjusting blower fan speed for proper temperature rise	Unit 38, p. 1154-1156
Describing the procedure for measuring static pressure	Unit 37, p. 1087
Sizing wires with regards to voltage drop and length of wiring run	Unit 12, p. 292; Unit 15, p. 366
Describing and demonstrating proper soldering procedures for electrical wiring	Not Available
Describing and demonstrating proper installation of a single and two stage thermostats	Unit 16, p. 398-402
Describing and demonstrating proper installation of a communication type thermostat	Unit 14, p. 331-334
Describing the procedure for adjusting air flow on a belt-driven blower assembly	Unit 37, p. 1092-1093, 1111, 1118, 1126
Describing the procedure to de-rate a gas furnace at altitudes of 2,000 feet and above	Not Available
Describing and demonstrating proper use of a combustion analyzer	Unit 5, p. 126-28; Unit 32, p. 904-905
Identifying the different types of conduit used for power	Not Available

Installing duct connectors and hangers	Unit 37, p. 1099, 1101; Unit 38, p. 1135, 1144-1145
Describing and demonstrating proper installation of a duct-mounted Carbon Monoxide detector	Unit 39, p. 1186

HVAC Standard	Whitman, 9E Unit, Page Number
<i>Students must have knowledge of and be able to describe and demonstrate the following safety requirements:</i>	
Ladder safety procedures	Unit 4, p. 83-84
Clearances to combustibles for venting materials	Unit 31, p. 865-868
Flue gas testing procedures for carbon monoxide	Unit 31, p. 825-827
Ambient air testing procedures for carbon monoxide	Unit 39, p. 1186-1188
Proper safety procedures to follow on discovery of an oil leak	Not Available
Describe the safety procedure to be followed upon discovery of a defective heat exchanger	Unit 39, p. 1186-1189

<i>Oil Heat troubleshooting and problem solving:</i>	
Troubleshooting and problem solving involves diagnostic procedures requiring the use of test instruments, data plate information, and wiring diagrams. All of the gas furnace system components, circuits, air distribution system, and/or power supply should be part of troubleshooting and problem solving.	Unit 31, p. 843, 846-852, 859-865, 870-877; Unit 32, p. 904, 922

HVAC Standard	Whitman, 9E Unit, Page Number
<i>Knowledge of the following test instruments and/or tools is required</i>	
Combustion analyzer	Unit 5, p. 126-128; Unit 32, p. 904-905
Stack Thermometers	Unit 32, p. 942-945, 948-949

Carbon Monoxide detector	Unit 39, p. 1186
Ammeter	Unit 11, p. 276-278
Manometer	Unit 5, p. 125-129
Anemometer	Unit 37, p. 1088
Ohmmeter	Unit 11, p. 276-278
Velometer	Unit 37, p. 1088
Pressure Gauges	Unit 25, p. 628-632
Voltmeter	Unit 11, p. 277-278