UA STAR

Residential/Light Commercial

HVACR Service Technician Study Guide

(With Practice Exams)

United Association Training Department

&

FERRIS STATE UNIVERSITY

The University Center for Extended Learning
Corporate & Professional Development Services

FORWARD

This Study Guide is designed to assist you in locating information in UA Textbooks and other sources that relate to the 11 categories and 46 tasks identified during the DACUM (Develop A CUrriculuM) process administered by Ferris State University. The DACUM is an in-depth job and task analysis that serves as the base for the UA STAR exam.

The 11 categories and 46 tasks identified during the DACUM are included in this Study Guide so that you can see first-hand the results of the study and the items that you can expect to encounter on the UA STAR exam. Each category and task is numbered, and each task is broken into a number of smaller jobs that a technician would be expected to perform in order to complete the task.

> Below each task you will find an underlined paragraph that looks like this and contains general reference to UA textbooks and other sources. In some cases, specific pages are cited. In others, chapters, but in most, only general reference is given.

You will find that the UA STAR exam is a comprehensive exam. It is designed to test the knowledge of the experienced technician. As such, this Study Guide is intended to be a reference for the experienced technician to use in preparing for the exam. It is expected that the inexperienced technician will not be able to successfully complete the exam based on the Study Guide and the information contained in the reference materials alone – experience is also required.

It is expected that the UA STAR test candidate is the technician who has completed the UA training and has gained several years of experience in the field. Many of the tasks and jobs identified in the DACUM are those that can only be learned by doing. The test candidate that expects to achieve success on the UA STAR exam by merely using the Study Guide to locate information in textbooks will likely be disappointed.

It is recognized that even the best technician does not work in all areas of the service industry. Further, some knowledge can be forgotten through lack of use. As such, it is recommended that you study a number of UA textbooks and other resources indicated in preparing for the UA STAR exam. A list is provided on the next page. These texts were cited throughout the Study Guide. You may wish to review the texts where you feel you need additional knowledge. In addition, there are many other excellent books on the market that can serve as reference for you. They are far too numerous to list. You may know of some of them or even own them. Feel free to use them in your studies.

The UA and Delmar text books contain many, many good questions that provide excellent practice material and act as a learning tool. If you spend time and answer the questions at the back of the texts successfully, you will be successful on the UA STAR exam.

This Study Guide also contains nearly 200 practice questions. All questions are multiple choice, with four possible answers. All questions contain explanations for each of the correct answers. The questions are designed to help you review some of the material that you will need to know when taking the exam. The practice test will indicate to you whether or not you have areas of difficulty. With the areas of difficulty identified, you can look into references identified and update your knowledge before taking the certification test.

The UA STAR exam is a tough test, but fair and recognized by your industry. With some hard work, you can be successful in passing it. Good luck!

UA Textbooks used as Reference in this Study Guide

UA HVACR Training Manual
HVAC Light Commercial STC Version 1-11-06
Modern Refrigeration and Air Conditioning
Air Conditioning, Mechanical Equipment Service Manual for UAJA
Practical Heating Technology, Johnson/Delmar
Electricity for Heating Refrigeration and Air Conditioning, Thompson/Delmar Learning
UA Related Mathematics, C1300
UA Star Equation Sheet
Commercial Refrigeration for Air Conditioning Technicians
Air Conditioning Refrigeration News On-Line
ARI Refrigeration and Air Conditioning 4th Edition & 5th Edition

www.hanford.gov/fire/safety/extingrs.htm#fetypes
www.chp.edu/besafe/adult/02frostbite.php?base=hs
www.osha.gov
www.ansi.org

CONTENTS

Category A: Applied Science & Math

Task 1. Matter, Energy and Science of heat basics

Matter (solids, liquids, gases)
Energy
--First and Second law of Thermodynamics
--Work
--Power
Heat
--heat and power relationship
--temperature and temperature scales
--heat transfer
--sensible heat
--latent heat
Pressure
--atmospheric pressure
--vacuum pressure
--vacuum pressure calculations and conversions

Reference

United Association HVACR Training Manual, Unit 1 and 2

Task 2. The Refrigeration Process

The refrigeration process
--pressure/temperature relationship
--evaporators
--compressors
--condensers
--metering devices
Refrigerants in the residential systems
--R-22
--R410A
The vapor-compression refrigeration cycle
--putting it together
--outside air conditioners
--from the compressor
--in the condenser
--through the metering devices
--indoor air conditions
--absorbing heat in the evaporator
--in the compressor

Reference

United Association HVACR Training Manual, Unit 3
P/T Chart

Task 3. Applied HVAC math

Basic algebra
CFM
Measuring (linear, cubic, square, volume)
GPM (flow rates)
Pulley formula
Micron
Conversions

Reference

United Association HVACR Training Manual
UA Star Equation sheet
Related Mathematics

Category B: Safety

Task 4. Personal safety

Clothing
Jewelry
Safety glasses
Work boots
Ear plugs
Gloves
Lifting objects and back support belts

Reference

United Association HVACR Training Manual

Task 5. Electrical safety

Electric shock
Ground wires
Extension cords and ground prongs
Ground fault circuit interrupters

Reference

United Association HVACR Training Manual, Unit 4

Task 6. Fire safety

Class A, B, C, and D fire extinguishers
Multiple purpose fire extinguishers
Fire extinguisher use
Fire extinguisher maintenance

Reference
www.hanford.gov/fire/extinrs.htm#fetypes

Task 7. Tools, equipment, and material safety

Wrenches
Screwdrivers
Ladders
Soldering and brazing equipment
Pressurized gas tanks and cylinders
Chemical and material safety

Reference

United Association HVACR Training Manual, Unit 4

Task 8. First aid

Frostbite
Bleeding
Asphyxiation
Chemical burns
Electric shock

Reference

United Association HVACR Training Manual, Unit 4
www.chp.edu/besafe/adult/02frostbite.php?base=hs

Task 9. Agencies

Occupational Safety and Health Administration (OSHA)
National Fire Protection Agency (NFPA)
American National Standards Institute (ANSI)

Reference

http://www.osha.gov/
http://www.ansi.org/

Category C: Installation

Task 10. Unit location and the air distribution system

Condensing unit location
--sound transmission
--wind factors
--location of electrical power
--airflow restrictions
--proximity to the indoor unit
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--location of electrical power supply
--length of the refrigerant lines
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--indoor unit configuration
--ease of condensate removal
--noise level
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--location of the space to be conditioned
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--duct system configuration
--duct system materials
--combination duct systems
--insulating and wrapping duct systems
--sealing duct systems
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Install flexible duct systems
Install fiberglass duct systems
Install round sheet metal duct systems

Reference

United Association HVACR Training Manual, Unit 37

Task 11 . System Connections

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--fittings
--copper pipe
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--length of the piping run
--choices of pipe fittings
--solder and solder joints
--refrigerant traps
Installing, supporting, and insulating condensate drain lines
--drain line size
--drain line materials
--pitching the line

--traps
--drain line terminations
--auxiliary drain pans
--safety float switches
System wiring
--line voltage power circuit wiring
--low voltage control wiring
Leak-checking the system
--pressurizing the system
--marking the gauge
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Swag soft-drawn copper tubing
Flare soft-drawn copper tubing
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Join plastic pipe

Reference

United Association HVACR Training Manual, Unit 7

Task 12. System Evacuation, Efficiency, Startup, and Charging

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--vacuum pump oil
--acceptable levels of vacuum
System holding charge
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--air handler
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--airflow through the air handler
--system pressures
--temperature differential across the evaporator coil
--evaporator superheat
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Calibrate the gauge manifold
Evacuate the air conditioning system
Measure the superheat in an air conditioning system
Measure the temperature differential across the evaporator coil
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Reference

United Association HVACR Training Manual, Unit 8, 10, 21, 38

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Reference

United Association HVACR Training Manual, Unit 34

Task 14. Air filtration

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Extended surface filters
Steel filters
High efficiency particulate arrester filters
Electrostatic air filters
Electronic air filters

Reference

United Association HVACR Training Manual, Unit 34

Task 15. Humidity and Humidification

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Reference

United Association HVACR Training Manual, Unit 34

Task 16: Installing and troubleshooting air quality devices

Fresh air and ventilators
Troubleshooting and maintaining air quality devices

Reference

United Association HVACR Training Manual, Unit 34

Category E: Comfort Cooling Troubleshooting

Task 17. Evaporator and condenser fan motor problems

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Reference

United Association HVACR Training Manual
Commercial Refrigeration for Air Conditioning Technicians
Electricity for Heating Refrigeration and Air Conditioning

Task 18. Refrigerant charge related problems

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Reference

United Association HVACR Training Manual

Task 19. Evaluating the metering device

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Evaluating the automatic expansion valve
Evaluating the thermostatic expansion valve

Reference

United Association HVACR Training Manual, Unit 24

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Reference

United Association HVACR Training Manual

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Reference

United Association HVACR Training Manual, Unit 9

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Reference

United Association HVACR Training Manual, Unit 9

Category G: Basic Electricity

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Reference

HVAC Light Commercial STC Version 1-11-06
Electricity for Heating Refrigeration and Air Conditioning

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Reference

HVAC Light Commercial STC Version 1-11-06

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Circuit protection (fuses, circuit breakers, GFCI)

Reference

HVAC Light Commercial STC Version 1-11-06
Electricity for Heating Refrigeration and Air Conditioning

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Reference

HVAC Light Commercial STC Version 1-11-06
Electricity for Heating Refrigeration and Air Conditioning

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Reference

HVAC Light Commercial STC Version 1-11-06
Electricity for Heating Refrigeration and Air Conditioning

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Reference

United Association HVACR Training Manual
Electricity for Heating Refrigeration and Air Conditioning

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Service call 3: defective contactor
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Reference

Electricity for Heating Refrigeration and Air Conditioning

Category I: Heating

Task 30. Install and service electric heat

Theory of electric heat
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Electronic furnace wiring
--interlocks
--thermostats
--multiple-stage electric heating
--electric heating safety devices
--fan operation
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Installing duct heaters
Troubleshooting electric heating systems
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Service call 2: defective blower motor
Service call 3: blocked air filter

Reference

United Association HVACR Training Manual
Electricity for Heating Refrigeration and Air Conditioning

Task 31. Install and service gas furnace

Combustion
--combustion efficiency
--complete combustion
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--the smoke tester

--carbon dioxide tester
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Fuels
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--heat exchangers
--fuel delivery to the furnace
--the gas manifold
--primary and secondary air
--fuel ignition
--venting and removing products of combustion
--fan motor and blower
--fan switches
--limit switches
Gas furnace installation
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--install the vent piping on conventional furnaces
--install the vent piping on condensing furnaces
Troubleshooting gas heating problems
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Service call 1: shorted gas valve coil
Service call 2: defective fan switch
Set gas pressure on an LP or gas-fired furnace
Cut and ream steel pipe
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Install steel fittings on threaded steel pipe

Reference

United Association HVACR Training Manual

Task 32. Install and service oil furnaces

The oil furnace
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Combustion chargers and heat
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--oil storage tanks
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--fan
--fuel pump
--nozzle assembly
--igniter/transformer

--primary controls
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--power and direct venting
--sizing and installing the flue pipe
Troubleshooting the oil burner
--air-distribution system
--fuel and fuel tank
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--system controls
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Reference

United Association HVACR Training Manual

Task 33-36. Install and service hydronic heat

Theory of hydronic heating systems
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--aquastat
--reset
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--expansion tank
--centrifugal pumps
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--zone valves
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--the radiant system
--radiant heating piping
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--water temperature and direct piping
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--fill the system
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Reference

United Association HVACR Training Manual
Electricity for Heating Refrigeration and Air Conditioning

Task 37. Install and service heat pumps

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--check valves
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--check valves in systems with thermostatic expansion valves
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--bidirectional filter driers
--bidirectional thermostatic expansion valves
Heat pump system configuration
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--liquid-to-aid heat pumps
Defrost methods
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--time and temperature initiation, temperature-termination defrost
--solid-state defrost
Geothermal heat pump theory
--geothermal heat pump system configuration
Troubleshooting geothermal systems
--water circuit problems
--airflow problems
Service call 1: Defective water pump
Service call 2: Mineral deposits in the water circuit

Reference

United Association HVACR Training Manual
Electricity for Heating Refrigeration and Air Conditioning

Category J: Soft Skills

Task 38. Computer skills

Basic literacy
Program thermostats
Upload and download files, move, copy, search
Search internet and access web
Adobe
Connect to printer

Reference

United Association HVACR Training Manual

Task 39. Documentation (invoicing)

Fax
Email
Complete work orders
Technically describe problems and situations
Office procedures
Invoicing--accuracy estimate time
Inventory control--accurate records

Reference

United Association HVACR Training Manual

Task 40. Customer relations

Greet customers
Vehicle appearance
Communication skills
Listening to customer skills
Personal appearance
Handling irate customers
Handle complaints
Explain operating instructions to customers

Reference

United Association HVACR Training Manual

Task 41. Ethics and professionalism

Maintain valid driving license
Time management (scheduling book)
Vehicle appearance and maintenance
Importance of image (vehicle and personal)
Handling money and credit cards
Background checks
Parking vehicle in appropriate places
--courtesy and proper procedures for operating company and commercial vehicle

Reference

United Association HVACR Training Manual

Category K: Light Commercial

Task 42. Roof top package units

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Economizer cycles
Free cooling
Low ambient
Roofing and water proofing (flashing and curbs)
Condensate drain
Roof access and location
Ladder and rigging safety
Remove trash from roof

Reference

United Association HVACR Training Manual
ARI Refrigeration and Air Conditioning 4th Edition
Modern Refrigeration and Air Conditioning
Electricity for Heating Refrigeration and Air Conditioning
Air Conditioning, Mechanical Equipment Service Manual for UAJA

Task 43. Ventilation equipment

Direct and indirect fire
Make up air
Building pressurization
Outside air
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Reference

Air Conditioning, Mechanical Equipment Service Manual for UAJA

Task 44. Exhaust fans

Kitchen hoods
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Bathroom exhaust fans
Fire suppression
Refrigerant exhaust

Reference

Air Conditioning, Mechanical Equipment Service Manual for UAJA
United Association HVACR Training Manual

Task 45. Types of air volume systems

Variable air volume rooftops
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Zoning systems

Reference

Air Conditioning, Mechanical Equipment Service Manual for UAJA

Task 46. Rooftop safety and hazards

Exhaust ducts on roof
Ladders
Rigging and
Openings and skylights
Roof access
Remove equipment and materials used on roof
Gas piping

Reference

Air Conditioning, Mechanical Equipment Service Manual for UAJA
Practical Heating Technology, Johnson, Delmar
www.osha.gov

Formulas

Energy Calculations

$Q_{(Total)} = 4.5 \times CFM \times \Delta h$

$Q_{(Sensible)} = 1.10 \times CFM \times \Delta T$

Q = BTUH

Δh = difference in enthalpy

Δg = difference in grains of moisture

ΔT = difference in temperature

Heat transfer

$BTUH = LB. \times \Delta T \times Specific\ heat$ (for any substance)

$BTUH = CFM \times \Delta T \times 1.08$ (for standard air)

$BTUH = GPM \times \Delta T \times 500$ (for water)

Force exerted by a round diaphragm with a pressure applied and measured in psig

$$Force = Area \times Pressure$$

$$= sq.in. \times \frac{pound}{sq.in.}$$

$$= \pi r^2 \times psig$$

Pressure conversions

1 psi = 2.31 feet of head

1 psi = 27.7 in. w.c.

1 psi = 2.04 in. Hg.

1 atmosphere = 34 feet of head

1 atmosphere = 29.9 in. Hg.

1 atmosphere = 14.7 psi

w.c. = water column

in. Hg. = inches Mecury

Air pressure in ducts

$$V = 4005\sqrt{VP}$$

$$VP = \left(\frac{V}{4005}\right)^2$$

Airflow in duct:

$$Q = A \times V$$

Q = CFM

A = Cross sectional area of duct (ft^2)

V=Velocity of air (feet per minute – FPM)

VP = inches water gage, "WG

Mixed air temperature (MAT)

$$MAT = OAT \times \%OA + RAT \times \%RA$$

Percent of outside air

$$\%OA = \frac{RAT - MAT}{RAT - OAT}$$

MAT=Mixed air temperature

OA=Outside air

OAT=Outside air temperature

RA=Return air

RAT=Return air temperature

Hydronic Pressure (Total Head)

Total Head = Static Head + Friction Head + Velocity Head

Static Head

Static Head = Static Discharge Head - Static Suction Head (calculated distance above pump as positive, distance below pump as negative)

Velocity Head (VH)

$$VH = \frac{V^2}{2g}$$

g = 32.2 ft/sec^2 (acceleration due to gravity)

V = Velocity of liquid

Total Dynamic Head

TDH = (DSH-SSH)+(DVH-SVH)

TDH = Total dynamic head

DSH = Discharge static head

SSH = Suction static head

DVH = Discharge velocity head

SVH = Suction velocity head

Flow Coefficient (Cv) rating of valve

$$Cv = \frac{Q}{\sqrt{H}}$$

Q = flow rate in gpm
H = head loss (pressure drop) in PSI
Cv = flow coefficient with valve wide open, equal to gpm of flow at a 1 PSI pressure drop across the valve. Cv decreases as the valve closes.

Temperature conversions

$$°F\,(\text{Fahrenheit}) = °C \times \frac{9}{5} + 32$$

$$°C\,(\text{Celsius}) = (°F - 32) \times \frac{5}{9}$$

$$°R\,(\text{Rankine}) = °F + 460$$

$$°K\,(\text{kelvin}) = °C + 273$$

Ohm's Law

Volts = Amps x Ohms
or
E=I x R

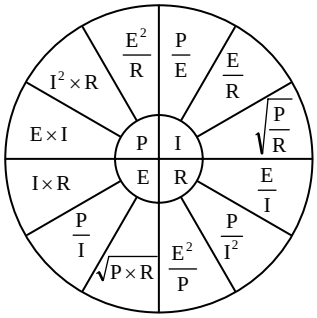
Watt's Law

Watts = Volts x Amps
or
P = E x I

Energy formula

W = P x t

Formula Circle for Ohm's and Watt's Laws



E = voltage
I = current (amps)
P = power (watts)
R = resistance (ohms)
W = energy (kWh, or kilowatt-hour)
t = time (hours)

Sum of resistance

Series circuits

$$R_T = R_1 + R_2 + R_3$$

Parallel circuits

$$R_t = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

Sum of capacitance (C)

Series circuits

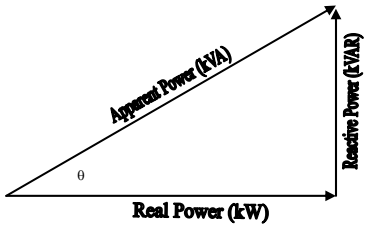
$$C_t = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}}$$

Parallel circuits

$$C_T = C_1 + C_2 + C_3$$

Power factor calculations

$$\text{Power Factor} = \frac{\text{true power (kW)}}{\text{apparent power (kVA)}} = \cos\theta$$



$$3\text{-phase apparent power}\,(\text{kVA}) = \frac{\text{Volts} \times \text{Amps} \times 1.73}{1000}$$

$$\text{single phase apparent power}\,(\text{kVA}) = \frac{\text{Volts} \times \text{Amps}}{1000}$$

$$\text{Reactive power}\,(\text{kVAR}) = \sqrt{\text{kVA}^2 - \text{kW}^2}$$

Percent of motor load

$$\%\,\text{load} = \frac{\text{MA} - 0.5\text{NPA}}{0.5\text{NPA}} \times \frac{\text{MV}}{\text{MPV}}$$

NA = Measured amps
NPA = Nameplate amps
MV = Measured volts
MPV = Nameplate volts

Transformer voltage/winding calculation

$$E_S = E_P \times \frac{N_S}{N_P}$$

E_S = secondary voltage
E_P = primary voltage
N_S = number of secondary turns
E_P = number of primary turns

Brake horsepower of a fan

$$\text{Bhp} = \text{NPhp} \times \frac{\text{MA}}{\text{NPA}} \times \frac{\text{MV}}{\text{MPV}} \times \text{LF}$$

NPhp = Nameplate horsepower
MA = Measured amps
NPA = Nameplate amps (FLA)
MV = Measured volts
NPV = Nameplate volts
LF = Load factor (by table)

Brake horsepower of a pump

$$\text{Bhp} = \frac{\text{GPM} \times \text{TDH}}{3960 \times \text{Eff}} \times \text{specific gravity}$$

$$\text{Bhp} = \frac{\text{kW} \times \text{Eff}}{0.746}$$

$$\text{Pump efficiency} = \frac{\text{Total head} \times \text{GPM}}{3960 \times \text{Bhp}} \times \text{specific gravity}$$

GPM=Gallons per minute
TDH = Total dynamic head
Eff = Pump efficiency
kW = real input power

Speed Calculation

Calculate new sheave diameter, changing motor sheave

$$\text{Dia}_{\text{new}} = \text{Dia}_{\text{old}} \times \frac{\text{RPM}_{\text{new}}}{\text{RPM}_{\text{old}}}$$

Compression ratio (R)

$$R = \frac{\text{Absolute discharge pressure}}{\text{Absolute suction pressure}}$$

Calculate new sheave diameter, changing fan or pump sheave

$$\mathrm{Dia}_{new} = \mathrm{Dia}_{old} \times \frac{\mathrm{RPM}_{old}}{\mathrm{RPM}_{new}}$$ Fan Laws

$$\mathrm{CFM}_{new} = \mathrm{CFM}_{old} \times \frac{\mathrm{RPM}_{new}}{\mathrm{RPM}_{old}}$$

$$\mathrm{SP}_{new} = \mathrm{SP}_{old} \times \left(\frac{\mathrm{CFM}_{new}}{\mathrm{CFM}_{old}} \right)^2$$

$$= \mathrm{SP}_{old} \times \left(\frac{\mathrm{RPM}_{new}}{\mathrm{RPM}_{old}} \right)^2$$

$$\mathrm{BHP}_{new} = \mathrm{BHP}_{old} \times \left(\frac{\mathrm{CFM}_{new}}{\mathrm{CFM}_{old}} \right)^3$$

$$= \mathrm{BHP}_{old} \times \left(\frac{\mathrm{RPM}_{new}}{\mathrm{RPM}_{old}} \right)^3$$

Pump Laws

$$\mathrm{GPM}_{new} = \mathrm{GPM}_{old} \times \frac{\mathrm{D}_{new}}{\mathrm{D}_{old}}$$

$$= \mathrm{GPM}_{old} \times \frac{\mathrm{RPM}_{new}}{\mathrm{RPM}_{old}}$$

$$\Delta\mathrm{P}_{new} = \Delta\mathrm{P}_{old} \times \left(\frac{\mathrm{GPM}_{new}}{\mathrm{GPM}_{old}} \right)^2$$

$$= \Delta\mathrm{P}_{old} \times \left(\frac{\mathrm{D}_{new}}{\mathrm{D}_{old}} \right)^2$$

$$= \Delta\mathrm{P}_{old} \times \left(\frac{\mathrm{RPM}_{new}}{\mathrm{RPM}_{old}} \right)^2$$

$$\mathrm{BHP}_{new} = \mathrm{BHP}_{old} \times \left(\frac{\mathrm{GPM}_{new}}{\mathrm{GPM}_{old}} \right)^3$$

$$= \mathrm{BHP}_{old} \times \left(\frac{\mathrm{D}_{new}}{\mathrm{D}_{old}} \right)^3$$

$$= \mathrm{BHP}_{old} \times \left(\frac{\mathrm{RPM}_{new}}{\mathrm{RPM}_{old}} \right)^3$$

General Gas Law

$pV = mRT$

Boyle's Law and Charles' Law

$T_1 p_2 = T_2 p_1$ (Charles' Law with constant volume)

$T_1 V_2 = T_2 V_1$ (Charles' Law with constant pressure)

$p_1 V_1 = p_2 V_2$ (Boyle's Law with constant temperature)

p=absolute pressure in pounds per square foot
V=volume in cubic feet
m=mass in pounds
R=gas constant of the particular gas (foot-pounds per pound per degree Rankine)
T=absolute temperature in degrees Rankine

Gas	*R*	Gas	*R*
Air	53.5	Hydrogen	765.9
Ammonia	90.5	Nitrogen	55.1
Carbon dioxide	35.1	Oxygen	48.3
Carbon monoxide	55.1	Sulfur dioxide	24.1

Practice Questions

Instructions:

The following questions are designed to give you the opportunity to practice for the UA STAR exam and to determine areas where you may need study and review.

Once you have taken the practice questions, you can check your answers using a separate document from the UA. This document contains explanations for most of the correct and incorrect answers. Task links are also provided with each question. These links direct you to specific areas of the DACUM. From there, you can locate the UA text to use for reference on your specific area of interest.

1. Matter is commonly explained as a substance that occupies space and has
   A. mass
   B. solid
   C. liquid
   D. gas

2. Solid mass exerts pressure
   A. in all directions
   B. downward only
   C. down and outward
   D. all of the above

3. Liquid mass exerts pressure
   A. downward only
   B. in all directions
   C. down and outward
   D. all of the above

4. The “Law of Conservation of Energy” states that energy is neither created nor destroyed but
   A. is renewable
   B. can be converted from one form to another
   C. is not renewable
   D. both a and b

5. Dalton's Law of Partial Pressures shows that the total pressure of a confined mixture of gases is
   A. an average of all the gases combined
   B. the least pressure of each of the gases
   C. the sum of all the gases
   D. not measurable

6. Heat flow is always in the direction of
   A. hot to cold
   B. cold to hot
   C. lower to higher
   D. higher to lower

7. Latent heat is experienced
   A. when the earths temperature decreases
   B. water turns to steam
   C. when ice melts
   D. both b & c

$$C = \frac{F - 32}{1.8} \qquad C = 21$$

8. Convert 70 degrees Fahrenheit to Celsius
   A. 17
   B. 21
   C. 34
   D. 38

9. An increase of temperature on a confined gas creates
   A. no change in pressure
   B. a decrease in pressure
   C. an increase in pressure
   D. creates a increase in pressure only if the gas becomes liquefied

10. What is the pressure of R-22 Refrigerant if the temperature is 32 degrees f?
    A. 9.0 psi
    B. 30.1 psi
    C. 57.5 psi
    D. 298.8 psi

11. An evaporator's primary purpose is to
    A. make the refrigerated product cold
    B. absorb heat from the refrigerated product
    C. remove heat from the refrigerant
    D. cause the refrigerant to condense into liquid form

12. Residential and light commercial HVAC systems typically use
    A. reciprocating compressors
    B. rotary compressors
    C. scroll compressors
    D. any of the above

13. The condenser receives hot refrigerant vapor from the compressor and
    A. cools the refrigerant causing a latent heat exchange
    B. adds heat to the refrigerant causing it to condense
    C. removes heat from the refrigerant causing a sensible heat change
    D. both a and c

14. Residential and light commercial HVAC systems typically use
    A. capillary metering
    B. thermal expansion valve metering
    C. automatic expansion valve metering
    D. all of the above

15. The most common refrigerant used in existing modern residential or light commercial air conditioning systems is
    A. R-12
    B. R-22
    C. R-134a
    D. R410a

16. Refrigerant 410 has special characteristics including higher operating pressure, a small temperature glide and is
    A. an azeotrope
    B. a near azeotrope
    C. a zoetrope
    D. a cfc

17. Absorbing heat in the evaporator causes the refrigerant to
    A. boil
    B. get cold
    C. sweat
    D. turn into a liquid

18. What is the volume of an office 20 feet wide, 30 feet long and 10 feet high?
    A. 60 cubic feet
    B. 200 cubic feet
    C. 300 cubic feet
    D. 600 cubic feet

19. The nominal evaporator CFM per 1 ton of air conditioning is _____ ?
    A. 200
    B. 400
    C. 1,200
    D. 12,000

20. The deep vacuum is measured with a micron gauge, how many microns are in 1 inch?
    A. 25,400
    B. 254,000
    C. 759,968
    D. none of the above

21. If a motor operating 1725 RPM is turning a blower wheel at 500 RPM and the blower pulley is 12", what is the diameter of the motor pulley?
    A. 2.5 inches
    B. 3 inches
    C. 3.5
    D. 4 inches

22. How many watts are required to operate a 1 hp motor for a period of 1 hour
    A. 74.6 watts
    B. 746 watts
    C. 7460 watts
    D. none of the above

23. A technician must use every precaution when working with pressure, electrical energy, heat, cold, rotating machinery, chemicals and when lifting heavy object
    A. to protect him/her self
    B. to protect others in the area
    C. to act as a professional
    D. all of the above

24. One of the most overlooked safety devices in this industry is
    A. safety glasses
    B. steel toed shoes
    C. leather gloves
    D. self contained breathing apparatus

25. Wearing metal jewelry can be most harmful because of
    A. frost bite
    B. shock or electrical burn
    C. magnetic electrical energy
    D. electrical ground fault

26. Whenever possible a technician should “Lock out/Tag out” the electrical service panel before working on system to prevent
    A. the unit starting up automatically
    B. electrical shock
    C. to prevent others from starting the system
    D. all of the above
    E.

27. The third wire or “ground wire” is utilized to prevent
    A. electrical shock from defective equipment
    B. the use of some extension cords
    C. high voltage from reaching electrical tools
    D. counter emf

28. A technician should never use an extension cord unless it has been plugged into a
    A. GFCI
    B. breaker panel
    C. a circuit with at least 20 amps of service
    D. all of the above

29. If you encounter a fire with a source of flammable liquids
    A. you must use a class “a” fire extinguisher
    B. you must use a class “b” fire extinguisher
    C. you must use a class “c” fire extinguisher
    D. you must use a class “d” fire extinguisher

30. Multi-purpose fire extinguishers rated “A” “B” “C” can be used on
    A. flammable liquids
    B. ordinary combustibles
    C. electrical equipment
    D. all of the above

31. When using a fire extinguisher always aim
    A. at the base of the fire
    B. in front of the fire
    C. at the top of the fire
    D. all of the above

32. A leaking refrigeration system not only can cause severe frost bite but can also cause
    A. asphyxiation
    B. lightheadedness
    C. heart arrhythmia
    D. all of the above

33. When soldering or brazing near combustible materials a technician should always use a
    A. flame retardant heat shield
    B. bucket of water to soak combustibles
    C. propane torch
    D. all of the above
    E.

34. If the working length of a ladder is 12 feet, how far should the base of the ladder be placed from the adjacent wall?
    A. 2 feet
    B. 3 feet
    C. 4 feet
    D. 6 feet

35. If a technician finds a person suffering from asphyxiation caused by breathing refrigerant he/she should
    A. call for help
    B. immediately move the person to an area of fresh air
    C. conduct CPR
    D. find and fix the refrigerant leak

36. If you find a person who is suffering from an electrical shock and has no pulse you should
    A. call for help
    B. begin CPR immediately
    C. drag the person to safety
    D. turn off the building's power supply

37. When treating frost bite you should
    A. gently rub the affected area
    B. run warm water over the affected area
    C. quickly warm the affected area with a heater or blow drier
    D. quickly put on butyl-line gloves

38. Which agency concerns itself with the health and safety of America's work force?
    A. Air Conditioning Refrigeration Institute
    B. American National Standards Institute
    C. Occupational Safety & Health Administration
    D. all of the above

39. Which organization coordinates the development and use of voluntary consensus standards in the United States and represents the needs and views of US. Stakeholders in standardization forums around the world?
    A. Occupational Safety & Health Administration
    B. American National Standards Institute
    C. Air Conditioning Contractors of America
    D. none of the above

40. Identify the air distribution system used in modern residential buildings in which the air pressure remains steady from one end of the system to the other
    A. radial duct system
    B. reducing plenum system
    C. perimeter loop system
    D. flex duct

41. When installing galvanized rectangle duct 8” x 20” the metal should be at least
    A. 16 gage
    B. 24 gage
    C. 28 gage
    D. 32 gage

42. When the proper size duct materials are used the occupants of the home should
    A. not feel air movement
    B. should not hear air noise
    C. should not feel temperature swing
    D. all of the above

43. When conditioned air travels through an unconditioned space such as an attic or crawl space the duct must be insulated if the air temperature difference is
    A. 5 degrees f
    B. 10 degrees f
    C. 15 degrees f
    D. 20 degrees f

44. Air Conditioning/Refrigeration (ACR) tubing is measured by its
    A. inside dimension
    B. outside dimension
    C. nominal dimension
    D. wall thickness

45. On air conditioning systems the _____ tubing is often insulated to reduce heat transfer to the refrigerant.
    A. liquid line
    B. high pressure line
    C. discharge line
    D. low pressure line

46. Most air conditioning tubing is brazed using _____ as a filler material.
    A. 15% silver
    B. 95/5 tin-antimony
    C. 50/50 tin-lead
    D. All of the above

47. _____ draws the filler alloy into space between the base metals when brazing
    A. Capillary action
    B. High temperature
    C. Vacuum
    D. Pressure

48. A vacuum pump is used to reduce a systems pressure to
    A. 0 psia
    B. 0 psig
    C. 500 microns
    D. 5000 microns

49. On larger systems it is more practical to add refrigerant in the liquid phase, however the technician must make certain no _____ enters the compressor.
    A. vapor
    B. contaminants
    C. moisture
    D. liquid

50. What is the superheat of an R-22 air conditioning system if the evaporator boiling point temperature is 40 degrees f and the suction line temperature is 52 degrees f?
    A. 12 degrees f
    B. 30 degrees f
    C. 62 degrees f
    D. 92 degrees f

51. When installing a central air conditioning system the entire refrigerant charge is typically
    A. added by the technician
    B. shipped and held in the evaporator
    C. shipped and held in the condensing unit
    D. recovered before evacuation

52. Vacuum pump oil must be changed on a regular basis because it can become very contaminated with
    A. CFC's
    B. Moisture
    C. HCFC's
    D. All of the above

53. To calibrate a gauge manifold a technician should
    A. open the gauge to atmosphere, it should read 0 psig
    B. use another gage manifold
    C. use a micron gage
    D. use a tire pressure gage

54. Under normal conditions mechanical ventilation can adequately remove indoor air pollution caused by
    A. moisture
    B. unvented gas stoves
    C. carpets
    D. all of the above

55. There may be as many as 100,000 different molds, as long as there is food and _____ these molds will not go away.
    A. darkness
    B. cool temperature
    C. moisture
    D. stale air

56. Indoor air pollution monitoring testing equipment is available to identify the source of contamination for
    A. carbon dioxide
    B. carbon monoxide
    C. ozone
    D. all of the above

57. To be most effective UV-C germicidal lamps should be placed
    A. in bedrooms
    B. open areas of the office or home
    C. in the duct work near the cooling coil
    D. all of the above

58. Fiberglass air filters use _____ to trap airborne matter
    A. tiny fiberglass particles
    B. continuous glass fiber
    C. desiccants
    D. formaldehyde

59. High Efficiency Particulate Arrester (HEPA) filters can remove pollutants from the indoor air as small as
    A. 20-30 microns
    B. 100-200 microns
    C. 200-300 microns
    D. 500-1000 microns

60. Electrostatic air filters use _____ to clean indoor air.
    A. a series of negatively and positively charged plates
    B. UV-b lamps
    C. UV-c lamps
    D. all of the above

61. _____ filters work best to prevent air turbulence and allow for a more even loading of contaminants.
    A. Cube
    B. Fiberglass
    C. Pleated
    D. HEPA

62. The recommended humidity level in homes or buildings is_____
    A. no more than 20%
    B. 20% - 40%
    C. 40% - 60%
    D. at least 70%

63. Duct mounted bypass humidifiers allows air from the supply duct to
    A. flow directly to the return air duct
    B. pass through a “media”
    C. be heated before entering the humidifier
    D. all of the above

64. Humidifiers should only operate
    A. when the air handler blower is operating
    B. when the humidistat signals for an increase of humidity
    C. when the system control is set for cooling
    D. both a and b

65. What is the maximum hardness of the water allowable for atomizing type humidifiers?
    A. 1-3 grains
    B. 8-10 grains
    C. 20-30 grains
    D. up to 50 grains

66. High quality energy recovery ventilators
    A. use high volume blowers to exhaust stale air
    B. use a heat exchanger to absorb heat from the air being exhausted
    C. use a small heater to “make-up” heat lost due to incoming fresh air
    D. all of the above

67. To help prevent allergic reactions or upper respiratory problems humidifiers should be
    A. cleaned regularly
    B. treated with algaecides
    C. drained regularly
    D. all of the above

68. To kill mold and algae and to prevent them from contaminating the area some manufacturers use
    A. UV lights
    B. radon
    C. fungicides
    D. all of the above

69. The required condenser air flow is approximately
    A. 400 CFM per ton
    B. 600 CFM per ton
    C. 800 CFM per ton
    D. 1000 CFM per ton

70. A dirty condenser prevents the rejection of heat and causes
    A. low head pressure
    B. high head pressure
    C. low suction pressure
    D. high suction pressure

71. A condenser fan motor with sleeve bearings should be lubricated
    A. 2 times per year
    B. 3 times per year
    C. 4 times per year
    D. once per month

72. Improper blower pulley alignment can cause
    A. unnecessary wear
    B. erratic speed
    C. premature belt failure
    D. all of the above

73. V-Belt tension should be set to about
    A. ½ inch
    B. 1 inch
    C. 1 ½ inches
    D. 2 inches

74. To add refrigerant to a partially charged air conditioning system a technician should read the manifold gages and then
    A. compare to a pressure temperature chart
    B. consult with the manufacturer
    C. recover the existing charge and weigh in the correct charge
    D. compare to relative humidity chart

75. Starting up an air conditioning system with the indoor temperature at 85 degrees f and the Rh at 70% would be considered
    A. an excessive load
    B. a normal load
    C. a light load
    D. none of the above

76. During a complete loss of charge condition with a leak on the systems low side and the systems low pressure cut-out control has opened the technician must consider
    A. finding and repairing the leak
    B. contaminant in the system
    C. the compressor will not start until the system is recharged
    D. all of the above

77. After a system evacuation _____ can cause a micron gage to rise from 250 microns to 500 microns before leveling off.
    A. oil still in the condenser
    B. an overcharge of refrigerant
    C. an undercharge of refrigerant
    D. excessive contamination

78. To clean an excessively moisture contaminated system a technician may perform a
    A. deep vacuum
    B. triple evacuation
    C. recovery
    D. system recharge

79. A full or partial restriction of the capillary tube is often the result of
    A. too much oil charge
    B. incorrect oil viscosity
    C. liquid refrigerant entering the compressor crankcase
    D. all of the above

80. An air conditioning system with a fluctuating evaporator pressure would most likely be the result of a
    A. defective circuit board
    B. defective AEV
    C. defective compressor
    D. defective capillary tube

81. A system operating with a loose thermal expansion valve sensing element would cause the systems superheat to be
    A. too low
    B. too high
    C. normal
    D. erratic

82. Any evaporator with a pressure drop in excess of _____ should use a thermal expansion valve with an external equalizer.
    A. 1 psig
    B. 2.5 psig
    C. 3.5 psig
    D. 5 psig

83. Any system operating with a thermal expansion valve can automatically adjust to a change in the load condition. In order to supply an adequate volume of refrigerant the system must also utilize
    A. an accumulator
    B. a receiver
    C. an oil separator
    D. a load controller

84. An air conditioning system using a TXV with an undercharge of refrigerant can be identified by
    A. low suction pressure
    B. low system capacity
    C. high superheat
    D. all of the above

85. If an air conditioning compressor is allowed to operate with a low refrigerant charge the compressor is likely
    A. to draw higher than normal amperage
    B. to make excessive noise
    C. to be very hot
    D. all of the above

86. An air conditioning system using a TXV and operating with an overcharge of refrigerant can be identified by
    A. high discharge pressure
    B. higher than normal suction pressure
    C. low system capacity
    D. all of the above

87. An overcharged air conditioning system using a capillary tube metering device would
    A. have high head pressure
    B. have high suction pressure
    C. allow liquid refrigerant to enter the compressor
    D. all of the above

88. A properly charged air conditioning system with a dirty air filter could
    A. frost back to the compressor
    B. cause the condenser fan to overheat
    C. cause ice buildup on the condenser
    D. all of the above

89. CFC refrigerants contain _____ which is considered the most harmful to the ozone layer
    A. fluorine
    B. chlorine
    C. hydrogen
    D. carbon

90. HCFC-based blends are considered
    A. short term replacements
    B. long term replacements
    C. ozone friendly
    D. inefficient

91. Stratospheric ozone is considered “good” ozone because it filters out
    A. Air pollution
    B. UV-b light rays
    C. UV-c light rays
    D. CFC’s

92. HFC-134a refrigerant uses synthetic oil called
    A. polyol ester oil
    B. mineral oil
    C. paraffin oil
    D. polyalkalene ester oil

93. ASHRAE’s Standard 34-1992 refrigerant safety group chart classifies _____ as the least toxic and not flammable.
    A. A3
    B. B3
    C. A1
    D. B1

94. The United States Clean Air Act Amendments of 1990 regulate the use and disposal of
    A. CFC’s
    B. HCFC’s
    C. both a and b
    D. neither a or b

95. The prohibition against refrigerant venting became effective
    A. September 1, 1987
    B. January 1, 1990
    C. July 1, 1992
    D. January 1, 1996

96. The process of removing refrigerant from a system and storage in an approved
container without any further testing is known as
A. recovery
B. recycling
C. reclaiming
D. evacuation

97. The process of used refrigerant being cleaned to meet new product specifications
called ARI 700 Standard is known as
A. recovery
B. recycling
C. reclaiming
D. evacuation

98. Type I refrigerant certification allows service on refrigeration equipment
A. with 5 pounds or less of charge
B. hermetically sealed
C. specifically listed
D. all of the above

99. If a DC power supply of 20 volts causes 2 amps of current to flow in a circuit
A. the resistance of the circuit is 10 ohms
B. the power consumed by the circuit is 100 watts
C. the power consumed by the circuit is 10 watts
D. the resistance of the circuit is 40 ohms

100. A _____ is often used as a graphic representation of alternating current
A. + positive symbol
B. negative symbol
C. Sine wave
D. North pole or South pole

101. Which of the following is true regarding current flow in a parallel circuit?
A. current flow is equal through all branches of the circuit
B. the paths with higher resistance will have higher current flow
C. the paths with lower resistance will have higher current flow
D. as addition branches are added to the circuit the total current will decrease

102. A control transformer rated at 50 VA and a 25 volt secondary voltage should be protected with a
A. 0.5 amp fuse
B. 1 amp fuse
C. 1.5 amp fuse
D. 2 amp fuse

103. The symbol used for electrical pressure is
A. “E”
B. “I”
C. “R”
D. “P”

104. What happens to the current if the voltage in a circuit doubles and nothing else changes?
A. the current will increase by 4 times
B. the current will decrease by 1/2
C. the current will increase by 2 times
D. the current will decrease by ¼

105. 1 millivolt equal
A. 1000 volts
B. 100 volts
C. 1/1000 of a volt
D. 1/100 of a volt

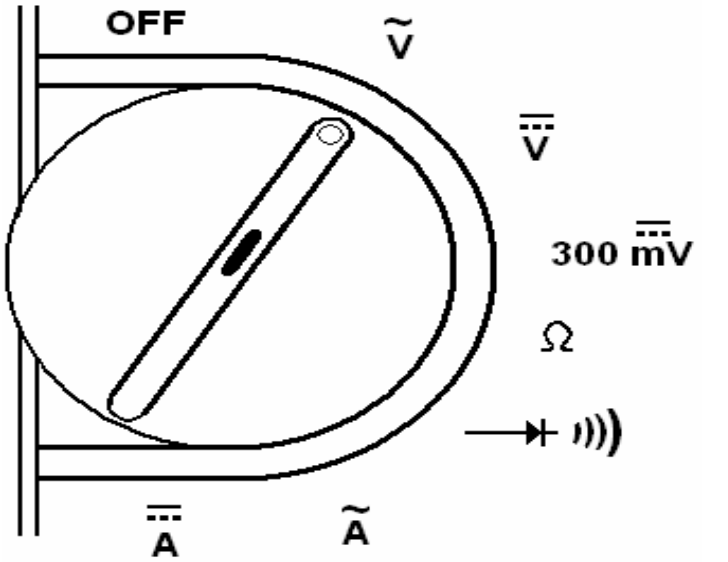
106. Which meter is used to test for potential?
A. Voltmeter
B. Ammeter
C. Ohmmeter
D. Potentiometer

107. To read the amperage draw from an alternating electrical device
A. set the meter to read voltage and place the two test leads on both sides of the load
B. set the meter to read amperage and clamp the meter around both conductors feeding power to the device
C. set the meter to read amperage and clamp the meter around one of the conductors feeding power to the device
D. set the meter to read amperage and place the test leads on both sides of the load

108. When testing a compressor motor with an ohmmeter, what reading would be obtained if its internal over-load is in the open position?
A. run to start—zero ohms
B. run to common—zero ohms
C. run to start—infinite ohms
D. run to common—infinite ohms

109. The capacitor analyzer is used to measure
A. shorted or open capacitors and micro-farad values
B. micro-farad ratings and the capacitors power factor
C. open capacitors, micro-farad ratings and the capacitor's power factor
D. open and shorted capacitors, micro-farad ratings and the capacitors power factor

110. What value is the meter presently set to read?



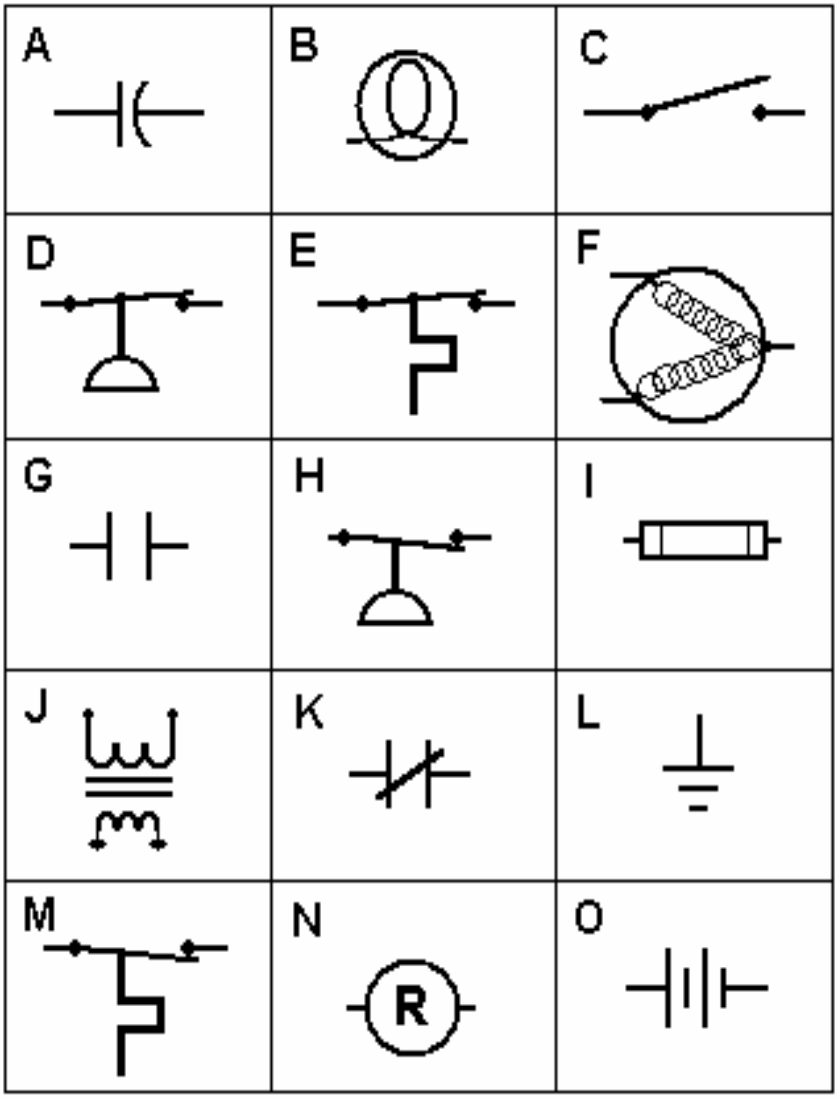
A. Amps
B. Ohms
C. AC volts
D. DC volts

111. To measure the out-put of a thermocouple which setting would the meter be placed?

A. Ṽ
B. Ω
C. 300 mV̿
D. V̿

112. When should a mega-ohmmeter never be used?
A. when the system is in a vacuum
B. when the system is at atmospheric pressure
C. when the system is in a positive pressure
D. when system is charged with refrigerant

Use the electrical symbols chart to answer questions 113-115



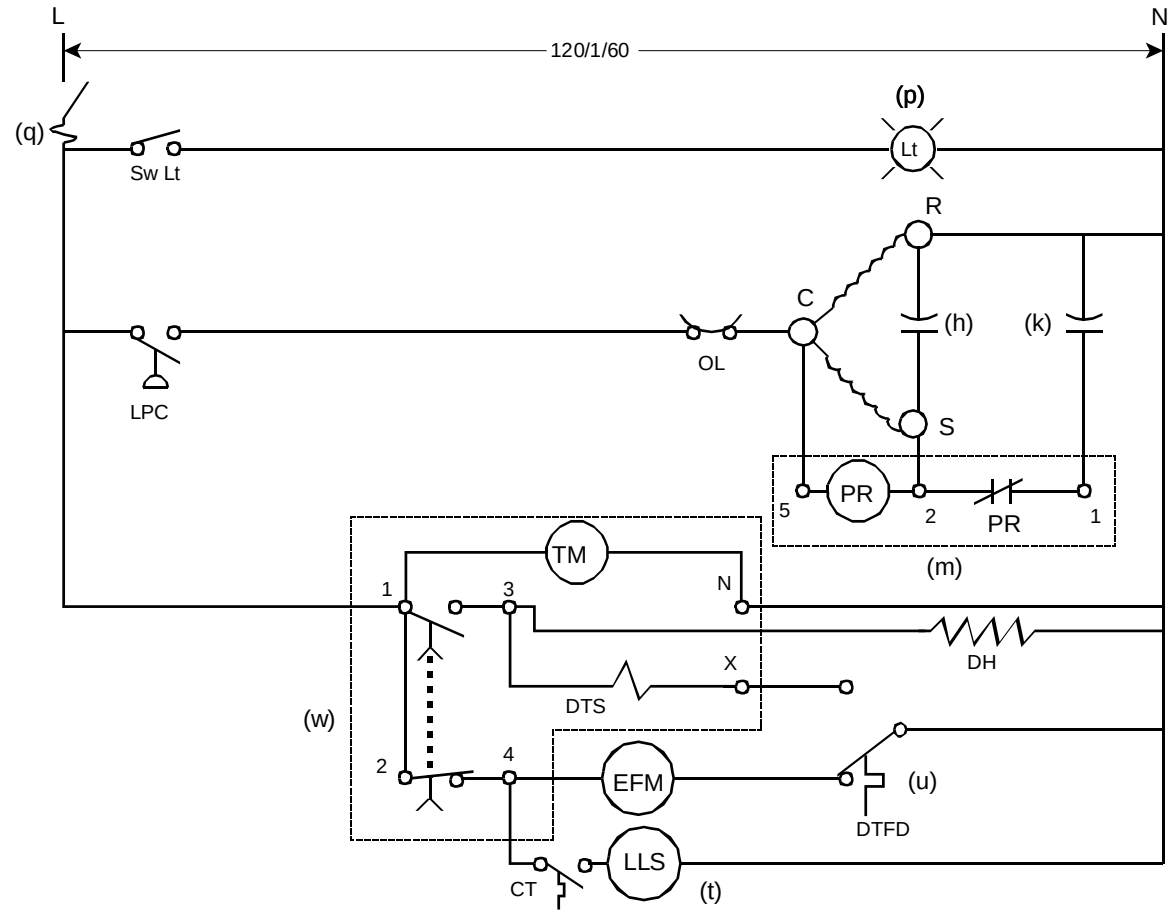
113. Which symbol represents a heating thermostat?
   A. D
   B. E
   C. H
   D. M

114. Which symbol represents a component which opens on a loss of pressure?
   A. D
   B. E
   C. H
   D. M

115. Which symbol represents a high pressure cut-out?
A. D
B. E
C. H
D. C

116. The four components of a circuit are
A. power source, current path, resistive load and inductive load
B. power source, current path, load and switch
C. current path, load, switch and light bulb
D. load, resistance, current and current path

Use the following schematic to answer questions 117 – 118



117. Identify the two (2) over-current devices in the schematic.
A. q and u
B. q and t
C. t and u
D. q and OL
E.

118. If fuse “q” opens which part of the circuit will still have voltage?
A. light circuit
B. compressor circuit
C. defrost circuit
D. l and n

119. According to American Wire Gauge (AWG) the largest diameter wire is?
A. 0000 (4/0)
B. 2 gauge
C. service lead wire
D. 50 gauge

120. Upon start-up of a roof top air conditioning system it is found that the condenser fan motors are rotating in the wrong direction. What should be done to correct the problem?
A. replace the motor with the correct rotation motors
B. disconnect the power and change any two phase leads of the incoming power
C. reverse the directional decal on the fan blades
D. turn the fan blades over

121. A single phase 120/240 volt electric service is made up of
A. L1, L2 and Neutral
B. L1 and Neutral
C. L1, L2 and L3
D. L1, L2, L3 and a ground

122. _____ refers to the number of currents alternating at different time intervals in the circuit
A. amperage
B. resistance
C. phase
D. sine wave

123. In the United States 3 phase power operates at
A. 60 Hz
B. 120 Hz
C. 180 Hz
D. 240 Hz

124. On a 240 volt circuit, L1 and L2 cycle
A. 60 degrees apart
B. 120 degrees apart
C. 180 degrees apart
D. 240 degrees apart

125. Most commercial building's electrical service is
   A. 120 volt single phase
   B. 120/240 volt 3 phase
   C. 240/440 volt single phase
   D. 440 volt 3 phase

126. A 3 phase Wye configuration supply voltage measures 208 volts between each leg. What is the measured voltage from each leg to ground?
   A. 60 volts
   B. 104 volts
   C. 120 volts
   D. 208 volts

127. Because most induction motors require additional starting torque _____ are implemented.
   A. start and run capacitor
   B. start windings
   C. shaded pole circuits
   D. three phase winding

128. Shaded-pole motors can most easily be identified by
   A. a heavy copper band
   B. a start capacitor
   C. a run capacitor
   D. both start and run capacitor

129. The primary application for shaded-pole motors would be
   A. when low start torque is required
   B. when low run torque is required
   C. when three phase power is not available
   D. both a and b

130. One of the most popular motors used in the HVAC industry with moderate starting torque and good running efficiency is the _____ motor.
   A. capacitor start capacitor run
   B. shaded pole
   C. permanent split capacitor
   D. three phase

131. Identify the most rugged and reliable motor used in the industry which operates
without the assistance of start components
   A. induction motor
   B. permanent split capacitor motor
   C. three phase-motor
   D. shaded pole

132. Identify the difference between a three pole contactor and a three pole magnetic starter
A. a contactor has an overload circuit
B. a magnetic starter has an overload circuit
C. a magnetic starter has a solenoid coil
D. a contactor has solenoid coil

133. In identifying the common, start, run terminals of a split phase motor; terminal A to B = 10 ohms, terminal A to C = 3 ohms, and terminal B to C = 7 which terminal is common
A. terminal A
B. terminal B
C. terminal C
D. ground terminal

134. Electronically commutated motors alter the output drive speed. This is accomplished by altering
A. electrical frequency
B. electrical voltage
C. electrical current
D. electrical resistance

135. To safely test a motor capacitor a technician should
A. charge the capacitor with a low voltage
B. discharge the capacitor with a resistor
C. unplug the appliance
D. remove the bleed resistor

136. If a compressor with an internal motor overload opens, what should the technician do before condemning the compressor
A. wait 1 hour
B. allow the compressor to cool down
C. cool the compressor down with nitrogen
D. replace the internal overload

137. An air conditioning system uses a 24 volt control thermostat to maintain room temperature. The same system also utilizes a low pressure switch. What is the most likely purpose of this low pressure switch?
A. to cycle the compressor on when the room ambient increases
B. to cycle the compressor on when the room ambient decrease
C. to cycle the compressor off if the system runs low on charge
D. to cycle the compressor off if the system is over charged

138. A roof top air conditioning system with a defective condenser fan motor would be protected by
   A. a low pressure safety cut out switch
   B. a high pressure safety cut out switch
   C. fan cycling pressure switch
   D. a temperature delay switch

139. A roof top air conditioner operating with a pressure type fan control maintains a minimum head pressure
   A. during low ambient conditions
   B. during high ambient conditions
   C. during high temperature conditions
   D. during high pressure conditions

140. When adding central air conditioning to an existing heating system a fan relay center control (or fan relay) may need to be added, this relay would be controlled by which thermostat lead?
   A. R-Red
   B. W-White
   C. Y-Yellow
   D. G- Green

141. To prevent room temperature “overshoot” most HVAC room thermostats employ a
   A. set back module
   B. heat anticipator
   C. cooling anticipator
   D. fan on/auto mode

142. Solenoid valves are
   A. magnetically controlled
   B. high pressured controlled
   C. low pressured controlled
   D. motor controlled

143. A potential magnetic relay is controlled by the back electromotive force created by
   A. high amperage
   B. high resistance
   C. the run winding
   D. the start winding

144. After a defrost timer control initiates a defrost period the defrost cycle may terminate by means of
   A. time, pressure, or temperature
   B. temperature only
   C. pressure only
   D. time only

145. A solid state starting relay is employed with fractional horse power compressors.
after the motor starts the relay
A. increases in resistance disconnecting the run winding
B. increases in resistance disconnecting the start winding
C. decreases resistance disconnecting the run winding
D. decreases resistance disconnecting the start winding

146. When troubleshooting a capacitor-start-capacitor- run motor and the technician finds the start capacitor and the run capacitor defective the technician must also check the operation of
A. thermal over load
B. current magnetic relay
C. compressor contactor
D. potential magnetic relay

147. Most low voltage HVAC room thermostats can adjust temperature over shooting, this adjustment would be a function of
A. fan cycle switch
B. heat anticipator
C. programmable timer circuit
D. time delay relay

148. A current sensing lockout relay is an overload device that senses the current draw
of the compressor through the _____
A. lockout loop
B. thermo overload
C. lockout timer
D. condenser fan motor limit

149. When diagnosing the compressor contactor coil a proper resistance reading would be
A. Infinity
B. Zero OHMS
C. 45 OHMS
D. Zero OHMS to ground

150. The best method to test the condition of the contacts in a compressor contactor would be
A. voltage drop test
B. meg-ohm test
C. visual inspection
D. micro-amp test

151. When troubleshooting a fuse with a volt meter a reading of line voltage across both ends of the fuse would indicate the fuse is
    A. good
    B. open
    C. shorted
    D. closed

Service Calls:

Determine the problem and recommend a solution for the following service calls.

152. Application: Residential conditioned air system
Type of Equipment: Gas furnace with air-cooled condensing unit
Complaint: No cooling
Symptoms:
1. Correct line voltage to furnace and condensing unit.
2. Thermostat calling for cooling.
3. Condensing unit receiving 24 volts.
4. All safety controls in condensing circuitry are closed.

Contactor coil resistance reading is 0 ohms.

    A. low on refrigerant charge
    B. dirty condenser
    C. burnt out contactor coil
    D. shorted contactor coil

153. Application: Residential conditioned air system
Type of Equipment: Fan coil unit air-cooled condensing unit
Complaint: No cooling
Symptoms:
1. Correct line voltage to furnace and condensing unit.
2. Thermostat calling for cooling.
3. Compressor contactor closed.
4. Compressor and condenser fan motor extremely hot.
5. Condenser fan motor resistance readings are C to R = 6 ohms. C to S + 28 ohms, and R to S =34 ohms.
6. Compressor run capacitor in good condition.
7. Compressor motor and bearings in good condition.
8. Condenser fan blade turns with ease.
9. Condenser fan turning slower than normal until overload cuts out.

    A. low supply voltage
    B. high supply voltage
    C. shorted compressor and condenser motors
    D. too small of condensing unit

154. Application: Residential conditioned air system
Type of Equipment: Packaged air conditioner
Complaint: No cooling and no indoor fan operation
Symptoms:
1. Line voltage available to unit.
2. Closing of thermostat fan switch causes no action.
3. Voltage at terminals C to R on unit low-voltage terminal board is 0 volts.

A. shorted run winding
B. open secondary transformer circuit
C. shorted compressor run capacitor
D. defected room thermostat

155. The heating element found in electric forced air furnaces is typically made from

A. silver
B. chrome
C. nichrome
D. silver/tungsten

156. An electric heat system operating with a low voltage thermostat would have the heat relay wired in series with the
A. blower motor
B. electric heat element
C. thermostat heat anticipator
D. thermostat Y terminal

157. Identify the safety found in electric duct heating systems
A. interlock
B. heat anticipator
C. transformer
D. high pressure switch

158. Contactors and _____ are commonly used to control the operation of the electric resistance heaters in electric furnaces
A. transformer
B. heat anticipator
C. high limit control
D. sequencer

159. The U.S. Federal Trade Commission requires manufactures to provide an annual fuel utilization efficiency rating (AFUE). AFUE ratings are for the benefit of
A. the consumer
B. manufacture
C. the technician
D. the EPA

160. A high efficiency gas furnace utilizing hot surface ignition (HIS) will enter into lockout mode if ignition is not detected
A. 2 seconds or less
B. 4 to 11 seconds
C. 15 to 20 seconds
D. 30 seconds

161. High efficiency furnaces use plastic vent piping because
A. acidic flue gases
B. lower flue temperatures
C. condensation of flue gases
D. all of the above

162. A technician uses which instrument to measure gas service and manifold pressure?
A. anemometer
B. draft gauge
C. water manometer
D. manifold gauge

163. When servicing the ignition transformer of an oil furnace correct secondary voltage would be
A. 120 volts
B. 600 volts
C. 6,000 volts
D. 10,000 Volts

164. When servicing the oil burner that repeatedly locks out, the technician tests the Cad Cell. In the presence of light the correct OHM reading should be
A. 0 OMHS
B. 600 to 1000 OMHS
C. 50,000 to 100,000 OMHS
D. Infinity

165. A standard oil burner nozzle identified as 80 degrees of angle and 1.00 GPH would deliver approximately how many BTUs per hour?
A. 40,000 BTUs
B. 80,000 BTUs
C. 100,000 BTUs
D. 140,000 BTUs

166. Centrifugal pumps used in hydronic heating are considered non-positive displacement pumps because
A. they do not add significant pressure to the system
B. because they do add significant pressure to the system
C. because the pistons are very small
D. none of the above

167. A typical residential/light commercial hydronic heating system the expansion tank
A. provides space for the heated water to expand
B. provides space when the water cools down
C. increases the water pressure so the water does not expand
D. maintains a constant water pressure equal to house pressure

168. A residential hydronic heating system using three zone valve controls (rated 24 Volt, .50 amp each) would require a control transformer rated at
A. 20VA
B. 30VA
C. 40VA
D. 60 VA

169. When installing a hydronic heating system the use of slow opening/closing zone valves allows for
A. the thermostat's heat anticipator to operate correctly
B. zone operation without water hammering
C. heating and cooling temperature control from the same thermostat
D. all of the above

170. A geothermal heat pump absorbs heat
A. in the evaporator in the heating mode
B. in the condenser in the heating mode
C. in the condenser during the cooling mode
D. none of the above

171. On a split system air source heat pump operating with an outdoor ambient of 30 degrees f the refrigerant boiling temperature would be approximately
A. -10 degrees
B. 10 degrees
C. 30 degrees
D. 70 degrees

172. A coaxial heat exchanger used on geothermal heat pumps allows
A. water to flow in one direction and refrigerant in the opposite direction

B. water and refrigerant to flow in the same direction
C. water to flow only if the water check valve is open
D. none of the above

173. During the heating mode air source heat pumps must periodically defrost the outdoor coil, some systems use time and or temp to initiate the defrost cycle. Other modern systems use
A. a low pressure control connected to the indoor coil
B. a high pressure control connected to the outdoor coil
C. an air pressure switch sensing air pressure at the indoor coil
D. an air pressure switch sensing air pressure at the outdoor coil

174. When attaching a document using Microsoft “Outlook” e-mail you must
A. click on the “forward” icon
B. click on the “paperclip” icon
C. click on the “new” icon
D. click on the “outbox” icon

175. From the following identify the most helpful internet map search engine.
A. Adobe
B. Google
C. www.com
D. Home page

176. When completing a service call the last action taken is presenting the invoice to the customer and obtaining a signature. Why is it important that all work performed is accurately described on the invoice?
A. to reference details at a later date
B. to identify warranty parts or service
C. to provide service details in written communication form
D. all of the above

177. Service technicians must be thorough in order to prevent a breakdown in communication that results in lost time (money). Which of the following is not part of the required invoice information?
A. date of repair
B. actual labor
C. total cost
D. original supplier of equipment

178. What measures can service technicians take to ensure that work orders are complete?
A. write legibly
B. do not rush
C. explain the work order to the customer and ask if they have any questions
D. all of the above

179. The most important element(s) of non-verbal communication is (are)
A. spoken words
B. voice inflection
C. body language
D. all of the above

180. The quality of customer service can be enhanced if the technician takes the time to
A. actively listen
B. explain in detail how the HVAC system works
C. explain the billing process and when the bill is due
D. use HVAC technical terms in explaining the work that has been completed

181. An HVAC technician should always attempt to convey a professional image by
A. clean and neat personal appearance
B. clean and neat service vehicle (inside and outside)
C. maintaining a clean and organized work site
D. all of the above

182. If a technician determines he can not keep a scheduled customer appointment he should
A. travel as fast as possible to get there as soon as possible
B. call the customer to keep them informed of your delay
C. do nothing, the customer expects service people to be late
D. call the customer and tell them you have been on a more important service call

183. Background checks are necessary to disclose employee history associated with
A. criminal records
B. credit reports
C. drug testing
D. all of the above

184. Which of the following would be a display of professionalism
A. work uniform with company logo
B. being punctual
C. use of good people skills
D. all of the above

185. Parallel compressors are piped into a system in such a manner that
A. the discharge lines are connected to a common manifold
B. the suction lines are connected to a common manifold
C. the liquid lines are connected to a common manifold
D. both a and b
E.

186. An advantage of the parallel compressor systems would be
A. load matching
B. higher efficiency
C. less compressor cycling
D. all of the above

187. An optional arrangement added to a roof top air conditioning system which has a motorized damper and opens when the room thermostat calls for cooling and outdoor temperature and humidity conditions are met is called
A. an economizer
B. heat recovery
C. free ventilation
D. desiccant cooling

188. Roof-top air conditioners typically are mounted on top of a roof curb to help provide a leak proof connection to the roof. The roof curb is generally _____ high.
A. 2-4 inches
B. 6-10 inches
C. 12-15 inches
D. 24-30 inches

189. Many roof top heating/air conditioning systems are 2-stage heating or 2-stage cooling or both. The primary purpose for this is
A. to allow a wider application of equipment
B. to allow for fluctuating loads
C. less costly to build equipment
D. to use smaller gas lines and refrigerant lines

190. To maintain operating effectiveness and performance the air pressure in a building should be
A. slightly positive to the outdoor pressure
B. slightly negative to outdoor pressure
C. equal to the outdoor pressure
D. positive in the cooling season and negative in the heating season

191. Air brought into a building to replace ventilated air leaving the building is called _____
A. infiltration air
B. make-up air
C. latent air
D. none of the above

192. Some applications such as hospital rooms require
A. 20% make-up air
B. 50% make-up air
C. 75% make-up air
D. 100% make-up air

193. The most common method of indoor air odor control is
A. electronic air filters
B. disposable filters
C. heap filters
D. dilution with ventilation air

194. If more air is exhausted through ventilation than is made-up from fresh air inlets the building is considered
A. equally pressured
B. negatively pressured
C. positively pressured
D. to have poor air quality

195. In kitchens where appliances may add a considerable amount of both latent and sensible heat, the heating and cooling load can be reduced by the proper installation and use of_____
A. exhaust hoods
B. heat recovery systems
C. roof-top condensers
D. all of the above

196. Correct installation and use of bathroom exhaust fans can greatly reduce the risk of
A. indoor humidity issues
B. radon gas build up
C. electrical equipment malfunctions
D. severe “sick building syndrome”

197. Proper ventilation in modern mechanical rooms is important because the refrigerant leaked from a system
A. is corrosive
B. can cause asphyxiation
C. is flammable
D. is toxic

198. The primary purpose(s) for the use of a Variable Air Volume (VAV) system is to gain operating efficiency by
A. offering building zone control
B. reducing the indoor blower rpm
C. capitalizing on passive solar gains
D. all of the above

199. The constant air volume system is less efficient than a variable air volume system because
A. the system always runs in the maximum heat position
B. the system always runs in the maximum cooling position
C. the system is always bringing in outside air
D. the system is always exhausting inside air

200. When “zoning” a building for the purpose of climate control, zones are generally divided into areas by
A. floors (1st floor, 2nd floor)
B. exposure (north side, south side etc.)
C. occupancy (number of people, type of activity)
D. all of the above

201. When working on an upper floor or a roof top of a building the top of the ladder should extend above the top edge of the roof by at least
A. 1 foot
B. 3 feet
C. 5 feet
D. never use an extension ladder on a roof top

202. When gas pipe is installed across a roof the pipe must be
A. fastened with galvanized joints
B. sealed with Teflon tape
C. supported and fastened
D. all of the above

203. According to OSHA falls from _____ are one of the leading causes of occupational fatalities and injuries.
A. ladders
B. roof tops
C. windows
D. cranes

204. OSHA recommends _____ when climbing a ladder.
A. keep your body out away from the ladder as far as possible
B. keep your feet as far to the outside of the rungs as possible
C. maintain a “3-point” contact with the ladder at all times
D. all of the above

205. Design specifications for “Suspended Personnel Platforms” require the support platform rating be at least _____ the maximum intended load.
A. 2 times
B. 3 times
C. 5 times
D. 7 times

Practice Questions with Explanations

Instructions:

The following questions are designed to give you the opportunity to practice for the UA STAR exam and to determine areas where you may need study and review.

Once you have answered the practice questions, you can check your answers using a separate document from the UA. This document contains explanations for most of the correct and incorrect answers. Task links are also provided with each question. These links direct you to specific areas of the DACUM. From there, you can locate the UA text to use for reference on your specific area of interest.

A-Applied Science & Math

A-1 Matter, Energy and Science of heat basics
UA HVACR Training Manual (UAHTM) unit 1 & 2

A-1-a

1. Matter is commonly explained as a substance that occupies space and has
    a. **Mass UAHTM 2.1**
    b. Solid
    c. Liquid
    d. Gas

    Mass is correct, solid liquid and gas are merely the states or forms of matter.

A-1-a

2. Solid mass exerts pressure
    a. In all directions
    b. **Downward only UAHTM 2.2, f 2-1**
    c. Down and outward
    d. All of the above

    A vapor or gas exerts pressure in all directions; a solid can only exert pressure in a downward manner.

A-1-a

3. Liquid mass exerts pressure
    a. Downward only
    b. In all directions
    c. **Down and outward UAHTM 2.2, f 2-2**
    d. All of the above

    A liquid exerts pressure downward and outward the force of gravity would prevent liquid from exerting pressure upward.

A-1-b

4. The “Law of Conservation of Energy” states that energy is neither created nor destroyed but
    a. Is renewable
    b. **Can be converted from one form to another UAHTM2.8**
    c. Is not renewable
    d. Both a and b

    The Law of Conservation of Energy states that energy is neither created nor destroyed. It also states that energy can be converted from one form to another such as from electrical energy to mechanical energy or to heat energy or vise-versa.

A-1-d

5. Dalton's Law of Partial Pressures shows that the total pressure of a confined mixture of gases is
    a. An average of all the gases combined
    b. The least pressure of each of the gases
    c. **The sum of all the gases UAHTM f 2-7**
    d. Not measurable

    Dalton's Law states the total pressure of multiple gases (gas "a" + gas "b" + gas "c") = the sum of all the gases.

A-1-c

6. Heat flow is always in the direction of
    a. **Hot to cold UAHTM 2.9**
    b. Cold to hot
    c. Lower to higher
    d. Higher to lower

    Regardless of the quantity of heat, heat flow is always in the direction of the warmer substance to the cooler substance. Answers c and d refer to the stratification of heat.

A-1-c

7. Latent heat is experienced
    a. When the earths temperature decreases
    b. Water turns to steam
    c. When ice melts
    d. **Both b & c UAHTM 1.7**

    There are 2 forms or examples of "latent" heat. 1) Latent heat of fusion- when liquid becomes a solid or when a solid becomes a liquid. 2) Latent heat of vaporization—when a liquid becomes a vapor or when a vapor becomes a liquid.

C = $\frac{F - 32}{1.8}$ C= 21 (use formula page 23)

A-1-c

8. Convert 70 degrees Fahrenheit to Celsius
    a. 17
    b. **21 UAHTM 1.13**
    c. 34
    d. 38

    $C = \frac{F - 32}{1.8}$ C= 21

A-2 The Refrigeration Process
UA HVACR Training Manual (UAHTM) unit 3 P/T Chart

A-2-g

9. An increase of temperature on a confined gas creates
    a. No change in pressure
    b. A decrease in pressure
    c. **An increase in pressure UAHTM 3.5**
    d. Creates a increase in pressure only if the gas becomes liquefied

    An increase of heat applied to a confined gas would bring about an increase of pressure on that gas. Example; a can partially filled with gasoline sitting in the sunlight would increase in temperature because of solar heat gain, that increase of temperature would cause the molecules of the liquid and vapors in the gas can to expand, this expansion in a confined space would bring about an increase in the pressure inside of the gas can.

A-2-g

10. What is the pressure of R-22 Refrigerant if the temperature is 32 degrees f?
    a. 9.0 psi
    b. 30.1 psi
    c. **57.5 psi UAHTM f 3-15**
    d. 298.8 psi

    (See pressure/temperature chart)

A-2-a

11. An evaporator's primary purpose is to
    a. Make the refrigerated product cold
    b. **Absorb heat from the refrigerated product UAHTM 3.7**
    c. Remove heat from the refrigerant
    d. Cause the refrigerant to condense into liquid form

    Making the product is a misuse of terminology—a product is not "made cold" rather the heat is removed from the product.
    Correctly stated the evaporator absorbs heat from the product.
    "c" and "d" refer to the function of the condenser.

A-2-a

12. Residential and light commercial HVAC systems typically use
    a. Reciprocating compressors
    b. Rotary compressors
    c. Scroll compressors
    d. **Any of the above UAHTM 3.8**

    Most typically rotary or reciprocating compressors are used in refrigeration systems while reciprocating and scroll compressors are

used in air conditioning systems. Compressors not used in residential and light commercial HVAC systems would include centrifugal and screw type compressors.

A-2-d

13. The condenser receives hot refrigerant vapor from the compressor and
    a. Cools the refrigerant causing a latent heat exchange
    b. Adds heat to the refrigerant causing it to condense
    c. Removes heat from the refrigerant causing a sensible heat change
    d. **Both a and c UAHTM 3.9**

    The condenser receives heat laden vaporous refrigerant from the compressor then by cooling the vapor (removing the latent heat) the refrigerant liquefies. " b" is incorrect, heat is added to the refrigerant in the evaporator.

A-2-a

14. Residential and light commercial HVAC systems typically use
    a. Capillary metering
    b. Thermal expansion valve metering
    c. Automatic expansion valve metering
    d. **All of the above UAHTM f 3-35**

    In small systems virtually any metering device could be found including these and more, but primarily because of the difference in cost, capillary tubes are used more widely.

A-2-b

15. The most common refrigerant used in existing modern residential or light commercial air conditioning systems is
    a. R-12
    b. **R-22 UAHTM 3.12**
    c. R-134a
    d. R410a

    Because of overall system efficiencies and operational purposes air conditioners using R-12 and R-134a were never widely marketed. R-22 has been used almost exclusively since the early 1960's. In the past few years the development of R-410a (Puron) has changed everything and today most manufacturers are beginning to produce A/C systems with this new environmentally friendly refrigerant. Over the next several years R-410a will command the greater market share.

A-2-b

16. Refrigerant 410 has special characteristics including higher operating pressure, a small temperature glide and is
    a. An azeotrope
    b. **A near azeotrope UAHTM 3.12**
    c. A zoetrope
    d. A CFC

Technically R-410a is a zeotrope. However, because of its very low temperature glide it is identified as a “near azeotrope”. An azeotrope is a combination of refrigerants that when mixed together combine chemically to create a “new” molecule. A zeotrope is defined as a combination of refrigerants which when combined does not chemically bond to form a new molecule. Zeotropes also are called refrigerant “Blends”. Although R-410a is not an azeotrope, chemically under pressure of the a/c system it performs as an azeotrope**.**

A-2-d

17. Absorbing heat in the evaporator causes the refrigerant to
    a. **Boil** **UAHTM 3.7**
    b. Get cold
    c. Sweat
    d. Turn into a liquid

    Absorbing heat is the purpose of the evaporator. Heat added to a “low pressure/low temperature” liquid refrigerant causes the refrigerant to boil. The refrigerant does not “get cold”. The low temperature refrigerant may cause the evaporator to sweat the refrigerant itself must remain absolutely dry.

A-3 Applied HVAC Math
UA HVACR Training Manual (UAHTM)
UA STAR Equation Sheet
Related Mathematics

A-3-c

18. What is the volume of an office 20 feet wide, 30 feet long and 10 feet high?
    a. 60 cubic feet
    b. 200 cubic feet
    c. 300 cubic feet
    d. **600 cubic feet** **RM p 46 fig 3-4**

    20’ x 30’ x 10’ = 600 Cu. Ft.

A-3-b

19. The nominal evaporator CFM per 1 ton of air conditioning is _____ ?
    a. 200
    b. **400** **UAHTM 37.26**
    c. 1,200
    d. 12,000

    In a typical a/c system for every 12,000 BTU’s of cooling produced a supply of 400 CFM is needed to move the air throughout the ductwork and structure.

A-3-f

20. The deep vacuum is measured with a micron gauge, how many microns are in 1 inch?

a. **25,400** **UAHTM 8.8**
b. 254,000
c. 759,968
d. None of the above

This is a measurement equivalency.

A-3-e

21. If a motor operating 1725 RPM is turning a blower wheel at 500 RPM and the blower pulley is 12", what is the diameter of the motor pulley?
    a. 2.5 inches
    b. 3 inches
    c. **3.5** **3.5 inches** ***3.5 = 1725 x 12 (use formula page 437)***
    d. 4 inches ***500***

    See formula.

A-3-g

22. How many watts are required to operate a 1 hp motor for a period of 1 hour
    a. 74.6 watts
    b. **746 watts** **UAHTM 2.14**
    c. 7460 watts
    d. None of the above

    A 1 horsepower motor operating for 1 hour will require 746 watts of power.

B-Safety

UA HVACR Training Manual (UAHTM)
B-4 Personal Safety

B-4-a

23. A technician must use every precaution when working with pressure, electrical energy, heat, cold, rotating machinery, chemicals and when lifting heavy object
    a. To protect him/her self
    b. To protect others in the area
    c. To act as a professional
    d. All of the above **UAHTM Summary**

    Each area of safety is of equal importance and the technician must also be aware of others in the vicinity.

B-4-d

24. One of the most overlooked safety devices in this industry is
    a. **Safety glasses** **UAHTM 4 intro p 67**
    b. Steel toed shoes
    c. Leather gloves
    d. Self contained breathing apparatus

    Eye injury is one of the most often reported injuries and is most easily prevented.

B-4-c

25. Wearing metal jewelry can be most harmful because of
    a. Frost bite
    b. **Shock or electrical burn 4.2**
    c. Magnetic electrical energy
    d. Electrical ground fault

    Although frost bite could be more intense and magnetism could draw metal jewelry to an electrical energy source, the most important thing to know is that metal jewelry on the skin creates an excellent conductor making shocks or burns even more severe.

B-5 Electrical Safety
UA HVACR Training Manual (UAHTM) unit 4

B-5-a

26. Whenever possible a technician should "Lock out/Tag out" the electrical service panel before working on system to prevent
    a. The unit starting up automatically
    b. Electrical shock
    c. To prevent others from starting the system
    d. All of the above 4.2

    A, B, or C are all possible if the technician fails to Lock-out/Tag-out.

B-5-c

27. The third wire or "ground wire" is utilized to prevent
    a. **Electrical shock from defective equipment 4.2**
    b. The use of some extension cords
    c. High voltage from reaching electrical tools
    d. Counter EMF

    Most 2 wire extension cords will not receive a grounded electrical cord to prevent the appliance from shocking the user if the appliance is internally grounded. It is not for the purpose of inconvenience of the user or for use with other voltages. Counter EMF is a distracter and does not apply to this question.

B-5-d

28. A technician should never use an extension cord unless it has been plugged into a
    a. **GFCI 4.2**
    b. Breaker panel
    c. A circuit with at least 20 amps of service
    d. All of the above

    The GFCI circuit should be used to interrupt the current flow any time an extension cord is used. It does not need to be installed at the breaker panel nor is limited to a specific amperage circuit.

B-6 Fire Safety
www.hanford.gov/fire/safety/extingrs.htm#fetypes

B-6-a

29. If you encounter a fire with a source of flammable liquids
    a. You must use a class “A” fire extinguisher
    b. You must use a class “B” fire extinguisher
    www.hanford.gov/fire/safety/extingrs.htm#fetypes
    c. You must use a class “C” fire extinguisher
    d. You must use a class “D” fire extinguisher

    Fire extinguishers are designed for use on a specific source of fires.

B-6-b

30. Multi-purpose fire extinguishers rated “A” “B” “C” can be used on
    a. Flammable liquids
    b. Ordinary combustibles
    c. Electrical equipment
    d. **All of the above**
    www.hanford.gov/fire/safety/extingrs.htm#fetypes

    Multi purpose fire extinguishers may be used on flammable liquids, ordinary combustibles and electrical equipment type fires.

B-6-c

31. When using a fire extinguisher always aim
    a. **At the base of the fire**
    www.hanford.gov/fire/safety/extingrs.htm#fetypes
    b. In front of the fire
    c. At the top of the fire
    d. All of the above

    Fire extinguishers when used should always be aimed at the base of the flame source.

B-7-e

32. A leaking refrigeration system not only can cause severe frost bite but can also cause
    a. Asphyxiation
    b. Lightheadedness
    c. Heart arrhythmia
    d. All of the above f 4-17

    All of the above are possible; refrigerant vapors are heavier than air which displaces oxygen to a higher stratified level.

B-7-d

33. When soldering or brazing near combustible materials a technician should always use a
    a. Flame retardant heat shield f 4-19
    b. Bucket of water to soak combustibles
    c. Propane torch
    d. All of the above

    Soaking of nearby combustibles with water is impractical and a propane torch is ineffective for brazing. A heat shield should be used to protect equipment components as well as to prevent combustion of near by flammable articles.

B-7-c

34. If the working length of a ladder is 12 feet, how far should the base of the ladder be placed from the adjacent wall?
    a. 2 feet
    b. 3 feet f 4-17
    c. 4 feet
    d. 6 feet

    The proper angle of a ladder placed against a wall is, 1 foot away from the wall for every 4 foot of vertical rise.

B-8 First aid and CPR
UA HVACR Training Manual (UAHTM) unit 4
www.chp.edu/besafe/adults/02frostbite.php?base=hs

B-8-c

35. If a technician finds a person suffering from asphyxiation caused by breathing refrigerant he/she should
    a. Call for help
    b. Immediately move the person to an area of fresh air UAHTM 4.7
    c. Conduct CPR
    d. Find and fix the refrigerant leak

    The most important response would be to remove the person to safety first before beginning CPR or calling for help.

B-8-e

36. If you find a person who is suffering from an electrical shock and has no pulse you should
    a. Call for help
    b. Begin CPR immediately 4-2
    c. Drag the person to safety
    d. Turn off the building's power supply

    As soon as it is established the victim has no pulse CPR should begin immediately.

B-8-a

37. When treating frost bite you should
    a. Gently rub the affected area
    b. Run warm water over the affected area
    www.chp.edu/besafe/adults/02frostbite.php?base=hs
    c. Quickly warm the affected area with a heater or blow drier
    d. Quickly put on butyl-lined gloves

    To treat frost bite you should run warm water over the affected area as soon as possible. Do not rub the area and do not apply any intense or direct heat. Butyl-lined gloves should be used before working materials of very low temperatures.

B-9 Agencies

http://www.osha.gov

http://www.ansi.org

B-9-a

38. Which agency concerns itself with the health and safety of America's work force?
    a. Air Conditioning Refrigeration Institute
    b. American National Standards Institute
    c. **Occupational Safety & Health Administration** www.osha.gov/
    d. All of the above

    OSHA is the governing body of occupational health and safety concerns.

B-9-c

39. Which organization coordinates the development and use of voluntary consensus standards in the United States and represents the needs and views of US. Stakeholders in standardization forums around the world?
    a. Occupational Safety & Health Administration
    b. **American National Standards Institute** www.ansi.org
    c. Air Conditioning Contractors of America
    d. None of the above

    ANSI is the organization for U.S. and world wide industry standardization.

C-Installation

UA HVACR Training Manual (UAHTM) unit 37

C-10 Unit Location and Air Distribution System

C-10-c

40. Identify the air distribution system used in modern residential buildings in which the air pressure remains steady from one end of the system to the other
    a. Radial duct system
    b. Reducing plenum system 37.12
    c. Perimeter loop system
    d. Flex duct

    Radial systems are seldom used today for supply air delivery because of a difference in pressure and volume of the air delivered through each opening. The reducing plenum system delivers a more uniform pressure and volume to each outlet. Flex duct is a distracter and does not apply to this question.

C-10-c

41. When installing galvanized rectangle duct 8" x 20" the metal should be at least
    a. 16 gage
    b. 24 gage
    c. 28 gage f 37-28
    d. 32 gage

16 and 24 gauge may be used on larger dimension duct work and 32 gauge may be used for smaller dimension duct work but 28 gauge is the standard for 8 x 20 ductwork.

C-10-b

42. When the proper size duct materials are used the occupants of the home should
    a. Not feel air movement
    b. Should not hear air noise
    c. Should not feel temperature swing
    d. All of the above 37.3

    These conditions of comfort can all be achieved by a correctly designed and installed duct system.

C-10-c

43. When conditioned air travels through an unconditioned space such as an attic or crawl space the duct must be insulated if the air temperature difference is
    a. 5 degrees f
    b. 10 degrees f
    c. 15 degrees f 37.23
    d. 20 degrees f

    A 5 or 10 degree difference in temperature is not of major significance, but at 15 degrees or more the dew point is likely to be met causing condensation on or in the ductwork. As well, the greater the temperature difference the greater the amount of duct heat gain or loss causing higher energy cost.

C-11 System Connections
UA HVACR Training Manual (UAHTM) unit 7

C-11-a

44. Air Conditioning/Refrigeration (ACR) tubing is measured by its
    a. Inside dimension
    b. Outside dimension f 7-1
    c. Nominal dimension
    d. Wall thickness

    Copper tubing used for air conditioning or refrigeration is identified by its outside dimension. Waste and water tubing is measured by is inside or nominal dimension. Wall thickness is typically identified as type K, L or M.

C-11-b

45. On air conditioning systems the _____ tubing is often insulated to reduce heat transfer to the refrigerant.
    a. Liquid line
    b. High pressure line
    c. Discharge line
    d. Low pressure line 7.3

The low pressure or suction line tube is insulated to reduce condensation on the tubing and to reduce unwanted heat gain of the refrigerant before reaching the compressor.

C-11-j

46. Most air conditioning tubing is brazed using _____ as a filler material.
    - **a. 15% silver 7.7**
    - b. 95/5 tin-antimony
    - c. 50/50 tin-lead
    - d. All of the above

    15 % silver is often used in brazing copper tubing. 95/5, 50/50 are solders and are used at lower temperatures than for brazing.

C-11-b

47. _____ draws the filler alloy into space between the base metals when brazing
    - **a. Capillary action f 7-13**
    - b. High temperature
    - c. Vacuum
    - d. Pressure

    Filler material is drawn into a soldered or brazed joint by capillary action created by the appropriate amount of heat applied. Neither pressure nor vacuum is necessary to draw the filler material into the joint space.

C-12 System Evacuation, Efficiency, Start-up and Charging
UA HVACR Training Manual (UAHTM) unit 8, 10, 21, 38

C-12-a

48. A vacuum pump is used to reduce a systems pressure to
    - a. 0 psia
    - b. 0 psig
    - **c. 500 microns 8.10**
    - d. 5000 microns

    0 psia can not be obtained, 0 psig equals atmospheric pressure, 5000 microns is an insufficient vacuum to thoroughly clean the system. Proper evacuation should always be 500 microns or less.

C-12-l

49. On larger systems it is more practical to add refrigerant in the liquid phase, however the technician must make certain no _____ enters the compressor.
    - a. Vapor
    - b. Contaminants
    - c. Moisture
    - **d. Liquid 10.3**

    Moisture and other contaminants should never be allowed to enter the system. Although it is much more practical to charge larger systems in

the liquid state the technician must be certain that liquid is not allowed to enter into the compressor itself to prevent compressor damage.

C-12-i

50. What is the superheat of an R-22 air conditioning system if the evaporator boiling point temperature is 40 degrees f and the suction line temperature is 52 degrees f?
    - **a. 12 degrees f 21.13**
    - b. 30 degrees f
    - c. 62 degrees f
    - d. 92 degrees f

    Equation Super Heat = Suction line temperature – evaporator pressure converted to temperature. 52 – 40 = 12 degrees super heat.

C-12-e

51. When installing a central air conditioning system the entire refrigerant charge is typically
    - a. Added by the technician
    - b. Shipped and held in the evaporator
    - **c. Shipped and held in the condensing unit 38.11**
    - d. Recovered before evacuation

    Most modern central air conditioning systems are shipped pre-charged. The charge is held in the condenser of the condensing unit during shipment. The technician needs to verify the appropriate charge after system start-up.

C-12-f

52. Vacuum pump oil must be changed on a regular basis because it can become very contaminated with
    - a. CFC's
    - **b. Moisture 8.8**
    - c. HCFC's
    - d. All of the above

    When correctly performed all CFC's or HCFC's are recovered by a system recovery. It is moisture that is attracted to the vacuum pump oil during evacuation.

C-12-g

53. To calibrate a gauge manifold a technician should
    - **a. Open the gauge to the atmosphere, it should read 0 psig 11.4**
    - b. Use another gauge manifold
    - c. Use a micron gauge
    - **d.** Use a tire pressure gauge

    The proper method to test the accuracy of manifold gauges is to open the gauge to atmospheric pressure, it should read 0 psig. If not adjust to 0 psig.

D-13-c

54. Under normal conditions mechanical ventilation can adequately remove indoor air pollution caused by
    a. Moisture
    b. Unvented gas stoves
    c. Carpets
    d. All of the above f 34-1

    Indoor air pollution can be greatly reduced if not eliminated by adequate ventilation.

D-13-d

55. There may be as many as 100,000 different molds, as long as there is food and _____ these molds will not go away.
    a. Darkness
    b. Cool temperature
    c. Moisture 34.4
    d. Stale air

    Molds account for a vast amount of the indoor air contaminants. The primary biological requirements to sustain molds are food and moisture. Other factors are of less importance.

D-13-a

56. Indoor air pollution monitoring testing equipment is available to identify the source of contamination for
    a. Carbon dioxide
    b. Carbon monoxide
    c. Ozone
    d. All of the above 34.5

    All of these and many other contaminants can be specifically tested for with modern equipment.

D-13-e

57. To be most effective UV-C germicidal lamps should be placed
    a. In bedrooms
    b. Open areas of the office or home
    c. In the duct work near the cooling coil 34.7
    d. All of the above

    Primarily because of the moisture found on and around the evaporator coil UV lamps should be placed near the evaporator coil. UV germicidal lamps must be placed out of the line-of-sight to prevent damage to the eye.

D 14 Air Filtration
UA HVACR Training Manual (UAHTM) unit 34

D-14-b

58. Fiberglass air filters use _____ to trap airborne matter
    a. Tiny fiberglass particles
    b. Continuous glass fiber 34.7
    c. Desiccants
    d. Formaldehyde

    Continuous glass fiber is spun molded into shape to entrap larger particle of airborne particulate. Tiny fiberglass particles and formaldehyde are contaminants which would need to be removed. Desiccants are used to remove moisture not particulate.

D-14-e

59. High Efficiency Particulate Arrester (HEPA) filters can remove pollutants from the indoor air as small as
    a. 20-30 microns 34.7
    b. 100-200 microns
    c. 200-300 microns
    d. 500-1000 microns

    The HEPA filter is capable of removing particulate, bacteria, and other contaminants as small as 20-30 microns.

D-14-f

60. Electrostatic air filters use _____ to clean indoor air.
    a. a series of negatively and positively charged plates 34.7
    b. UV-b lamps
    c. UV-c lamps
    d. All of the above

    Electrostatic or electronic air filters to attract particulate matter. UV-C lamps kill air borne organisms. UV-B is a distracter and does not apply to the question.

D-14-c

61. _____ filters work best to prevent air turbulence and allow for a more even loading of contaminants.
    a. Cube
    b. Fiberglass
    c. Pleated 34.7 f 34-16
    d. HEPA

    Cube, Fiberglass, and HEPA filters have a tendency to restrict air flow as the filter "loads-up". Pleated filters provide a much great surface area therefore creating much less air turbulence as the filter begins to fill.

D 15 Humidity and Humidification
UA HVACR Training Manual (UAHTM) unit 34

D-15-a

62. The recommended humidity level in homes or buildings is_____
    a. No more than 20%
    b. 20% - 40%
    c. 40% - 60% 34.9
    d. At least 70%

    For most people 40-60% relative humidity is very comfortable, less than 40% is too dry and greater than 70% is too wet.

D-15-a

63. Duct mounted bypass humidifiers allows air from the supply duct to
    a. Flow directly to the return air duct
    b. Pass through a "media"
    c. Be heated before entering the humidifier
    d. All of the above 34.9

    A by-pass humidifier is simply a connection from the supply air side to the return air side of the duct system. In this type system the heated air from the furnace passes through the humidifier media, absorbs humidity and then is recycled through the furnace allowing the treated air to mix into the return air and be distributed throughout the structure via the supply air duct.

D-15-a

64. Humidifiers should only operate
    a. When the air handler blower is operating
    b. When the humidistat signals for an increase of humidity
    c. When the system control is set for cooling
    d. Both a and b 34.9

    A humidifier typically should only operate during the heating season when outdoor humidity levels are low. The air handler blower must be operating and the system humidistat must be closed for the humidifier to operate.

D-15-a

65. What is the maximum hardness of the water allowable for atomizing type humidifiers?
    a. 1-3 grains
    b. 8-10 grains 34.9
    c. 20-30 grains
    d. Up to 50 grains

    The maximum allowable hardness of water for atomizing humidifiers is 8-10 grains. More than that will cause damage to the humidifier and a decreased amount of treated air.

D 16 Installing and Troubleshooting Air Quality Devices
UA HVACR Training Manual (UAHTM) unit 34

D-16-a

66. High quality energy recovery ventilators
    a. Use high volume blowers to exhaust stale air
    b. Use a heat exchanger to absorb heat from the air being exhausted 34.6
    c. Use a small heater to "make-up" heat lost due to incoming fresh air
    d. All of the above

    High quality energy recovery systems typically lower velocity blower and allow for a rather efficient heat exchange between incoming and outgoing air. Typically these units do not mechanically heat or cool the incoming air.

D-16-b

67. To help prevent allergic reactions or upper respiratory problems humidifiers should be
    a. Cleaned regularly
    b. Treated with algaecides
    c. Drained regularly
    d. All of the above 34.12

    During the cooling season humidifiers should be shut down. Furthermore regular cleaning and chemical treating is necessary.

D-16-b

68. To kill mold and algae and to prevent them from contaminating the area some manufacturers use
    a. UV lights 34.12
    b. Radon
    c. Fungicides
    d. All of the above

    UV lamps are used to kill mold and algae. Radon and fungicides do not apply to this question.

E-17 Evaporator and Condenser Fan Motor Problems
UA HVACR Training Manual (UAHTM)
Commercial Refrigeration for Air Conditioning Technicians (CRACT)
Electricity for Heating Refrigeration and Air Conditioning (EHRAC)

E-17-a

69. The required condenser air flow is approximately
    a. 400 CFM per ton
    b. 600 CFM per ton
    c. 800 CFM per ton
    d. 1000CFM per ton CRACT p36

    The nominal air flow requirement is 1000 CFM on the condenser side of the system. The condenser side must not be confused with the evaporator portion of the system where 400 CFM is the nominal requirement.

E-17-a

70. A dirty condenser prevents the rejection of heat and causes
    a. Low head pressure
    b. High head pressure CRACT p36, 37
    c. Low suction pressure
    d. High suction pressure

    When heat from the condenser cannot be rejected, system pressure will be increased. Head pressure will have the most dramatic increase but depending on other factors suction pressure as well can increase.

E-17-b

71. A condenser fan motor with sleeve bearings should be lubricated
    a. 2 times per year EHRAC 10.6
    b. 3 times per year
    c. 4 times per year
    d. Once per month

    The recommended lubrication interval is 6 months or twice per year. More often is not necessary.

E-17-c

72. Improper blower pulley alignment can cause
    a. Unnecessary wear
    b. Erratic speed
    c. Premature belt failure
    d. All of the above EHRAC 10.7

    When motor and blower pulleys are not properly aligned all of the above symptoms are possible.

E-17-d

73. V-Belt tension should be set to about
    a. ½ inch
    b. 1 inch EHRAC 10.7
    c. 1 ½ inches
    d. 2 inches

    Proper belt tension is about 1". If set tighter additional wear may be noticed as well as increased noise. If set too loose the belt will likely slip reducing overall air flow and system capacity.

E-18 Refrigerant Charge and Related Problems
UA HVACR Training Manual (UAHTM) unit 41

E-18-a

74. To add refrigerant to a partially charged air conditioning system a technician should read the manifold gauges and then
    a. Compare to a Pressure Temperature Chart UAHTM 41.5
    b. Consult with the manufacturer
    c. Recover the existing charge and weigh in the correct charge
    d. Compare to relative humidity chart

    Smaller systems with an identified volume of charge could be recovered and then the exact charge weighed in. However, weighing in a charge on larger system or systems without a stated amount of charge is not practical and the pressure temperature chart must be applied followed by superheat measurement.

E-18-a

75. Starting up an air conditioning system with the indoor temperature at 85 degrees f and the Rh at 70% would be considered
    a. An excessive load UAHTM 41.5
    b. A normal load
    c. A light load
    d. None of the above

    This is an excessive load, at 85 degrees it is a high sensible load and with 70% Rh this is considered a high latent load. Sensible plus latent equals the total heat load. A normal load would resemble a 75 degree indoor temperature with a 55-60% Rh.

E-18-b

76. During a complete loss of charge condition with a leak on the systems low side and the systems low pressure cut-out control has opened the technician must consider
    a. Finding and repairing the leak
    b. Contaminant in the system
    c. The compressor will not start until the system is recharged
    d. All of the above UAHTM f 39-22

    First it is essential the refrigerant leak is located and repaired. Second, typically the low pressure safety cut-out is set at just above atmospheric pressure (2-5 psi) If the low pressure switch opened then

it is also likely that the system pressure dropped to 0 psi or lower and contamination has occurred and an evacuation must be performed. Finally, the technician must realize the compressor will not restart until the system pressure is restored.

E-18-c

77. After a system evacuation _____ can cause a micron gauge to rise from 250 microns to 500 microns before leveling off.
    a. Oil still in the condenser
    b. An overcharge of refrigerant
    c. An undercharge of refrigerant
    d. Excessive contamination CRACT p 196

    Oil remaining in the system will not have an effect on the micron reading, an over charge or an undercharge also would have no effect after a proper recovery procedure. When a system is excessively contaminated, contaminants often cause an increase in micron gauge readings as these contaminants continue to vaporize.

E-18-d

78. To clean an excessively moisture contaminated system a technician may perform a
    a. Deep vacuum
    b. Triple evacuation CRACT p 197
    c. Recovery
    d. System recharge

    System recovery and system recharge play no role in removing the system contaminants. Only by system evacuation can moisture be removed and on excessively contaminated systems a triple evacuation is sometimes necessary.

E-19 Evaluating the Metering Device
UA HVACR Training Manual (UAHTM) unit 24

E-19-a

79. A full or partial restriction of the capillary tube is often the result of
    a. Too much oil charge
    b. Incorrect oil viscosity
    c. Liquid refrigerant entering the compressor crankcase
    d. All of the above UAHTM 24.29

    A small amount of oil is always compressed and forced through the system. However too much oil charge, oil with too high of viscosity or liquid flooding of the compressor forcing excessive oil out of the compressor and into the system can cause full or partial capillary tube restriction.

E-19-b

80. An air conditioning system with a fluctuating evaporator pressure would most likely be the result of a
    a. Defective circuit board
    b. Defective AEV UAHTM 24.26, 24.27
    c. Defective compressor
    d. Defective capillary tube

    A defective circuit board, compressor or capillary tube would not have an appreciable effect on fluctuating evaporator pressure. The automatic expansion valve is designed to maintain a constant outlet or evaporator pressure. If the low side pressure is fluctuating the AEV would be suspect.

E-19-c

81. A system operating with a loose thermal expansion valve sensing element would cause the systems superheat to be
    a. Too low UAHTM 24.28
    b. Too high
    c. Normal
    d. Erratic

    The TXV sensing element must be securely attached to the suction line for proper refrigerant metering. If the element is loose and making poor contact with the suction line the result will be an overfeeding of the valve and a superheat reading that is too low.

E-19-d

82. Any evaporator with a pressure drop in excess of _____ should use a thermal expansion valve with an external equalizer.
    a. 1 psig
    b. 2.5 psig UAHTM 24.15
    c. 3.5 psig
    d. 5 psig

    The purpose of the external equalizer is to maintain a minimal pressure drop across the evaporator coil.

E-19-d

83. Any system operating with a thermal expansion valve can automatically adjust to a change in the load condition. In order to supply an adequate volume of refrigerant the system must also utilize
    a. An accumulator
    b. A receiver UAHTM 24.28
    c. An oil separator
    d. A load controller

    Accumulators, oil separators and load controllers are not necessary system components when a TXV is utilized. A system receiver is necessary to hold the volume of refrigerant needed for times when the TXV throttles to the open position.

E-20 Troubleshooting Steps and Service Calls

E-20-b

84. An air conditioning system using a TXV with an undercharge of refrigerant can be identified by
    a. Low suction pressure
    b. Low system capacity
    c. High superheat
    d. All of the above **UAHTM 29.11**

    All of these conditions would be obvious; low charge would cause low suction pressure, low capacity is normal with a low charge, and low evaporator pressure and high return suction temperature equates to high superheat.

E-20-b

85. If an air conditioning compressor is allowed to operate with a low refrigerant charge the compressor is likely
    a. To draw higher than normal amperage
    b. To make excessive noise
    c. To be very hot **UAHTM 29.11**
    d. All of the above

    With a low charge the amp draw would likely be lower than normal. Unless there is also a loss of oil the compressor would actually operate more quietly. A low refrigerant charge means high superheat, and high superheat means high compressor temperature.

E-20-a

86. An air conditioning system using a TXV and operating with an overcharge of refrigerant can be identified by
    a. High discharge pressure
    b. Higher than normal suction pressure
    c. Low system capacity
    d. All of the above **UAHTM 29.12**

    An overcharged system will cause high discharge and suction pressure, as well as low sub-cooling, all of which lead to low system capacity.

E-20-a

87. An overcharged air conditioning system using a capillary tube metering device would
    a. Have high head pressure
    b. Have high suction pressure
    c. Allow liquid refrigerant to enter the compressor
    d. All of the above **UAHTM 29.12**

    All of the above are indicative of an overcharged cap-tube system.

E-20-c

88. A properly charged air conditioning system with a dirty air filter could
    - **a. Frost back to the compressor UAHTM 29.13**
    - b. Cause the condenser fan to overheat
    - c. Cause ice buildup on the condenser
    - d. All of the above

    A dirty air filter will reduce the amount of heat absorbed by the evaporator, this can cause frost build up on the evaporator as well as the compressor. No effect would be realized by the condenser fan and although the condenser temperature would likely be reduced by the dirty filter the condenser temperature would still remain well above the freezing point.

F-Refrigerant Management

F-21 Refrigerant and Oil Types
UA HVACR Training Manual (UAHTM) unit 9

F-21-a

89. CFC refrigerants contain _____ which is considered the most harmful to the ozone layer
    - a. Fluorine
    - **b. Chlorine UAHTM 9.5**
    - c. Hydrogen
    - d. Carbon

    Most CFC refrigerants are made from the elements listed above. However, it is chlorine which is considered to be harmful to the ozone layer.

F-21-b

90. HCFC-based blends are considered
    - **a. Short term replacements UAHTM 9.10**
    - b. Long term replacements
    - c. Ozone friendly
    - d. Inefficient

    HCFC blends are considered “short term” replacements because although greatly reduced they still contain some chlorine.

F-21-c

91. Stratospheric ozone is considered “good” ozone because it filters out
    - a. Air pollution
    - **b. UV-b light rays UAHTM 9.2**
    - c. UV-c light rays
    - d. CFC’s

Ozone at ground level is toxic and very dangerous but ozone found in the stratosphere is considered good ozone as it filters out UV-b rays from the sun.

F-21-d

92. HFC-134a refrigerant uses synthetic oil called
    - **a. Polyol ester oil UAHTM 9.11**
    - a. Mineral oil
    - b. Paraffin oil
    - c. Polyalkalene ester oil

    Polyol Ester oil is used in modern compressors operating with HFC refrigerants. Mineral oil was used in azeotrope refrigerant compressors. Paraffin is a wax found in mineral oil. Polyalkalene ester oil is a distracter.

F-21-e

93. ASHRAE's Standard 34-1992 refrigerant safety group chart classifies _____ as the least toxic and not flammable.
    - a. A3
    - b. B3
    - c. **A1 UAHTM f 9-10**
    - d. B1

    The ASHREA standard 34-1992 classifies refrigerants in "A" column as low toxicity and "B" column as high toxicity. The number assigned represents their flammability with the higher the number the higher the flammability.

F-22 Refrigerant Handling and Transporting Regulations

F-22-a

94. The United States Clean Air Act Amendments of 1990 regulate the use and disposal of
    - a. CFC's
    - b. HCFC's
    - **c. Both a and b UAHTM 9.14**
    - d. Neither a or b

    Both CFC's and HCFC's are regulated under the authority of the Clean Air Act of 1990 and amendments.

F-22-a

95. The prohibition against refrigerant venting became effective
    - a. September 1, 1987
    - b. January 1, 1990
    - **c. July 1, 1992 UAHTM 9.14**
    - d. January 1, 1996

    Refrigerant venting became unlawful July 1, 1992.

F-22-d

96. The process of removing refrigerant from a system and storage in an approved container without any further testing is known as
    - **a. Recovery UAHTM 9.15**
    - b. Recycling
    - c. Reclaiming
    - d. Evacuation

    Recovery is simply the process of removal and storage of system refrigerant.

F-22-f

97. The process of used refrigerant being cleaned to meet new product specifications called ARI 700 Standard is known as
    - a. Recovery
    - b. Recycling
    - **c. Reclaiming UAHTM 9.15**
    - d. Evacuation

    Reclaiming of refrigerant means processing refrigerant to return the compound to its original manufactured condition known as the ARI 700 purity standard.

F-22-b

98. Type I refrigerant certification allows service on refrigeration equipment
    - a. With 5 pounds or less of charge
    - b. Hermetically sealed
    - c. Specifically listed
    - **d. All of the above UAHTM 9.16**

    Type I classification includes appliances with; 5 pounds or less of factory charge, hermetically sealed and specifically listed as Type I such as household refrigerators and freezers, dehumidifiers, window air conditioners, packaged terminal air conditioners and under counter ice makers.

G-Basic Electricity

G-23Electrical Theory
HVAC Light Commercial STC Version 1-11-06
Electricity for Heating Refrigeration and Air Conditioning

G-23-a

99. If a DC power supply of 20 volts causes 2 amps of current to flow in a circuit
    - a. **The resistance of the circuit is 10 ohms HVAC LC**
    - b. The power consumed by the circuit is 100 watts
    - c. The power consumed by the circuit is 10 watts
    - d. The resistance of the circuit is 40 ohms

    Apply ohms law; R=E/I

G-23-b

100. A _____ is often used as a graphic representation of alternating current

a. + positive symbol
b. – negative symbol
c. Sine wave **EHRAC 7.1**
d. North pole or South pole

The sine wave symbol shows the alternating current from its peak positive voltage to its peak negative voltage.

G-23-c

101. Which of the following is true regarding current flow in a parallel circuit?

a. Current flow is equal through all branches of the circuit
b. The paths with higher resistance will have higher current flow
c. The paths with lower resistance will have higher current flow HVAC LC
d. As addition branches are added to the circuit the total current will decrease

Apply ohms law.

G-23-c

102. A control transformer rated at 50 VA and a 25 volt secondary voltage should be protected with a

a. 0.5 amp fuse
b. 1 amp fuse
c. 1.5 amp fuse
d. 2 amp fuse **HVAC LC**

Apply ohms law.

G-23-c

103. The symbol used for electrical pressure is

a. "E" **HVAC LC**
b. "I"
c. "R"
d. "P"

E = voltage (pressure), I = current or amperage, R = Ohms or resistance, P = power or watts.

G-23-c

104. What happens to the current if the voltage in a circuit doubles and nothing else changes?

a. The current will increase by 4 times
b. The current will decrease by ½ **HVAC LC**
c. The current will increase by 2 times
d. The current will decrease by ¼

Apply ohms law

G-23-j

105. 1 millivolt equals
    a. 1000 volts
    b. 100 volts
    c. 1/1000 of a volt **HVAC LC**
    d. 1/100 of a volt

    1 millivolt is equal to 1/1000 of a volt

G-24 Measuring Instruments
HVAC Light Commercial STC Version 1-11-06

G-24-a

106. Which meter is used to test for potential?
    a. Voltmeter **HVAC LC**
    b. Ammeter
    c. Ohmmeter
    d. Potentiometer

    A volt meter is used to measure the “potential” voltage difference.

G-24-b

107. To read the amperage draw from an alternating electrical device
    a. Set the meter to read voltage and place the two test leads on both sides of the load
    b. Set the meter to read amperage and clamp the meter around both conductors feeding power to the device
    c. Set the meter to read amperage and clamp the meter around one of the conductors feeding power to the device HVAC LC
    d. Set the meter to read amperage and place the test leads on both sides of the load

    A clamp on amp meter is used by opening the jaws and placing 1 (only) conductor feeding the load inside then close the jaws, read amperage with the load operating. The test leads are not used.

G-24-c

108. When testing a compressor motor with an ohmmeter, what reading would be obtained if its internal over-load is in the open position?
    a. Run to start—zero ohms
    b. Run to common—zero ohms
    c. Run to start—infinite ohms
    d. Run to common—infinite ohms HVAC LC

    Run to start should equal the total sum of the run winding resistance plus the start winding resistance; (.e. 3 + 7 = 10)

    Run to common is open producing an infinite resistance?

G-24-e

109. The capacitor analyzer is used to measure

a. Shorted or open capacitors and micro-farad values HVAC LC

b. Micro-farad ratings and the capacitors power factor

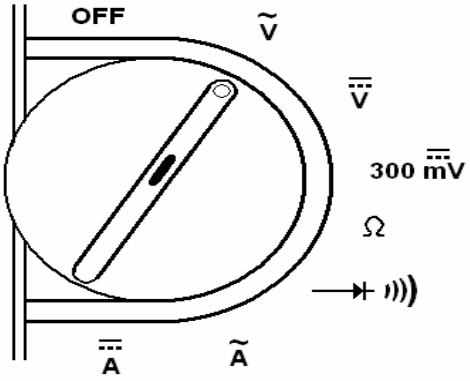
c. Open capacitors, micro-farad ratings and the capacitor's power factor

d. Open and shorted capacitors, micro-farad ratings and the capacitors power factor

A capacitor analyzer does not measure power factor. It does measure micro-farad values and identifies open or shorted capacitors.

G-24-f

110. What value is the meter presently set to read?



a. Amps

b. Ohms

c. AC volts HVAC LC

d. DC volts

Voltage is identified by the "V" and the sine wave above the "V" indicates the voltage is alternating.

111. To measure the out-put of a thermocouple which setting would the meter be placed?

a. $\tilde{V}$

b. Ω

c. 300 mV **HVAC LC**

d. $\overline{V}$

A normal thermocouple out-put is 30 mV DC. The correct setting would be 300mV DC.

G-24-g

112. When should a mega-ohmmeter never be used?

a. When the system is in a vacuum **HVAC LC**

b. When the system is at atmospheric pressure

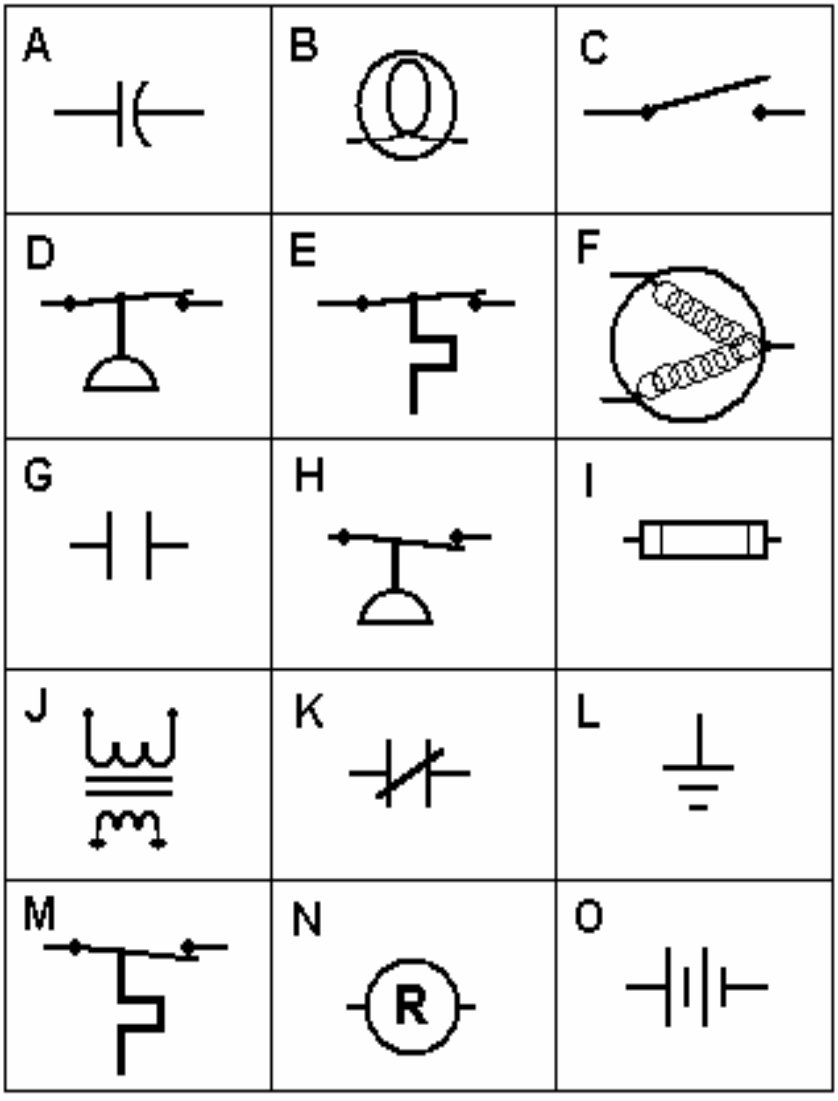
c. When the system is in a positive pressure

d. When system is charged with refrigerant

A mega-ohmmeter applies an electrical charge to the windings and a compressor should never be energized when in a deep vacuum.

G-25 Electrical Circuits (Series and Parallel)
HVAC Light Commercial STC Version 1-11-06
Electricity for Heating Refrigeration and Air Conditioning

Use the electrical symbols chart to answer questions 113-115



G-25-a

113. Which symbol represents a heating thermostat?

a. D
b. E HVAC LC
c. H
d. M

"E" and "M" are both thermostats, "E" opens on a rising temperature signal and "M" opens on a falling temperature signal. "E" is the correct answer.

G-25-a

114. Which symbol represents a component which opens on a loss of pressure?

a. D
b. E
c. H HVAC LC
d. M

"H" and "D" are both pressure controls "D" is a pressure switch which opens on a rising pressure signal. "H" is a pressure switch which opens on a falling pressure signal. "H" is the correct answer

G-25-a

115. Which symbol represents a high pressure cut-out?

a. D HVAC LC
b. E
c. H
d. C

"H" and "D" are both pressure controls "D" is a pressure switch which opens on a rising pressure signal. "H" is a pressure switch which opens on a falling pressure signal. "D" is the correct answer

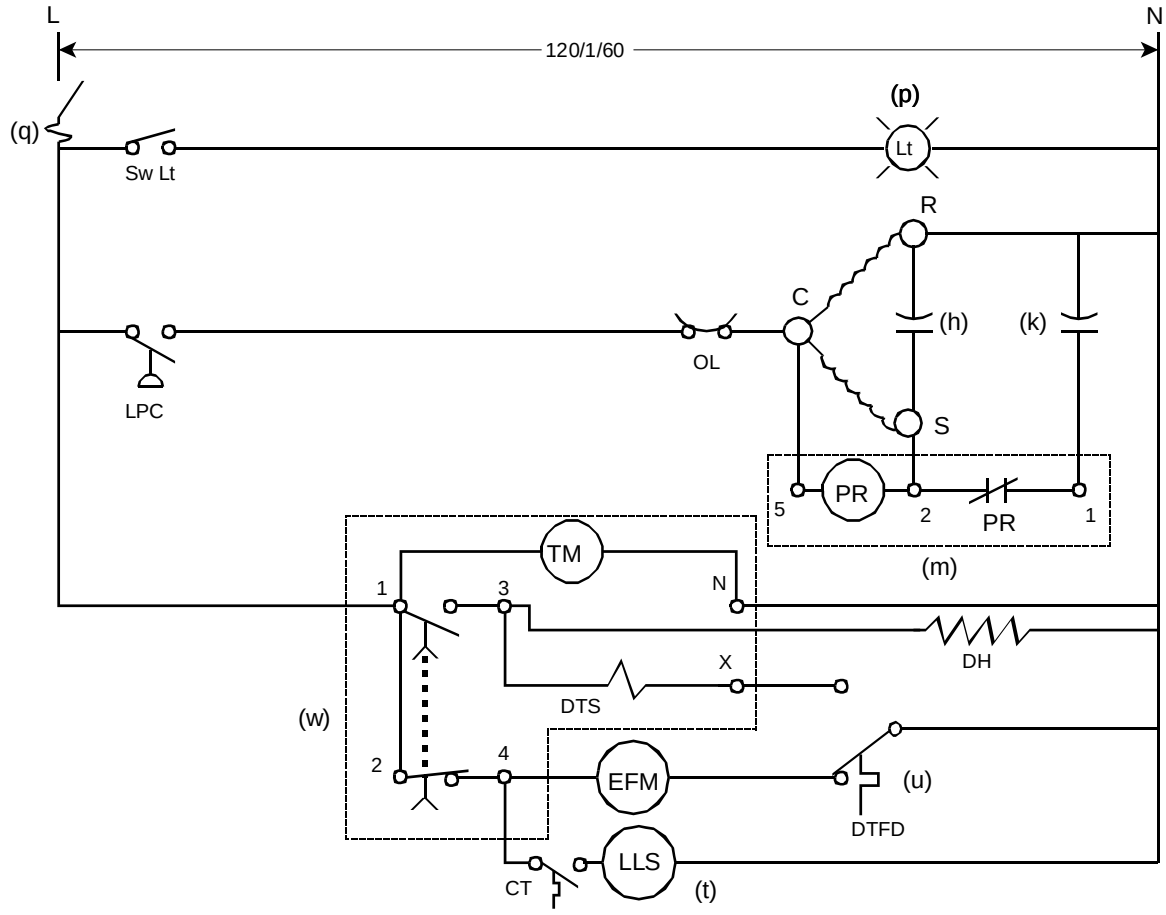
G-25-a

116. The four components of a circuit are

a. Power source, current path, resistive load and inductive load
b. Power source, current path, load and switch HVAC LC
c. Current path, load, switch and light bulb
d. Load, resistance, current and current path

A power source, current path, load and switch are 4 components of a complete circuit. The type of load is not dictated, (resistive, inductive, light bulb)

Use the following schematic to answer questions 117 – 118



G-25-c

117. Identify the two (2) over-current devices in the schematic.

a. q and u
b. q and t
c. t and u
d. q and OL **HVAC LC**

Q is a line fuse, OL is a thermal overload

G-25-c

118. If fuse "q" opens which part of the circuit will still have voltage?
    a. Light circuit
    b. Compressor circuit
    c. Defrost circuit
    d. L and N **HVAC LC**

    L and N would be the only remaining part of the system which still has power.

G-25-b

119. According to American Wire Gauge (AWG) the largest diameter wire is?
    a. 0000 (4/0) **EHRAC 8.1**
    b. 2 gauge
    c. Service lead wire
    d. 50 gauge

    AWG identifies the lower number as a larger diameter (4/0) and the higher numbers are a smaller diameter.

G-26 Electrical service

HVAC Light Commercial STC Version 1-11-06
Electricity for Heating Refrigeration and Air Conditioning

G-26-b

120. Upon start-up of a roof top air conditioning system it is found that the condenser fan motors are rotating in the wrong direction. What should be done to correct the problem?
    a. Replace the motor with the correct rotation motors
    b. Disconnect the power and change any two phase leads of the incoming power
    c. Reverse the directional decal on the fan blades **HVAC LC**
    d. Turn the fan blades over

    The problem in this scenario is that the phases (legs) of the unit do not match the phases of the power supply. The correct response is to switch 2 of the legs of power at the condenser fan motor power supply.

G-26-a

121. A single phase 120/240 volt electric service is made up of
    a. L1, L2 and Neutral **HVAC LC**
    b. L1 and Neutral
    c. L1, L2 and L3
    d. L1, L2, L3 and a ground

    An L1 and an L2 along with a neutral makes up a 120/240 volt single phase power supply. 120 volts is derived from this service by using either L (1 or 2) phase and the neutral.

G-26-b

122. _____ refers to the number of currents alternating at different time intervals in the circuit

a. Amperage
b. Resistance
c. Phase **EHRAC 7.1**
d. Sine wave

Each phase (L1, L2, and L3) is a current carrying conductor cycling at 120 (180) degrees from the other phase(s).

G-26-b

123. In the United States 3 phase power operates at

a. 60 Hz **EHRAC 7.1**
b. 120 Hz
c. 180 Hz
d. 240 Hz

Standard power supply in the United States is delivered at 60Hz (cycles).

G-26-a

124. On a 240 volt circuit, L1 and L2 cycle

a. 60 degrees apart
b. 120 degrees apart
c. 180 degrees apart **EHRAC 7.1**
d. 240 degrees apart

The difference in sine wave angle is 180 degrees on a 240 (2 pole) supply.

G-26-b

125. Most commercial building's electrical service is

a. 120 volt single phase
b. 120/240 volt 3 phase **EHRAC 7.4**
c. 240/440 volt single phase
d. 440 volt 3 phase

The service brought into most commercial buildings is 120/240 3 phase. (L1, L2, and L3) from this 3 phase service 240 volt single phase and 120 volt single phase can be obtained.

G-26-b

126. A 3 phase Wye configuration supply voltage measures 208 volts between each leg. What is the measured voltage from each leg to ground?

a. 60 volts
b. 104 volts
c. 120 volts **EHRAC 7.6** **fig. 7.15**
d. 208 volts

On a 3 phase Wye connection any leg to ground would measure 120 volts.

H-CONTROLS

H-27 Controls-Electric motors and starting components

HVAC Light Commercial STC Version 1-11-06
Electricity for Heating Refrigeration and Air Conditioning

H-27-b

127. Because most induction motors require additional starting torque _____ are implemented.
   a. Start and run capacitor
   b. Start windings **ERHAC 9.4**
   c. Shaded pole circuits
   d. Three phase winding

   Start windings are typical of induction motors to momentarily increase the torque during starting.

H-27-c

128. Shaded-pole motors can most easily be identified by
   a. A heavy copper band **ERHAC 9.4**
   b. A start capacitor
   c. A run capacitor
   d. Both start and run capacitor

   Shaded pole motors can easily be identified by the heavy gauge copper band located around the stator of the motor.

H-27-d

129. The primary application for shaded-pole motors would be
   a. When low start torque is required
   b. When low run torque is required
   c. When three phase power is not available
   d. Both A and B **ERHAC 9.4**

   Shaded pole motors are very common throughout the industry and are used in low torque applications.

H-27-d

130. One of the most popular motors used in the HVAC industry with moderate starting torque and good running efficiency is the _____ motor.
   a. Capacitor start capacitor run
   b. Shaded pole
   c. Permanent split capacitor **ERHAC 9.7**
   d. Three phase

   PSC motors provide a moderate torque while maintaining good running efficiency. The capacitor start capacitor run motor is less efficient. The 3 phase motor is high torque.\

H-27-e

131. Identify the most rugged and reliable motor used in the industry which operates without the assistance of start components

a. Induction motor
b. Permanent split capacitor motor
c. Three phase-motor ERHAC 9.9
d. Shaded pole

While all of these motors used in the proper application are reliable the 3 phase motor is the most rugged and reliable and it never requires the use of start components.

H-27-e

132. Identify the difference between a three pole contactor and a three pole magnetic starter

a. A contactor has an overload circuit
b. A magnetic starter has an overload circuit ERHAC 11.3
c. A magnetic starter has a solenoid coil
d. A contactor has solenoid coil

In principal the contactor and the magnetic starter provide the same function except the magnetic starter also incorporates an overload circuit which opens each phase if an over current situation exists.

H-27-g

133. In identifying the common, start, run terminals of a split phase motor; terminal A to B = 10 ohms, terminal A to C = 3 ohms, and terminal B to C = 7 which terminal is common

a. Terminal A
b. Terminal B
c. Terminal C ERHAC 9.10 fig 9.40
d. Ground terminal

To identify the common terminal of a typical compressor measure the resistance across each pair (A to B, A to C and B to C) when the pair with the highest resistance is located the remaining terminal is the common terminal.

H-27-f

134. Electronically commutated motors alter the output drive speed. This is accomplished by altering

a. Electrical frequency UAHTM 17.24
b. Electrical voltage
c. Electrical current
d. Electrical resistance

Electronically commutated motors use a circuit board which converts 60 Hz current into DC current and then fabricates the Hz into a fully variable output. The higher the frequency the greater the RPM output of the motor. Voltage and resistance are not altered.

H-27-g

135. To safely test a motor capacitor a technician should
    a. Charge the capacitor with a low voltage
    b. Discharge the capacitor with a resistor UAHTM 20.11
    c. Unplug the appliance
    d. Remove the bleed resistor

    Even after the appliance has been unplugged and the capacitor removed, the capacitor can still hold a very dangerous charge.

H-28 -Automatic controls and devices

H-28-a

136. If a compressor with an internal motor overload opens, what should the technician do before condemning the compressor
    a. Wait 1 hour
    b. Allow the compressor to cool down UAHTM 25.22
    c. Cool the compressor down with nitrogen
    d. Replace the internal overload

    The internal motor overload will close only after it cools down sufficiently. Misdiagnosis can occur if testing is conducted while too hot. An internal overload can not be replaced.

H-28-c

137. An air conditioning system uses a 24 volt control thermostat to maintain room temperature. The same system also utilizes a low pressure switch. What is the most likely purpose of this low pressure switch?
    a. To cycle the compressor on when the room ambient increases
    b. To cycle the compressor on when the room ambient decrease
    c. To cycle the compressor off if the system runs low on charge ERHAC 14.5
    d. To cycle the compressor off if the system is over charged

    The room thermostat is used to cycle the compressor and the low pressure control is used as a safety device which will open if the systems low side pressure drops to the cut-out point usually about 2-5 psig

H-28-c

138. A roof top air conditioning system with a defective condenser fan motor would be protected by
    a. A low pressure safety cut out switch
    b. A high pressure safety cut out switch ERHAC 14.5
    c. Fan cycling pressure switch
    d. A temperature delay switch

    A high pressure safety cut-out switch is used to shut the system down if a maximum head pressure is obtained. A low pressure

switch is used to open the circuit if a minimum low pressure is met. Fan cycling controls energize the condenser fan motors by high side pressure sensing, this is commonly used where low ambient conditions are likely.

H-28-e

139. A roof top air conditioner operating with a pressure type fan control maintains a minimum head pressure
    a. During low ambient conditions **UAHTM 25.21**
    b. During high ambient conditions
    c. During high temperature conditions
    d. During high pressure conditions

    Typically called a fan cycling control, this pressure switch closes on pressure rise (in the normal condensing pressure range) and then opens on the fall of pressure (during low ambient conditions).

H-28-f

140. When adding central air conditioning to an existing heating system a fan relay center control (or fan relay) may need to be added, this relay would be controlled by which thermostat lead?
    a. R-Red
    b. W-White
    c. Y-Yellow
    d. G- Green **UAHTM 42.10**

    Typical color code;
    R=power=red
    W=heat = white
    Y= cooling= yellow or blue if no yellow is present
    G= fan=Green

H-28-f

141. To prevent room temperature “overshoot” most HVAC room thermostats employ a
    a. Set back module
    b. Heat anticipator **ERHAC 12.2**
    c. Cooling anticipator
    d. Fan ON/AUTO mode

    The heat anticipator is a small resistive coil or resistor which applies heat to the thermostat sensing element. When properly adjusted it causes the room thermostat prematurely open the burner circuit allowing the blower to remove the final quantity of heat in the heat exchanger and meeting the room thermostat set point.

H-28-g

142. Solenoid valves are

a. Magnetically controlled ERHAC 12.6

b. High pressured controlled

c. Low pressured controlled

d. Motor controlled

Solenoid valves are directly operated by electro magnetic coils. The control signal could come from anytime, temperature or pressure sensing device.

H-28-h

143. A potential magnetic relay is controlled by the back electromotive force created by

a. High amperage

b. High resistance

c. The run winding

d. The start winding ERHAC 10.3

The potential relay uses a normally close contact which opens when “back” or counter electromotive force (EFM) is built up as the motor starts rotating. Much like an electrical generator produces EMF or voltage, the start winding also produces a considerable voltage.

H-28-h

144. After a defrost timer control initiates a defrost period the defrost cycle may terminate by means of

a. Time, pressure, or temperature ERHAC 6.2

b. Temperature only

c. Pressure

d. Time only

Some defrost systems will terminate operation by time only others will terminate by pressure or temperature if the timer does not “time-out” first.

H-28-j

145. A solid state starting relay is employed with fractional horse power compressors. after the motor starts the relay

a. Increases in resistance disconnecting the run winding

b. Increases in resistance disconnecting the start winding ERHAC 10.5

c. Decreases resistance disconnecting the run winding

d. Decreases resistance disconnecting the start winding

The solid state relay also called a positive temperature co-efficient relay (PTC relay) very quickly increases in resistance which effectively eliminates current flow to the start winding.

H-29-Elctrical troubleshooting

H-29-b

146. When troubleshooting a capacitor-start-capacitor- run motor and the technician finds the start capacitor and the run capacitor defective the technician must also check the operation of

a. Thermal over load
b. Current magnetic relay
c. Compressor contactor
d. Potential magnetic relay ERHAC 9.8

A capacitor start capacitor run motor uses a potential magnetic relay. When a technician is making a diagnosis on this motor and finds a defective start and defective run capacitor, the technician must also search for the cause of the defective capacitors which could have become defective because the potential magnetic relay failed to open after the system started.

H-29-b

147. Most low voltage HVAC room thermostats can adjust temperature over shooting, this adjustment would be a function of

a. Fan cycle switch
b. Heat anticipator ERHAC 12.2
c. Programmable timer circuit
d. Time delay relay

The heat anticipator circuit in a low voltage room thermostat is designed to eliminate thermostat temperature overshoot. When properly adjusted the heat anticipator opens the thermostat prior to the thermostat set point having been met. The furnace blower would continue to operate removing the heat still in the heat exchanger and the thermostat set point would eventually be met.

H-29-a

148. A current sensing lockout relay is an overload device that senses the current draw of the compressor through the _____

a. Lockout loop ERHAC 17.5
b. Thermo overload
c. Lockout timer
d. Condenser fan motor limit

The “Lockout loop” consists of the current sensing lockout relay and any other control limit switches. When ever the lockout relay has opened the technician must be certain that no other reason exists for the compressor to be operating at a high amperage condition.

H-29-b

149. When diagnosing the compressor contactor coil a proper resistance reading would be

a. Infinity
b. Zero OHMS
c. 45 OHMS ERHAC 11.1
d. Zero OHMS to ground

Some measurable resistance must be found in the coil. Infinity would indicate the coil is burned out. Zero ohms across the coil would indicate the coil is shorted. Zero ohms to ground would indicate the coil is grounded.

H-29-b

150. The best method to test the condition of the contacts in a compressor contactor would be

a. Voltage drop test
b. Meg-ohm test
c. Visual inspection **ERHAC 11.1**
d. Micro-amp test

A voltage drop may be realized across the contacts and a test of resistance or amp draw may show an increase. If so the contacts should be replaced. Sometimes no significant change in meter readings would be detected. The best way to test the contacts of an open contactor is by a visual inspection.

H-29-b

151. When troubleshooting a fuse with a volt meter a reading of line voltage across both ends of the fuse would indicate the fuse is

a. Good
b. Open **ERHAC 14.3**
c. Shorted
d. Closed

A reading of line voltage at the ends of the fuse could only be obtained if an open circuit existed between the leads of the meter.

Service Calls:

Determine the problem and recommend a solution for the following service calls.

H-29-e

152. **Application:** Residential air conditioning system
Type of Equipment: Gas furnace with air-cooled condensing unit
Complaint: No cooling
Symptoms:
1. Correct line voltage to furnace and condensing unit.
2. Thermostat calling for cooling.
3. Condensing unit receiving 24 volts.
4. All safety controls in condensing circuitry are closed.
5. Contactor coil resistance reading is 0 ohms.

a. Low on refrigerant charge
b. Dirty condenser
c. Burnt out contactor coil
d. Shorted contactor coil **ERHAC 14. Practice service calls**

The contactor coil should have a measurable amount of resistance (approx 50 ohms). A reading of O zero ohms indicates a shorted coil. The condensing unit will not energize until the coil is replaced.

H-29-c

153. **Application:** Residential conditioned air system

Type of Equipment: Fan coil unit air-cooled condensing unit

Complaint: No cooling

Symptoms:

1. Correct line voltage to furnace and condensing unit.
2. Thermostat calling for cooling.
3. Compressor contactor closed.
4. Compressor and condenser fan motor extremely hot.
5. Condenser fan motor resistance readings are C to R = 6 ohms. C to S + 28 ohms, and R to S =34 ohms.
6. Compressor run capacitor in good condition.
7. Compressor motor and bearings in good condition.
8. Condenser fan blade turns with ease.
9. Condenser fan turning slower than normal until overload cuts out.

a. Low supply voltage
b. High supply voltage
c. Shorted compressor and condenser motors
d. **Defective condenser fan motor capacitor ERHAC 14.**

Practice service calls

A shorted condenser fan motor capacitor could allow the fan motor to operate but it would operate at lower than normal RPMs. After a short period of time the motor overload would open breaking the current path to the motor. Within a short period of time with the fan motor not operating the compressor too would trip its overload.

H-29-d

154. **Application:** Residential conditioned air system

Type of Equipment: Packaged air conditioner

Complaint: No cooling, no indoor fan operation

Symptoms:

1. Line voltage available to unit.
2. Closing of thermostat fan switch causes no action.
3. Voltage at terminals C to R on unit low-voltage terminal board is 0 volts.

a. Shorted run winding
b. **Open transformer circuit ERHAC 14. Practice service calls**
c. Shorted compressor run capacitor
d. Defected room thermostat

The Transformer has no output voltage. If line voltage is present at unit the transformer should also have power. The transformer has an open winding.

I-Heating

I-30 Install and service electric heat

I-30-b

155. The heating element found in electric forced air furnaces is typically made from

a. Silver
b. Chrome
c. Nichrome **UAHTM 30.7**
d. Silver/tungsten

Resistive heating elements are typically made from Nichrome because of its durability and electrical conductivity properties.

I-30-c

156. An electric heat system operating with a low voltage thermostat would have the heat relay wired in series with the

a. Blower motor
b, Electric heat element
c. Thermostat heat anticipator UAHTM 15.3
d. Thermostat Y terminal

One of the advantages of using a low voltage thermostat is that a heat anticipator can be incorporated.

I-30-c

157. Identify the safety found in electric duct heating systems

a. Interlock **UAHTM 30.7**
b. Heat anticipator
c. Transformer
d. High pressure switch

The interlock component prevents the duct heater element from energizing unless the indoor blower is operating, which keeps the heating elements from overheating and causing a fire hazard condition.

I-30-h

158. Contactors and _____ are commonly used to control the operation of the electric resistance heaters in electric furnaces.

a. Transformer
b. Heat anticipator
c. High limit control
d. Sequencer **ERHAC 14.7**

Sequencers are often used to cycle heat elements in electric heating systems.

I-31 Install and service gas furnace

I-31-a

159. The U.S. Federal Trade Commission requires manufactures to provide an annual fuel utilization efficiency rating (AFUE). AFUE ratings are for the benefit of

a. The consumer **UATHM 31.21**

b. Manufacture

c. The technician

d. The EPA

The consumer can use AFUE data to shop and compare heating systems on the basis operating efficiency.

I-31-g

160. A high efficiency gas furnace utilizing hot surface ignition (HIS) will enter into lockout mode if ignition is not detected

a. 2 seconds or less

b. 4 to 11 seconds **UAHTM 31.19, 31.22**

c. 15 to 20 seconds

d. 30 seconds

Ignition circuit boards used on HSI systems will typically lockout after 4-11 seconds if ignition is not detected.

I-31-f

161. High efficiency furnaces use plastic vent piping because

a. Acidic flue gases

b. Lower flue temperatures

c. Condensation of flue gases

d. All of the above **UAHTM 31.25**

All of the above are true of high efficiency furnace venting. The flue gases are acidic; the plastic pipe is not affected by the acid. The flue gases are lower in temperature permitting the use of the less costly plastic vent pipe. Flue gases will condense in the secondary heat exchanger, the plastic pipe allows for tight leak proof joints and seams.

I-31-f

162. A technician uses which instrument to measure gas service and manifold pressure?

a. Anemometer

b. Draft gauge

c. Water manometer **UAHTM 31.3**

d. Manifold gauge

Gas pressure can only be accurately be measured by a water manometer.

32 Install and service oil furnaces

I-32-h

163. When servicing the ignition transformer of an oil furnace correct secondary voltage would be

a. 120 volts
b. 600 volts
c. 6,000 volts
d. **10,000 Volts** **UAHTM 32.14**

The intense arc necessary to ignite fuel oil is produced by the secondary side of the ignition transformer with an output voltage of 10,000 volts.

I-32-i

164 When servicing the oil burner that repeatedly locks out, the technician tests the Cad Cell. In the presence of light the correct OHM reading should be

a. 0 OMHS
b. 600 to 1000 OMHS **UAHTM 32.9**
c. 50,000 to 100,000 OMHS
d. Infinity

The primary control on the oil burner will lock-out after a preset time usually 45-120 seconds unless the cad cell detects the light from ignition which causes the cad cells resistance to decrease from approximately 100,000 ohms (in the absence of light) to 600-1000 ohms (in the presence of light).

I-32-h

165 A standard oil burner nozzle identified as 80 degrees of angle and 1.00 GPH would deliver approximately how many BTUs per hour?

a. 40,000 BTUs
b. 80,000 BTUs
c. 100,000 BTUs
d. 140,000 BTUs **RACT 32.6**

The nozzle identified as 1.00 means 1 gallon of fuel can flow through the nozzle in 1 hour of operation. 1 gallon of fuel oil contains about 140,000 BTU's.

33/36 Install and service hydronic heat

I-33(36)-a

166 Centrifugal pumps used in hydronic heating are considered non-positive displacement pumps because

a. They do not add significant pressure to the system UAHTM 33.8

b. Because they do add significant pressure to the system

c. Because the pistons are very small

d. None of the above

Centrifugal pumps are used in hydronic systems are a circulator type pump. They are not designed to increase system pressure.

I-33(36)-a

167 In a typical residential/light commercial hydronic heating system the expansion tank

a. Provides space for the heated water to expand. UAHTM 33.6

b. Provides space when the water cools down

c. Increases the water pressure so the water does not expand

d. Maintains a constant water pressure equal to house pressure

When water is heated the molecular structure expands, this expanded volume is absorbed into the expansion tank, when the water cools down it contacts and is forced back into the water system.

I-33(36)-d

168 A residential hydronic heating system using three zone valve controls (rated 24 Volt, .50 amp each) would require a control transformer rated at

a. 20VA

b. 30VA

c. 40VA ERHAC 12.1

d. 60 VA

VA = I x E 3valves @.5 amp = 1.5 amps

1.5 amps x 24 volts = 36 VA minimum

I-33(36)-d

169 When installing a hydronic heating system the use of slow opening/closing zone valves allows for

a. The thermostat's heat anticipator to operate correctly
b. Zone operation without water hammering UAHTM 33.7
c. Heating and cooling temperature control from the same thermostat
d. All of the above

Water hammering in the hydronic system can be a nuisance to the customer. The use of slow opening/closing zones valves will eliminate water hammer noise.

I-37 Install and Service Heat Pumps

I-37-a

170 A geothermal heat pump absorbs heat

a. In the evaporator in the heating mode UAHTM 43.1
b. In the condenser in the heating mode
c. In the condenser during the cooling mode
d. None of the above

Heat transfer is always in the direction of hot to cold. The heat medium (water) is typically 40 to 50 degrees (the hot source) the refrigerant temperature in the evaporator would typically be about 20 degrees (the cold source) thus the heat would leave the 50 degree water and be absorbed into the 20 degree refrigerant.

1-37-b

171 On a split system air source heat pump operating with an outdoor ambient of 30 degrees f the refrigerant boiling temperature would be approximately

a. -10 degrees
b. 10 degrees UAHTM 43.15
c. 30 degrees
d. 70 degrees

Approximately 20 degrees of temperature difference is maintained between the heat medium (30 degrees) and the refrigerant boiling temperature (10).

I-37-d

172 A coaxial heat exchanger used on geothermal heat pumps allows

a. Water to flow in one direction and refrigerant in the opposite direction UAHTM 44.4

b. Water and refrigerant to flow in the same direction

c. Water to flow only if the water check valve is open

d. None of the above

A coaxial heat exchanger is a smaller tube (refrigerant) inside a larger tube (water). The two mediums travel through the heat exchanger in opposite directions allowing for a maximum amount of heat transfer.

I-37-c

173 During the heating mode air source heat pumps must periodically defrost the outdoor coil, some systems use time and or temp to initiate the defrost cycle. Other modern systems use

a. A low pressure control connected to the indoor coil

b. A high pressure control connected to the outdoor coil

c. An air pressure switch sensing air pressure at the indoor coil

d. An air pressure switch sensing air pressure at the outdoor coil UAHTM 43.25

This type of defrost initiation is more efficient as it only will defrost if a build up of frost is sensed because of an air pressure resistance increase.

J-Soft Skills

UA HVACR Training Manual (UAHTM)
Air Conditioning Refrigeration News On-Line
J-38 Computer Skills

J-38-c

174 When attaching a document using Microsoft “Outlook” e-mail you must

a. Click on the “forward” icon

b. Click on the “paperclip” icon Microsoft Outlook Help

c. Click on the “new” icon

d. Click on the “outbox” icon

The paperclip icon is used to attach a file to an email.

J-38-d

175 From the following identify the most helpful internet map search engine.

a. Adobe
b. Google **www.google.com**
c. www.com
d. Home page

Google is the only internet search engine listed above.

J-39 Documentation (invoicing)

J-39-d

176 When completing a service call the last action taken is presenting the invoice to the customer and obtaining a signature. Why is it important that all work performed is accurately described on the invoice?

a. To reference details at a later date
b. To identify warranty parts or service
c. To provide service details in written communication form
d. All of the above **Tech to Tech Chapter 9**

For all parties concerned complete and accurate documentation should be completed on all invoices.

J-39-c

177 Service technicians must be thorough in order to prevent a breakdown in communication that results in lost time (money). Which of the following is not part of the required invoice information?

a. Date of repair
b. Actual Labor
c. Total cost
d. Original supplier of equipment **Customer Service Skills p 47**

Date of repair, actual labor and the total cost are all very important to have listed on the invoice. The identification of the equipment supplier is not necessary.

J-39-c

178 What measures can service technicians take to ensure that work orders are complete?

a. Write legibly
b. Do not rush
c. Explain the work order to the customer and ask if they have any questions
d. **All of the above** **Customer Service Skills p 47**

All of the above will help to assure completeness of invoices. Writing legibly helps yourself to double check your own

documents as well as the customer will be able to understand what you have written and service you have performed. Further, a well written, clear, concise and legibly written invoice is a display of professionalism.

J-40 Customer Relations

J-40-c

179 The most important element(s) of non-verbal communication is (are)

a. Spoken words
b. Voice inflection
c. **Body language** **Customer Service Skills p 18**
d. All of the above

Body language or motions and gestures during personal communication can speak volumes. Body language often communicates more than spoken words.

J-40-d

180 The quality of customer service can be enhanced if the technician takes the time to

a. Actively listen **Customer Service Skills p 27**
b. Explain in detail how the HVAC system works
c. Explain the billing process and when the bill is due
d. Use HVAC technical terms in explaining the work that has been completed

What you say to the customer is very important but just as important is what the customer has to say to you. Listen to your customer and reiterate at the conclusion of your conversations to be certain all points are clear and understood.

J-40-b, f

181 An HVAC technician should always attempt to convey a professional image by

a. Clean and neat personal appearance
b. Clean and neat service vehicle (inside and outside)
c. Maintaining a clean and organized work site
d. All of the above **Customer Service Skills p 13**

An HVAC technician is a professional and should always present himself as professional. Part of the professional image includes; clean and neat personal appearance, clean and neat service vehicle, and maintaining an organized work space.

J-41 Ethics and Professionalism

J-41-b

182 If a technician determines he can not keep a scheduled customer appointment he should

a. Travel as fast as possible to get there as soon as possible
b. **Call the customer to keep them informed of your delay**
c. Do nothing, the customer expects service people to be late
d. Call the customer and tell them you have been on a more important service call

Most customers recognize service companies/technicians are very busy people and that scheduled appointments sometimes get delayed. However, the customer is likely just as busy and may even have to take time off from work to meet you. Whenever you discover that you can not meet for a scheduled customer appointment at least be courteous and professional and give the customer a phone call so they are not "left hanging". They may not be happy that you have cancelled or postponed but it is far better than not making contact at all.

J-41-f

183 Background checks are necessary to disclose employee history associated with

a. Criminal records
b. Credit reports
c. Drug testing
d. **All of the above**

Background checks can identify all of the above character faults. In today's world background checks are a part of life we all must get used to.

J-41-d

184 Which of the following would be a display of professionalism

a. Work uniform with company logo
b. Being punctual
c. Use of good people skills
d. **All of the above**

Professionalism is boundless, all of the above are indicative of professionals.

K-Light Commercial

UA HVACR Training Manual (UAHTM)
HVAC Light Commercial STC Version 1-11-06
Modern Refrigeration and Air Conditioning
Air Conditioning Mechanical Equipment Service Manual for UAJA
Practical Heating Technology Johnson, Delmar
Electricity for Heating Refrigeration and Air Conditioning
ARI Refrigeration and Air Conditioning 4th Edition

http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10405

www.osha.gov/Publications/3100.html

K-42 Roof Top (Packaged Units)

K-42-a

185 Parallel compressors are piped into a system in such a manner that
a. The discharge lines are connected to a common manifold
b. The suction lines are connected to a common manifold
c. The liquid lines are connected to a common manifold
d. **Both a and b** **UAHTM 26.6**
Dual compressors could be piped in 2 different configurations, parallel and series. In a parallel system all discharge lines are common to each other as well as all suction lines are common to each other.

K-42-a

186 An advantage of the parallel compressor systems would be
a. Load matching
b. Higher efficiency
c. Less compressor cycling
d. All of the above **UAHTM 26.6**
There is a long list of advantages of a parallel compressor set up; when capacity requirements change compressors can be brought online to match the demand, overall system efficiency is improved and less compressor cycling will occur.

K-42- c

187 An optional arrangement added to a roof top air conditioning system which has a motorized damper and opens when the room thermostat calls for cooling and outdoor temperature and humidity conditions are met is called

a. An economizer **ARI Chapter 17 p 798**

b. Heat recovery

c. Free ventilation

d. Desiccant cooling

In geographic regions when moderate temperatures and low humidity is common during the cooling season an economizer package can significantly add to overall air conditioning efficiency.

K-42-f

188 Roof-top air conditioners typically are mounted on top of a roof curb to help provide a leak proof connection to the roof. The roof curb is generally _____ high.

a. 2-4 inches

b. 6-10 inches

c. **12-15 inches** **MRAC 24.20**

d. 24-30 inches

The bottom of the roof curb is flashed into the building's roof to prevent rain and snow melt from penetrating into the building. The Air conditioning unit is set on top of the curb above the normal snow line usually 12 to 15 inches.

K-42-b

189 Many roof top heating/air conditioning systems are 2-stage heating or 2-stage cooling or both. The primary purpose for this is

a. To allow a wider application of equipment

b. To allow for fluctuating loads **ERHAC 12.3**

c. Less costly to build equipment

d. To use smaller gas lines and refrigerant lines

With this type of equipment greater AFUE and SEER ratings can be achieved with smaller capacity systems such as 2, 2 horsepower compressors will have better efficiency than 1, 4 horsepower compressor. If an application is likely to have varying capacity demands both circuits would operate during the greater demand period and only one compressor would operate during a lower demand period.

K-43 Ventilation Equipment

K-43-c

190 To maintain operating effectiveness and performance the air pressure in a building should be

a. Slightly positive to the outdoor pressure AC UAJA p77

b. Slightly negative to outdoor pressure

c. Equal to the outdoor pressure

d. Positive in the cooling season and negative in the heating season

A building with a slight positive pressure to the outdoors will ex-filtrate rather than infiltrate, building infiltration can add 30% or more to the overall heat load. Fresh or make up air will be introduced at a regulated volume to account for ex-filtration.

K-43-b

191 Air brought into a building to replace ventilated air leaving the building is called _____

a. Infiltration air

b. **Make-up air AC UAJA p77**

c. Latent air

d. None of the above

Make-up air, sometimes called fresh air is introduced into the duct system, heated or cooled and distributed throughout the structure. Make-up air is necessary to provide adequate air changes per hour to maintain a healthy indoor environment.

K-43-d

192 Some applications such as hospital rooms require

a. 20% make-up air

b. 50% make-up air

c. 75% make-up air

d. 100% make-up air AC UAJA p77

For sanitary and health concerns HVAC equipment in applications such as hospitals use 100% make-up air, heat or cool as needed and then exhaust that volume of air.

K-43-e

193 The most common method of indoor air odor control is

a. Electronic air filters

b. Disposable filters

c. Heap filters

d. Dilution with ventilation air AC UAJA p76

Filtering of air can remove some odor contamination. However, the best method of removing odors is to ventilate the affected air mass.

K-43-c

194 If more air is exhausted through ventilation than is made-up from fresh air inlets the building is considered

a. Equally pressured
b. Negatively pressured AC UAJA p77
c. Positively pressured
d. To have poor air quality

This building would be considered negative and it would infiltrate.

K-44 Exhaust Fans

K-44-a

195 In kitchens where appliances may add a considerable amount of both latent and sensible heat, the heating and cooling load can be reduced by the proper installation and use of_____

a. Exhaust hoods AC UAJA p 106
b. Heat recovery systems
c. Roof-top condensers
d. All of the above

Commercial kitchen areas are a difficult area to air condition and sometimes hard to heat as well. A properly installed and balanced ventilation system or "exhaust hood" will remove the affected air above and around the cooking equipment and have a lower impact on the balance of the controlled space.

K-44-c

196 Correct installation and use of bathroom exhaust fans can greatly reduce the risk of

a. Indoor humidity issues AC UAJA p 80
b. Radon gas build up
c. Electrical equipment malfunctions
d. Severe "sick building syndrome"

Bath exhaust fans when installed properly keep the humidity level in check and prevent problems such as mold, mildew and moisture damage to interior surfaces.

K-44-e

197 Proper ventilation in modern mechanical rooms is important because the refrigerant leaked from a system

a. Is corrosive
b. Can cause asphyxiation UAHTM 4.7
c. Is flammable
d. Is toxic

Most modern refrigerant are designated by ASHREA A-1; low toxicity and non-flammable. The greatest concern in mechanical rooms from a refrigerant leak is the possibility of asphyxiation.

K-45 Types of Air Volume Systems

K-45-a

198 The primary purpose(s) for the use of a Variable Air Volume (VAV) system is to gain operating efficiency by

a. Offering building zone control
b. Reducing the indoor blower RPM
c. Capitalizing on passive solar gains
d. All of the above AC UAJA p 365

In many applications VAV systems offer many advantages, some of which are listed above.

K-45-b

199 The constant air volume system is less efficient than a variable air volume system because

a. The system always runs in the maximum heat position
b. The system always runs in the maximum cooling position ACUAJA p 364
c. The system is always bringing in outside air
d. The system is always exhausting inside air

Constant air volume systems are operated in the max cool position, the air is then tempered in necessary.

K-45-c

200 When "zoning" a building for the purpose of climate control, zones are generally divided into areas by

a. Floors (1st floor, 2nd floor)
b. Exposure (north side, south side etc.)
c. Occupancy (number of people, type of activity)
d. All of the above AC UAJA p 353

Due to stratification of air (warm air rises to a higher level) zoned systems would separate one floor from another. Also exposure considerations can be considered such as (one wall has many square feet of window area and an adjacent wall has no window exposure) in this case separate zones for these two areas would deliver greater comfort and efficiency. Finally, occupancy the number of people and the type of activity provide a varying heating and cooling demand and should be zoned accordingly.

K-46 Roof Top Safety and Hazards

K-46-b

201 When working on an upper floor or a roof top of a building the top of the ladder should extend above the top edge of the roof by at least

a. 1 foot
b. 3 feet **UAHTM fig 4-17**
c. 5 feet
d. Never use an extension ladder on a roof top

An extension ladder should extend at least 3 feet above the top edge of the roof to serve as a hand hold and to aid in stability of the person using the ladder.

K46-g

202 When gas pipe is installed across a roof the pipe must be

a. Fastened with galvanized joints
b. Sealed with Teflon tape
c. Supported and fastened **PHT 4.1**
d. All of the above

Gas pipe must be installed in accordance with state and local codes. Joints should be made with malleable black pipe and fittings and sealed a soft set thread compound. Gas pipe must also be supported to prevent sagging and fastened to keep the system secure.

K-46-b

203 According to OSHA falls from _____ are one of the leading causes of occupational fatalities and injuries.

a. Ladders **www.osha.gov**
b. Roof tops
c. Windows
d. Cranes

OSHA statistics show falls from ladders are one of the leading causes of occupational fatalities and injuries.

K-46-b

204 OSHA recommends _____ when climbing a ladder.

a. Keep your body out away from the ladder as far as possible
b. Keep your feet as far to the outside of the rungs as possible
c. **Maintain a "3-point" contact with the ladder at all times**
www.osha.gov
d. All of the above

The recommendation by OSHA is "3 point contact with the ladder at all times. This means 2 hands and 1 foot or 2 feet and one hand should be firmly set on the ladder when traversing up or down the ladder.

K-46-e

205 Design specifications for “Suspended Personnel Platforms” require the support platform rating be at least _____ the maximum intended load.

a. 2 times
b. 3 times
c. 5 times
d. 7 times

According to OSHA, suspended personnel platforms must be rated at 5 times the intended load.