Certificate for Apartment Maintenance Technicians (CAMT)

Interior & Exterior Maintenance and Repair Course

Skill Check #1 – Answer Key

You are Here: Make-ready Maintenance:

1. Why is it important to inspect the apartment before a resident moves out?
    - Check for damages to the apartment and charge the resident for them.
    - Estimate work needed in the apartment to have it ready for new move-in.
    - Estimate materials and time needed for the make-ready process.
    - Schedule contractors needed for the make-ready process.
2. What are some of the uses for Make-ready Checklists?
    - Record apartment conditions before a resident moves out.
    - List items needed to have the apartment ready for new residents.
    - Used as a guideline by maintenance technician to complete a make-ready apartment.
3. Who inspects the apartment when a resident moves out?
    - Manager and/or Maintenance Supervisor
    - Assistant Manager
4. Who inspects the apartment when it is ready for a new move-in.
    - Manager and/or Maintenance Supervisor
    - Leasing Consultant
5. What is the purpose of keeping track of the make-ready process?
    - To know how much progress has been made at any given time.
    - To ensure make-readies are being completed in a timely manner.
    - To know when the apartment will be ready.
6. How can we keep track of the make-ready process?
    - Use a make-ready board.
    - Use a computer generated make-ready process.

Caulking:

7. Why is it important to use masking tape when caulking?
    - To have a professional clean and sharp edge.
8. Why is it important to wet your finger and/or rag when taking off excess caulk?
    - To have a smooth joint.

9. What are some of the safety procedures when caulking?
    - Use Personal Protective Equipment to protect eyes, nose, skin, and hands.
    - Be careful with sharp objects.

Ceiling and Walls: Fixing a Dent or Gouge in Drywall:

10. What are some of the safety procedures when working on drywall repairs?
    - Use Personal Protective Equipment to protect eyes, nose, skin, and hands.
    - Be careful with sharp objects.
    - Use ladders properly.
11. What are the steps to perform a drywall repair?
    - Prepare area
    - Apply Patch
    - Apply Joint Compound
    - Apply Joint Tape
    - Sand
    - Texture and Paint.

Ceiling and Walls: Repairing Orange Peel Surfaces:

12. Which are the two most common ways to do texture repairs?
    - Manually
    - Machine Spray.

Re-keying a Door Lock:

13. Why do we re-key a lock during the make-ready process?
    - To ensure no one has a key other than the new resident.

14. What are the steps to re-keying a lock?
    - Disassemble and/or remove the cylinder
    - Take out the old pins and throw them away
    - Using key gauge, determine proper pins to insert
    - Put in new pins and reassemble the lock
    - Make new keys and ensure that they work properly

Tile: Cleaning Grout

15. What are the steps to clean grout properly?
    - Apply spray cleaner

- Scrub with a stiff brush
- Rinse
- Dry
- Apply Sealer.

Curb Appeal and Exterior Inspections:

16. Why is curb appeal important?
    - To make sure the community is always attractive to residents, guests and prospective residents.

17. What are some of the benefits of having attractive curb appeal?
    - Residents are proud to live there.
    - It is attractive to new prospects.
    - The community is well maintained.

18. Whose job is it for a community to have attractive curb appeal?
    - All employees.

19. What are the uses of the curb appeal checklist?
    - To make sure all work is completed properly
    - To record conditions of the curb appeal
    - To list items needed to complete work.

Swimming Pool Area Safety:

20. Why are safety measures important?
    - To keep people safe and reduce or prevent accidents.
    - To comply with local, state and federal regulations.

Inspecting Building Exteriors:

21. How often should the exterior of a community be inspected?
    - Semi-annually (At least twice per year.)

22. What are the benefits of having a Building Exterior Checklist?
    - To record conditions of the exterior of the community
    - To schedule repairs
    - To inspect the community after repairs have been made.

Plumbing Maintenance and Repair Course

Skill Check #2 – Answer Key

You Are Here: Plumbing Maintenance and Repair:

1. What are some of the safety hazards when working on plumbing?
    - Having something falling on top of you
    - Burning yourself with something hot
    - Cutting yourself with something sharp
    - Falling on a wet floor or slippery floor
    - Getting infected with a body fluid or bacteria
    - Getting sick by breathing harmful chemicals.
    - Coming in contact with or splashing chemicals.
    - Getting electrocuted.

2. When is it best to use a plumber for a repair?
    - When the job is too large
    - When the employee does not have proper training or is not sure about the procedure
    - When the employee does not have the required specialty tools.
    - When employees are overloaded with work or shorthanded
    - When the item is under warranty.

Plumbing in an Apartment Building:

3. What are the three systems in plumbing?
    - Water distribution
    - Waste
    - Ventilation.

Plumbing Safety:

4. How can accidents be prevented when doing plumbing repairs?
    - Taking proper time to do repairs
    - Having a well organized work environment
    - Making sure water is off before doing any repairs
    - Using plumbing tools properly
    - Using the right parts for the job
    - Following lock-out/tag-out procedures

- Using personal protective equipment
- Following equipment safety directions
- Being familiar with MSDS Sheets for chemicals being used.

5. Describe the Lock-out/Tag-out Procedure:
    - Shut off the source of water or electricity
    - Attach a lock-out device and tag to this source
    - Release or drain any energy or pressure left in the plumbing or electrical lines or equipment.
    - Test to be sure the energy or pressure is turned off.

Key Tools for Plumbing Repairs:

6. What tools would be required to replace a bathtub and shower valve?
    - Screwdrivers
    - Adjustable wrench
    - Putty knife
    - Utility knife
    - Lock-out/Tag-out device
    - Tubing cutter
    - Propane torch
    - Pipe wrench
    - Fire extinguisher
    - Hammer/nail puller
    - Measuring tape

Pipes and Fittings:

7. What are some of the types of pipes found in plumbing systems?
    - Copper
    - Plastic
    - Galvanized
    - Cast Iron
    - Brass.

Faucets and Sinks:

8. Describe the most common types of faucets
    - Ball
    - Cartridge
    - Disc
    - Compression.

Replacing a Faucet:

9. What are the steps to replacing a faucet?
    - Turn water going to the faucet off
    - Check to make sure water is off
    - Remove faucet water and drain lines
    - Remove faucet lock nuts and faucet
    - Clean area
    - Install new faucet
    - Turn water back on and check for leaks.

Garbage Disposals:

10. What are some of the safety precautions when working with garbage disposals?
    - Follow lock-out/tag-out procedures
    - Use personal protective equipment to protect face, hands, and body
    - Do not place hands inside disposal.

11. What are some of things that we should never put in a garbage disposal?
    - Anything that is not biodegradable
    - Anything hard (bones, eggshells, potato skins, uncooked pasta or rice).

Tubs and Showers:

12. What are some of the safety precautions when working with tubs and showers?
    - Turn water off and check to make sure it is off
    - Use personal protective equipment to protect face, hands, and body
    - Use proper tools
    - Be careful with slippery surfaces
    - Clean working area.

13. What are the three main types of shower faucets?
    - Three handles
    - Two handles
    - Single handle.

14. What are the steps to change a tub diverter valve?
    - Turn water off and test to make sure it is off
    - Unscrew (counterclockwise bonnet nut and stem assembly)
    - Remove old stem and replace it with new one
    - Turn water back on and test.

Toilets:

15. What are some of the safety precautions when working with toilets?
    - Turn water off and test to make sure it is off
    - Use personal protective equipment to protect face, hands, and body
    - Handle body fluids with precaution
    - Be careful with slippery surfaces
    - Use proper tools
    - Follow installation instructions
    - Be familiar with MSDS sheets for chemicals being used.

16. What are the steps to replace a toilet?
    - Turn water off and test to make sure it is off
    - Remove water from the old toilet
    - Disconnect water supply line
    - Disconnect toilet from floor/wall
    - Remove old toilet (request assistance if necessary)
    - Clean area
    - Install new wax seal
    - Install new bowl and tank
    - Turn water back on and test.

Drains and Clogs:

17. What is the best way to unclog a toilet?
    - Using a plunger or a toilet auger(never use any chemicals to unclog a toilet).

18. What is the best way to unclog a sink?
    - Remove standing water
    - Remove drain line
    - Clean drain line
    - Test sink for proper draining
    - When using drain opener chemicals, follow instructions properly.

19. What is the best way to unclog a tub?
    - Remove standing water
    - Remove drain cover
    - Remove hair or any other debris with needle nose pliers

- Test tub for proper draining
- When using drain opener chemicals, follow instructions properly.

Water Heaters:

20. What are some of the safety precautions when working with water heaters?
    - Follow lock-out/tag-out procedures for electricity, gas, and water
    - Drain water out completely if your replacing the water heater
    - Use proper tools and replacement parts
    - Use personal protective equipment to protect face, hands, and body
    - Follow equipment instructions properly
    - Request assistance when necessary
    - Follow lifting techniques properly.

21. What are the steps to replace a water heater?
    - Turn water and power or gas off and test to make sure it is off
    - Follow lock-out/tag-out procedures
    - Disconnect water and power or gas lines
    - Drain water from old water heater completely
    - Clean area
    - Install new water heater according to equipment specifications
    - Fill tank with water prior to turning on the power or gas
    - Test water heater for proper operation.

22. What is the purpose of installing a Temperature and Pressure Relief Valve on a water heater?
    - Is a safety device required in all water heaters to release pressure in the tank in case of an excess increase in temperature or pressure above tank limits.
23. How do you replace a Thermocouple in a gas water heater?
    - Turn gas off and follow lock-out/tag-out procedures
    - Wait at least 10 minutes for gas to dissipate
    - Remove pilot gas tube or bracket if needed and remove the old thermocouple
    - Install new thermocouple and pilot gas tube or bracket if removed
    - Turn gas back on and test for leaks
    - Make sure pilot flame wraps around the tip of new thermocouple
    - Test for operation.

Electrical Maintenance and Repair Course

Skill Check #3 – Answer Key

You Are Here: Electrical Maintenance and Repair

1. When is it acceptable to call an electrician?
    - When it is required by local, state or federal regulations
    - When a technician does not have proper training or is uncomfortable performing the repair.
    - When the job is too large or the workload is too heavy.

Comparing Electricity and Plumbing:

2. What is the pressure of electrical current called?
    - Voltage

3. What is the purpose of having different size wires?
    - The larger the wire, the more current it can carry.

Electrical Terms:

4. What is Amp?
    - It is the rate at which current flows through an electrical device.

5. What is Ohms?
    - It is the Units to measure electrical resistance.

6. What is Voltage?
    - It is a measure of electricity in terms of pressure.

Electrical Safety:

7. What is the first thing you should do before working on electrical device?
    - Turn power off and follow tag-out/lock-out procedures

8. Describe the Lock-out/Tag-out procedure.
    - Turn off the source of electrical power
    - Attach a lock-out device to the power source
    - Attach a tag-out device to the power source
    - Discharge any remaining power source in capacitors or equipment
    - Test the device to make sure the power is off

- Make necessary repairs.
- Turn power back on and test device

9. What is some of the personal protective equipment that can be used in electrical work?
    - Goggles
    - Gloves
    - Rubber-soled shoes.

10. What is a GFCI Receptacle?
    - It is a receptacle equipped with a Ground Fault Circuit Interrupter safety device. The GFCI constantly monitors electricity flowing in and out of a circuit, and can sense any loss of current. If the current flowing through the circuit differs by a small amount, the GFCI quickly switches off power to that circuit.

The Electrical System:

11. Where does power come from?
    - Power Plant

12. How does the power company measure the electricity we use?
    - With an electrical meter that measures kilowatts being used

13. What protects circuits from shorts and overloads?
    - Breakers or fuses

14. What types of voltage are found in apartment homes?
    - 120 Volt for electrical outlets, lamps, and small appliances
    - 240 Volt for HVAC, water heaters, electric ranges, and dryers.
    - 24 Volts for HVAC controls and the thermostat.

Electrical Circuits:

15. What is the purpose of the black wire?
    - The hot wire carries electrical current to the electrical device.

16. What is the purpose of the white wire?
    - The neutral wire returns current to the service panel.

17. What is the purpose of the green or bare wire?
    - The safety ground wire directs electricity to the ground to make it harmless in the event of a short in the circuit or defective appliance.

Tools for Electrical Repairs:

18. What type of ladder is recommended for electrical work?
    - Fiberglass

19. What type of tool is recommended to remove plastic insulation from wires?
    - Wire strippers

20. What is the purpose of having well insulated handles on electrical tools?
    - To prevent electrocution

21. What is the purpose of using electrical test tools?
    - To check if power is off in the electrical device
    - To check if there is an open circuit
    - To check if an electrical device is grounded or shorted out.
    - To check if the proper amount of voltage or amperage is supplying the device.

22. What are some of the functions of an electric meter?
    - To check resistance in an electrical device with Ohms
    - To check pressure in an electrical device with Volts
    - To check the current in an electrical device with Amps.

Electrical Wires:

23. What sizes wire is recommended for 15 amps, 120 volt light fixtures and receptacles?
    - #14
24. What size wire is recommended for 30 amps, 240 volts large appliances?
    - #10

Main Service Panels, Fuses, and Circuit Breakers:

25. What is most common size of a circuit panel in apartment homes?
    - 125 Amp

26. What makes a breaker trip?
    - A short in the circuit
    - A faulty connection
    - An overloaded circuit.

27. How do you reset a tripped breaker?
    - Flip breaker all the way to the OFF position
    - Flip breaker to the ON position.

Wall Switches:

28. What could be the problem if the breaker trips when you turn a wall switch on?
    - Shorted/Grounded out switch
    - Faulty connection
    - Shorted/Grounded out electrical device.

29. What is a 3 way switch?
    - It is a switch that can operate an electrical circuit or device from two different locations.

Receptacles:

30. What is the small slot in an electrical receptacle?
    - It is the “Hot” slot with 120 volts.

31. What can be the problem in a receptacle that feels warm?
    - The receptacle is overloaded
    - There is a faulty connection in the wiring
    - The wire is too small.

Fluorescent Light Fixtures:

32. What are the parts of a fluorescent light fixture?
    - Ballast
    - Sockets
    - Gas-filled tubes
    - Cover
    - Shade/diffuser.

33. What could be the problem in a fluorescent light fixture that is flickering?
    - Light bulb is loose
    - Light bulb is defective

- Defective ballast
- Defective socket
- Loose connection
- Defective starter (old fixtures)

Smoke Detectors and Carbon Monoxide Detectors:

34. What could be the problem in a smoke detector that does not sound when tested?
    - No power
    - Defective battery
    - Loose connection
    - Defective detector.

Air Conditioning Maintenance and Repair Course

Skill Check #4 – Answer Key

You Are Here: Air Conditioning Maintenance and Repair

1. When is it acceptable to call an Air Conditioning Specialist?
    - When is required by local, state or federal regulations
    - When the technician does not have the proper training or information
    - When the job is too large or workload is too heavy.
    - When the technician is not certified
    - When the equipment still under warranty.

Air Conditioning Safety:

2. What are some of the safety precautions to be taken when working on air conditioning equipment?
    - Turn power off and follow lock-out/tag-out procedures
    - Allow plenty time for equipment to cool off
    - Use personal protective equipment to protect face, hands, and body
    - Discharge accumulated power in capacitors by shortening the terminals
    - Take precautions to work with high temperatures and pressures
    - Have working area well ventilated to avoid breathing refrigerant
    - Report refrigerant leaks to supervisor
    - Be familiar with MSDS sheets for chemicals being used
    - Keep working area and tools clean and in excellent condition
    - Follow equipment and tool manufacturers'directions properly.

Key Tools for Air Conditioning Repairs:

3. Which tool is used to check voltage, ohms, and amperage in an Air Conditioning System?
    - Multi-meter.
4. Which tool is used to check refrigerant pressure in an Air Conditioning System?
    - Manifold Gauge Set.
5. What are two of the most popular ways to locate a refrigerant leak in an Air Conditioning System?
    - With an electronic leak detector
    - With leak detection soap bubbles.

6. Which is the equipment used to remove air and moisture from an Air Conditioning System?
    - Vacuum Pump

Refrigerants and their Special Properties

7. What are refrigerants?
    - They are chemical compounds that remove in a low pressure liquid state can absorb and hold heat. When the refrigerant absorbs heat, it is covered into a gas vapor. Once the refrigerant is in a gas vapor state, it can then be pressurized and squeezed to release any heat that the refrigerant compound has absorbed and the refrigerant converts back into the liquid state.
8. What are some samples of refrigerants found in Air Conditioning Systems?
    - R-22
    - R-410A
9. What happens to the refrigerant pressure when the temperature rises?
    - Pressure rises
10. What is refrigerant boiling point?
    - The temperature and pressure at which refrigerant changes from a liquid to a vapor.

The Air Conditioning System:

11. What are the 4 main parts of an Air Conditioning System?
    - Compressor
    - Condenser
    - Metering Device
    - Evaporator
12. What is the Air Handler Unit?
    - Piece of equipment inside the apartment that moves air throughout the apartment.
13. Where is the Condenser Unit located?
    - Outside the apartment
14. What connects the Air handler unit inside the apartment with the Condenser unit outside the apartment?
    - High and low pressure refrigerant lines
    - High and low voltage electrical lines.

The Refrigeration Cycle in an Air Conditioning System:

15. What is the stage of the refrigerant entering the compressor?
    - Low temperature and low pressure vapor

16. What is the stage of the refrigerant leaving the compressor?
    - High temperature and high pressure vapor
17. What is the stage of the refrigerant entering the condenser coils?
    - High temperature and high pressure vapor
18. What is the stage of the refrigerant leaving the condenser coils?
    - High temperature and high pressure sub cooled liquid
19. What is the stage of the refrigerant entering the metering device?
    - High temperature and high pressure liquid
20. What is the stage of the refrigerant leaving the metering device?
    - Low temperature and low pressure liquid
21. What is the stage of the refrigerant entering the evaporator?
    - Low temperature and low pressure liquid
22. What is the stage of the refrigerant leaving the evaporator?
    - Low temperature and low pressure superheated vapor

Key Parts of an Air Conditioning System:

23. What is the function of the compressor?
    - To pump refrigerant throughout the system, raising low temperature and low pressure vapor refrigerant to a high temperature and high pressure vapor refrigerant.
24. What is the function of the condenser?
    - To remove heat from high temperature and high pressure vapor refrigerant and condensing refrigerant to a high temperature and high pressure liquid.
25. What is the function of the metering device?
    - To regulate refrigerant flow to the evaporator, lowering its temperature and pressure to a low temperature and low pressure liquid refrigerant.
26. What is the function of the evaporator?
    - To use low temperature and low pressure liquid refrigerant to remove heat from the air traveling across the evaporator from the ambient inside the apartment.

The Superheat Method:

27. What is superheat?
    - Is the additional heat added to the refrigerant in the evaporator after it has already changed to a vapor.
28. How many degrees of superheat are expected in a system properly charged?
    - 15

The Sub-cooling Method:

29. What is sub-cooling?
    - Is the additional heat removed from the refrigerant in the condenser after it has already changed to a liquid.
30. How many degrees of sub-cooling are expected in a system properly charged?
    - 20

Recovering Refrigerant:

31. What is recovering refrigerant?
    - Is using a recovery machine or approved device to remove refrigerant from the system and place it into an approved container.

Evacuating and Dehydrating the System:

32. What is evacuating the system?
    - Removing air and moisture from inside the sealed refrigerant system and expelling it to the atmosphere with the use of a vacuum pump.

Electrical System Repairs:

33. What types of circuit are used in Air Conditioning Systems?
    - Load Circuits or High Voltage Circuits (usually 240 volts)
    - Low Voltage Circuits (usually 24 volts)
34. What type of device is used to check voltage in a system?
    - Volt Meter or a Multi-Meter
35. What is the proper way to check a thermostat?
    - Check 24 volts coming into the thermostat through the red wire
    - Check 24 volts going out to fan, cool, and heat (green, yellow, and white wires)
    - Check temperature setting for accuracy
    - Check for proper installation and that the thermostat is level.

Load Circuits: Compressors:

36. How many terminals are located in the compressor?
    - Three (Common, Start, and Run).
37. What can cause compressor not to start?
    - No power or improper voltage
    - Open winding inside the compressor or shorted out
    - Defective start capacitor or defective contactor
    - Broken wire on terminals
    - Compressor overheated

Load Circuits: Fan Motors

38. What can cause the condenser fan motor not to start?
    - No power or improper voltage
    - Open winding inside the fan motor or shorted out
    - Defective run capacitor
    - Broken wire on terminals
    - Defective contactor
    - Fan motor overheated

Air Distribution:

39. Which are the most common types of blowers used in Air Conditioning Systems?
    - Belt Drive
    - Direct Drive

40. How can you check a blower motor?
    - Check power to make sure motor is getting proper voltage
    - Turn power off and follow lock-out/tag-out procedures
    - Disconnect motor wires and check each wire for resistance with an Ohm meter
    - Disconnect capacitor and check it with an Ohm meter.

Heating Systems Maintenance and Repair Course

Skill Check #5 – Answer Key

You Are Here: Heating Maintenance and Repair

1. When is it acceptable to call a Heating Specialist?
    - When is required by local, state or federal regulations
    - When the technician does not have the proper training or information
    - When the job is too large or workload is too heavy.
    - When the technician is not certified (if refrigerant is used for heating)
    - When the equipment still under warranty.

Heating System Safety:

2. What are some of the safety precautions to be taken when working on heating systems?
    - Turn power off and follow lock-out/tag-out procedures
    - Allow plenty time for equipment to cool off
    - Use personal protective equipment to protect face, hands, and body
    - Discharge accumulated power in capacitors by shorting across the terminals
    - Take precautions to work with high temperatures
    - Have working area well ventilated to avoid breathing fumes from combustion
    - Report gas leaks to supervisor
    - Be familiar with MSDS sheets for chemicals being used
    - Keep working area and tools clean and in excellent condition
    - Follow equipment and tool manufacturers' directions properly.
    - If you smell gas do not turn any switches or electrical devices on or use the telephones, cell phones or two-way radios
    - Turn gas off and ventilate the area immediately
    - Do not bypass any safety switches or devices.

Key Tools for Heating Repairs:

3. What tool can be used to test heating element on an electric heater?
    - Multi-meter
4. What tool can be used to test presence of carbon monoxide in a gas heater?
    - Carbon Monoxide Detector.

Air Distribution:

5. What is the function of the blower in a heating system?
    - To pull filtered air from the return air plenum, force it through the heat exchanger, and distribute warm air throughout the apartment.

6. What is the function of the Fan Limit Control Switch?
    - To turn fan blower motor ON and OFF according to the preset temperature of air.

7. What problems can a clogged air filter cause?
    - Poor air circulation
    - System not heating properly
    - Heat Exchanger to overheat
    - Damage blower motor

8. What can cause blower motor not to start?
    - No power
    - Defective fan motor relay
    - Defective thermostat
    - Defective fan motor or capacitor

9. What are the different methods of heat transfer?
    - Conduction
    - Convection
    - Radiation

10. Which types of heating system are found in apartments?
    - Electric
    - Gas
    - Hydronic
    - Heat pump

Electric Furnace Heating:

11. What is the function of the heating coil?
    - To create heat by energizing heating element

12. What is the function of the sequencer relay?

- To turn ON and OFF fan motor and heating elements at the appropriate times to produce a comfortable environment at regular time intervals

13. Which are the two safety devices that turn the heating element OFF in case of a malfunction in the heating system?
    - Limit Switch and Fusible Link

14. What can cause heat not to work?
    - No power or improper voltage
    - Defective thermostat or transformer
    - Defective Sequencer Relay
    - Defective Fan Relay
    - Defective Limit Switch
    - Defective Fuse Link
    - Defective heating element

Gas Furnace Heating:

15. Which are the three elements to create combustion?
    - Fuel
    - Ignition
    - Oxygen

16. Which toxic gases are created when combustion is not fully achieved?
    - Carbon Monoxide and Aldehyde gasses

17. What is the function of the gas valve?
    - Gas valve controls the flow of gas to the furnace, turning the gas ON and OFF when is needed.

18. What is the function of the ignition system?
    - To ignite gas after it leaves the gas valve and travels to the appropriate location through the gas manifold or pilot system.

19. What is the name of the safety device that ignition systems with pilots use?
    - Thermocouple.

20. What is the function of the Flue Pipe?
    - The Flue Pipe is the vent responsible for directing the byproducts of combustion from the furnace to outside the building.

21. What can keep a pilot from staying ON?
    - Gas line to pilot is clogged up
    - Wind is turning flame OFF
    - Defective Thermocouple
    - Defective Gas Valve
    - Thermocouple is not properly seated in the flame or incorrectly installed

22. What happens when there is not enough oxygen in the heating exchanger?
    - Combustion is not fully completed, creating carbon monoxide
    - Yellow flames are created in the heat exchanger
    - Heater will not work properly and safely.

Hydronic Heating Systems:

23. How is heat created in a Hydronic System?
    - Hydronic Systems use the heat created by water heaters or boilers, sending hot water to a heat exchanger or radiator where a blower fan transfers the heat to the apartment.

24. What is the function of an Aquastat?
    - Is a temperature sensing device that turns boiler ON and OFF to keep the water at a desired temperature.

25. What is a Circulator?
    - A motor, a linkage, pump and an impeller that move water through the hydronic system.

26. How can rusty water be removed from a hydronic system?
    - Turn power OFF and follow lock-out/tag-out procedures
    - Turn drain valve OPEN until clear water comes out
    - Close drain valve and fill system up with clean water
    - Turn power back ON and test system.

Appliance Maintenance and Repair Course

Skill Check #6 – Answer Key

You Are Here: Appliance Maintenance and Repair

1. When is it acceptable to call an Appliances Specialist?
    - When is required by local, state or federal regulations
    - When the technician does not have the proper training or information
    - When the job is too large or workload is too heavy.
    - When the technician is not certified and the repair involves refrigerant
    - When the equipment still under warranty.

Appliance Safety:

2. What are some of the safety precautions to be taken when working with appliances?
    - Turn power OFF and follow lock-out/tag-out procedures
    - Allow plenty time for equipment to cool off
    - Use personal protective equipment to protect face, hands, and body
    - Discharge accumulated power in capacitors by shorting across the terminals
    - Take precautions to work with high temperatures
    - Follow proper directions for lifting heavy equipment
    - Report any unsafe conditions to your supervisor
    - Be familiar with MSDS sheets for chemicals being used
    - Keep working area and tools clean and in excellent condition
    - Follow equipment and tool manufacturers' directions properly
    - Do not bypass any safety switches or devices
    - Be careful with sharp edges on equipment.

Key Tools for Appliance Repairs:

3. What tool will be needed to check an electrical problem on an appliance?
    - A Multi-meter

4. What tool will be needed to check temperature on an appliance?
    - A Digital Thermometer.

Clothes Dryer Maintenance and Repair:

5. What are the three basic elements for a dryer to dry clothes?
    - Air, Heat, and Motion.

6. What is the main function of the Exhaust Duct?
    - To allow moisture to be transfer from the dryer to the outside of the building.

7. How is the temperature controlled inside the dryer?
    - By a thermostat located inside the dryer that senses the temperature and turns the heating element ON and OFF to maintain the desired temperature.

8. What can be the problem in a dryer that does not turn ON?
    - No power, caused by a tripped breaker or blown fuse
    - A faulty electrical cord
    - Defective start switch or motor
    - Defective internal fuse

9. What can be the problem in a dryer that runs but there is NO heat?
    - Not receiving proper voltage
    - Defective internal fuse
    - Defective heating element
    - Clogged exhaust duct
    - Defective thermostat

10. What device stops the dryer when the dryer door is opened?
    - Door Switch

11. What can be the problem in a dryer that dries clothes too hot?
    - Defective Thermostat
    - Obstruction in the exhaust vent.

Clothes Washer Maintenance and Repair:

12. What are the three basic elements for a washer to clean clothes?
    - Water, detergent, and motion

13. Which are the basic functions of a clothes washer?
    - Fill, agitate, drain, and spin

14. What is the Agitator?
    - Is the finned apparatus in the center of upright washing machines that moves back and forth or up and down to clean laundry.

15. Which are the two most common types of motors in washers?
    - Direct-Drive
    - Belt-Drive

16. What is the function of the timer switch in a washer?
    - To send power to different devices to make washer fill, agitate, drain, or spin as it goes through the cycles.

17. What can the problem be in a washer that does not turn ON?
    - No power, caused by a tripped breaker or blown fuse
    - Defective cord or wall electrical outlet
    - Defective timer or door switch

18. What can be the problem in a washer that the agitator does not work?
    - Defective agitator or agitator solenoid
    - Defective motor or transmission
    - Defective timer

19. What can be the problem in a washer that does not fill up with water?
    - Water valves are OFF
    - Clogged or kinked water hoses or filter screens
    - Defective water level switch
    - Defective timer solenoid

20. What can be the problem in a washer that shakes out of balance?
    - Washer has been overfilled with clothes
    - Machine is not level
    - Tub balance spring or bracket broken, loose or disconnected

21. What are the steps when replacing an electrical component in a washer?
    - Turn power OFF and follow lock-out/tag-out procedures
    - Check component with an Ohm meter

- Replace component with another one of the same model, capacity, voltage, and features.
- If a universal component is used, follow instructions in detail.
- Do not bypass or alter any functions or features.
- Turn power back ON and check for proper operation.

Cook-top and Oven Maintenance and Repair:

22. Which are the two most common types of cook-tops and ovens?
    - Gas and Electric

Key Parts of an Electric Range:

23. Which devices are located in the range control panel?
    - Burner switches
    - Oven thermostat
    - Clock
    - Indicator lights
    - Oven selector switch

24. What is the function of the burner switch?
    - Turn burner ON and OFF and maintain burner temperature at desired setting

25. What is the function of the oven thermostat?
    - Turn bake and broiler elements ON and OFF and maintain oven temperature at desired setting

26. What is the function of the indicator lights?
    - They are red lights that when turned ON indicate the cook-top or the oven are ON

27. What is the function of the oven selector switch?
    - To turn ON or OFF the bake or the broiler elements

28. What can the problem be in a range that does not turn ON?
    - No power, caused by a tripped breaker or blown fuse
    - Faulty cord
    - Defective wall electrical outlet
    - Defective terminal block or damaged internal wiring

29. What can the problem be in range where one burner does not work?
    - Defective burner switch
    - Defective burner
    - Faulty connection on burner terminal

30. What can the problem be in a range where the burners work, but the oven does not work?
    - Defective bake or broil element
    - Defective thermostat
    - Defective oven selector switch
    - Damaged, broken or burned wiring

31. What can the problem be in a range where the oven is overheating?
    - Defective thermostat
    - Defective door gasket
    - Defective oven selector switch

32. What are the steps when replacing an electrical component in a range?
    - Turn power OFF and follow lock-out/tag-out procedures
    - Check component with an Ohm meter
    - Replace component with another one of the same model, capacity, voltage, and features.
    - If a universal component is used, follow instructions in detail.
    - Do not bypass or alter any functions or features.
    - Turn power back ON and check for proper operation.

Common Gas Cook-Top Problems and Solutions:

33. What can be the problem with a pilot flame that does not stay ON?
    - Clogged gas line to pilot
    - Defective gas valve
    - Pilot flame adjustment screw not set properly

34. What keeps burner flames from working properly?
    - Clogged ports on burner from grease, food particles or dirt
    - Defective control switch on burner
    - Defective gas valve
    - Not enough primary air going to burner
    - Not enough gas pressure going to range

35. What is an Igniter?
    - Igniter is an electronic device that works just like a pilot but instead of gas it uses heat from an electrical spark to light the flames on a range.
36. What is the proper way to check a thermostat on an oven?
    - Inspect the oven thermostat probe for proper installation inside the oven
    - Place oven thermometer in the center of the oven
    - Turn oven ON and set temperature to 350 degrees
    - Let the oven warm until you hear the thermostat click OFF
    - Open the oven and read the thermometer and write the reading down
    - Repeat steps 4 and 5 two more times.
    - Take your three readings, add them together and divide by three
    - This final reading is the average thermostat reading.
    - If your oven temperature is too high or too low, adjust the thermostat settings located on the back of the oven knob or in some models, a set screw on the oven thermostat itself. Most have degree indicators to help you adjust the readings.
    - Re-test the oven temperature once you have adjusted it
    - If temperature difference cannot be adjusted and is more than 25 degrees off either direction, replace thermostat

Dishwasher Maintenance and Repair:

37. What are the basic cycles of a dishwasher to clean dishes?
    - Fill with hot water
    - Turn pump ON to spray hot water with internal arms/jets to clean dishes
    - Turn pump ON to drain dirty water out
    - Fill with hot water again
    - Turn pump ON to spray hot water with internal arms/jets to rinse dishes
    - Turn pump ON to drain dirty water out
    - Turn internal heater ON to dry dishes or air dry

Key Parts of a Dishwasher:

38. What are the functions of the timer in a dishwasher?
    - To send power to the different electrical components to turn them ON at different times of the filling, washing, draining, rinsing, and drying cycles.

39. What are the functions of the pump in a dishwasher?
    - To pump water to the internal arms/jets to wash dishes and to pump dirty water out of the dishwasher during the drain cycle.

Common Dishwasher Problems and Solutions:

40. What can be the problem when dishwasher does not come ON?
    - No power, caused by a tripped breaker or blown fuse
    - Defective cord or loose connections in the dishwasher electrical box
    - Defective door and/or latch switchs
    - Defective Timer
    - Defective water level switch
    - Defective pump motor

41. What are the steps when replacing an electrical component in a dishwasher?
    - Turn power OFF and follow lock-out/tag-out procedures
    - Check component with an Ohm meter
    - Replace component with another one of the same model, capacity, voltage, and features.
    - If a universal component is used, follow instructions in detail.
    - Do not bypass or alter any functions or features.
    - Turn power back ON and check for proper operation.

42. What can the problem be when there is water standing inside the dishwasher?
    - Clogged drain line or clogged garbage disposal
    - Kinked drain hose
    - Defective pump
    - Defective timer switch
    - Defective drain solenoid
    - Disposals drain plug for the dishwasher connection was not removed during disposal installation

43. What can cause water not to be hot enough in a dishwasher?
    - Cold water line connected to dishwasher
    - Water heater not working properly in the apartment
    - Defective heating element in dishwasher
    - Defective timer switch.
    - Due to pipe run and/or design, cold water sitting in the hot water pipe.

44. What can be the problem when dishes have spots on them?
    - Dishes not placed inside dishwasher correctly
    - Proper detergent not being used
    - Dirty water not draining properly

- Water amount or quality not sufficient
- Water temperature not hot enough

45. What can cause a dishwasher to leak water?
    - Proper detergent not being used
    - Defective door gasket
    - Water supply line connections are loose or water line is damaged
    - Drain hose damaged
    - Defective water level switch
    - Defective timer
    - Defective pump or motor seal

46. What can be the problem if NO water is going to the dishwasher?
    - Water is turned OFF
    - Inlet Valve clogged
    - Defective inlet valve
    - Defective timer
    - Defective water level switch
    - Defective door and/or latch switch(s)

47. What can cause dishes not to be dry enough?
    - Defective selector switch for air/heat dry setting
    - Defective heating element
    - Defective timer
    - Water not draining properly

Refrigerator Maintenance and Repair:

48. How does a refrigerator keep food cool?
    - Basically a refrigerator works much like an air conditioner, removes heat from an enclosed space with the use of refrigerant traveling to an evaporator and absorbing heat from the air and transporting this heat to the outside of the refrigerator.

49. What are the main components of a refrigerator?
    - Compressor
    - Condenser coils
    - Expansion device
    - Evaporator coils
    - Refrigerant

50. What is the main function of the compressor?
    - To pump refrigerant around the system and increase the temperature and pressure of the vapor refrigerant as it passes through its valves.

51. What is the main function of the condenser coils?
    - To remove heat from the high temperature/pressure vapor refrigerant and condense it to a high temperature/pressure liquid.

52. What is the main function of the expansion device?
    - To regulate flow of refrigerant entering the evaporator and lower its temperature and pressure to a low temperature/pressure liquid.

53. What is the main function of the evaporator?
    - To take the low temperature/pressure liquid refrigerant through a coil and absorb the heat in the air traveling across the coil, lowering the temperature inside the refrigerator.

Refrigerator Problems and Solutions:

54. What can cause refrigerator not to come ON?
    - No power, caused by a tripped breaker or fuse
    - Defective cord or wall electrical outlet
    - Defective defrost timer
    - Defective thermostat
    - Defective compressor or start relay

55. What can the problem be when refrigerator is ON but does not cool?
    - Defective thermostat
    - Defective compressor
    - Defective defrost timer
    - Low refrigerant pressure
    - Defective door gasket
    - Dirty coils
    - Blocked air circulation
    - Evaporator coils covered in ice

56. What causes refrigerator door to sweat?
    - Refrigerator overloaded with food
    - Damaged door gasket

- Defective defrost timer
- Defective mullion or case heater
- Oversized light bulb or defective light switch

57. What is the problem in a refrigerator that is freezing up?
    - Defective defrost heater
    - Defective defrost timer
    - Defective thermostat.
    - Defective evaporator fan

58. What causes water inside the bottom of the refrigerator?
    - Clogged drain cup or line
    - Door left open or constantly being open and close, creating condensation
    - Damaged door gasket
    - Defective defrost timer.

59. What can be the problem when ice maker is not working?
    - Clogged or dirty coils
    - Water turned OFF to the ice maker
    - Kinked water line
    - Freezer temperature not cold enough. 0° F to 8° F required.
    - Defective fill valve
    - Defective ice maker.

60. What are the steps when replacing an electrical component in a refrigerator?
    - Turn power OFF and follow lock-out/tag-out procedures
    - Check component with an Ohm meter
    - Replace component with another one of the same model, capacity, voltage, and features.
    - If a universal component is used, follow instructions in detail.
    - Do not bypass or alter any functions or features.
    - Turn power back ON and check for proper operation.

Inside the Apartment Business

Skill Check #7—Answer Key

You are Here: Maintaining the Community—Requested Maintenance

1. Who is responsible for curb appeal?
    - All members of the apartment community team including property managers, leasing consultants, and maintenance technicians.

2. What does curb appeal include?
    - Curb appeal includes the general appearance and condition of:
        - Signs and other advertising
        - Landscaping and grounds, fencing and lighting
        - Driveways, streets, parking lots, sidewalks, and breezeways
        - Building interiors, exteriors, and hallways
        - Amenities such as swimming pools and laundry rooms
        - Offices, other common use areas, model apartments, and vacant apartments

3. How do you ensure that the apartment community has a good appearance?
    - Find out if the community has a curb appeal or a grounds checklist, and if it does, make sure to use it.

4. What happens if a resident asks for maintenance as a personal favor?
    - Most apartment community or management companies have a policy on whether or not this is allowed. Review this policy before proceeding. If personal favors are allowed, be sure to keep a record of your work.

5. Why are service requests used?

    - To maintain a written record of all technical service that is performed for the following reasons.
        - Record how residents' needs were met and when they were met.
        - To track potential or actual maintenance problems.
        - To guide preventive maintenance efforts.
        - To guide budget planning and implementation for the community.
        - To demonstrate that the apartment community team has not discriminated in providing service to residents. Discrimination may be evidenced by delayed response or incomplete response.
        - To document and verify that they had permission to enter the unit.

6. What information is included on a service request?

    - Resident name and address
    - Date and time of request
    - Repair or maintenance required
    - Permission to enter
    - Name of service technician assigned
    - Description of work completed
    - Follow-up needed
    - Post inspection
    - Action taken: pre-inspection/work completed/repaired temporarily/parts replaced/parts reordered
    - Estimate of cost incurred
    - Amount of time spent for service/repair (time in and time out)
    - Follow-up call with resident or post-inspection

7. What happens if service requests can't be accommodated right away?
    - If a request has to be delayed for any reason:
        - Make sure the resident is notified
        - Write the reason for the delay on the form (i.e. parts on order)
        - Don't "save" the requests for some unscheduled future date
        - Make sure you don't lose requests
        - Place part (if needed) on your supply order sheet

Preventative Maintenance

8. How often does preventive maintenance need to be done?
    - Preventive maintenance must be repeated on a regular basis in order to preserve physical assets and avoid potential accidents and injuries. Some preventative maintenance is scheduled and monthly.

9. Why does preventative maintenance need to be done?
    - To preserve the physical assets that belong to the apartment community including: buildings, grounds, and equipment.
    - To provide reasonable protection for the personal safety of residents, guests, and members of the apartment community team.

Make-Ready Maintenance

10. What is "lost rent"?

    - Lost rent refers to rent that is not received each day that an apartment is not leased.

11. What are some tips and guidelines for safety during the make-ready process?

- Follow the community's or management company's policy on what personal protective equipment to wear when inspecting a vacant apartment or making it ready for the next resident.
- Wear disposable gloves and other personal protective equipment when a vacant apartment is especially dirty.
- Never reach into a space that can't be seen into. Sharp objects can pierce gloves.
- Review the area to ensure that there is no bodily fluid substances. If there is, mark the area in case anyone else should be nearby and report.
- Do not remove any potential safety hazard that may contain a bodily fluid substance until you have been trained to do so.
- Use common sense and ask your supervisor if you aren't sure.
- Use the proper tool for the job.
- Do not mix chemicals and study the MSDS sheets for the chemicals you do use.

Unscheduled Maintenance

12. What is considered to be an emergency?
    - Some examples of apartment community maintenance emergencies are:
        - anything that can cause harm to a person or the property
        - bad leak in a water pipe
        - severe weather such as a flood, hurricane, or a tornado
        - chemical spill
        - fire
        - gas leak
        - major equipment/system breakdown
        - electrical problems or something shocked a person
        - broken pool gate
        - plumbing system back-up

Scheduled Replacement

13. What is OSHA?
    - OSHA is a federal agency established by Congress to create and enforce standards and guidelines to improve on-the-job safety and health.
    - OSHA regulations require employers to provide training to ensure that employees understand the possible hazards of their job and how to protect themselves and others.
    - Employers are also required to provide employees with the proper safety equipment.

Protection from Workplace Hazards

14. What is a physical hazard and what are some potentially hazardous materials?
    - A physical hazard is an object that could cause injury, illness, or death through external contact with the body and can include:
        - sharp tools
        - heavy pieces of equipment
        - metal edges on appliance or equipment
        - slippery floors

    - A potentially hazardous material is a substance that could possibly cause injury, illness, or death by entering the body and can include:
        - electricity
        - body fluids (such as blood and other bodily substances)
        - chemicals (such as cleaning products, paints, and pesticides)
        - gases and airborne particles of matter (such as refrigerants, chlorine gas, and asbestos)

15. What is Personal Protective Equipment (PPE)?
    - PPE refers to special clothing and equipment that people wear to protect them from workplace hazards and protects from both physical hazards and potentially hazardous materials.
    - PPE includes wearing proper clothing to protect arms, legs, feet and body – without catching on an object or piece of equipment, little or no jewelry (including chains, earrings, and rings) to avoid getting caught on something or conducting electricity.

Compliance Matters

16. What is the federal Fair Housing law?
    - Federal Fair Housing laws state that it is illegal to discriminate against any person because of:
        - race
        - color
        - religion
        - sex
        - handicap
        - familial status
        - national origin
    - These laws apply to residents, their guests, and prospective residents and to what you say and what you do.
    - In addition to the federal fair housing laws protecting the classes of people listed above, there may be state and local laws that protect additional classes of people such as:
        - sexual orientation

- military residents
- students
- public housing clients

17. What is discrimination?
    - Discrimination is defined as unfair treatment of a person or group on the basis of prejudice. Illegal discrimination occurs when the choice results in treating certain unfairly.

18. What is a disability?
    - A disability is defined as a physical or mental condition that substantially limits one or more of a person's major life activities, such as caring for one's self, performing manual tasks, walking, seeing, hearing, speaking, breathing, learning and working.
        - A record of having such a disability, meaning that there is documentation somewhere about the condition.
        - Examples of disabilities include hearing, movement, and vision impairments; chronic alcoholism; chronic mental illness; AIDS; AIDS Related Complex; and mental retardation.

19. What is the difference between accommodations and modifications and what are some examples?
    - A "reasonable accommodation" is a change in the policy or practices of the property owner or apartment management that is designed to allow full enjoyment or access to an apartment and/or common areas. Reasonable accommodations must be made at all stages of the housing process, from application to tenancy to preventing eviction. Allowing a service animal in an apartment that has a "no pet" policy is an example of an accommodation one might make.
    - A "reasonable modification" is a structural modification that is made to allow persons with disabilities the full enjoyment of the housing and related facilities. Examples of modifications are the addition of a wheelchair ramp or the adjustment of a light switch. Reasonable modifications are generally made at the resident's expense.

20. What are some examples of accommodations?
    - An accommodation is any exception to the rules, policies, practices, or services of an apartment community that is needed for someone with a disability. For example, a building with a "no pets" policy must allow a visually impaired resident to keep a guide dog.

21. What are some examples of modifications?

- A modification is a physical change to the resident's apartment home or to the common use areas and can include the installation of grab bars in a shower and lowering thermostats or light switches.

22. What is the EPA?
    - The Environmental Protection Agency (EPA) is responsible for the establishment and enforcement of environmental protection standards.

People, Profits & Projects

Skill Check #8—Answer Key

You Are Here: People, Profits and Projects

1. What happens when there is a pet in an apartment in which you need to work?
    - In order to avoid any safety hazards, wait to complete the service request until the resident is home or until the animal is safely contained. Animals can pose a potential risk. You should make note of the date and time you first attempted to enter the apartment and notify management of the situation.

2. What happens when you are unable to complete work in an apartment?
    - Notify management and the resident that the work was not completed and explain why. Let them know when it will be completed.

3. How do you figure out when to replace something or just fixing it?
    - Determine the cost of repairing something versus fixing it. Consider the age, the frequency of problems, and the time and cost of repairs. For example, since it is almost as expensive to repair the motor on a garbage disposal as it is to replace the disposal, it makes more sense to buy a new disposal than to repair the disposal's motor.

4. What are some tips for working with contractors?
    - Be courteous and treat them with respect.
    - Be clear about the work that needs to be done.
    - Keep them informed of any schedule changes and keep track of their progress.

5. How should contractor invoices be handled?
    - When the invoice is received, check the work to ensure that it meets the standards set by the apartment management company. Once the work has been inspected and deemed satisfactory, give the invoice to your supervisor or the appropriate person in your management office.

6. How do you inspect a contractor's work?
    - Review the contractors work to ensure that it has first met the apartment community's standards and also completes all assigned tasks.
    - Review and match the written scope of the project and materials to the completed job.

7. What is the best way to prioritize work?
    - Most communities follow “first come, first served” as a general rule, with the exception of emergency maintenance which needs to be completed immediately.

The Future of HVAC

Skill Check #9—Answer Key

You Are Here: The Future of HVAC

1. Will technicians need to be re-trained to work around the new R-410a refrigerants and equipment?

- Yes. Without any question! HFC-410a systems are totally unique in many ways. The oils used are very different and require special safety and handling procedures. The system pressures are totally different and charging a system must be accomplished in a very special way.

2. If you are already EPA certified in Section 608, are you required by federal law to get re-certified to work with the new R-410a refrigerant?

- No. Not by federal law. The *EPA* as of this date has not amended to the rules of Section 608 that would require us to go back and get re-certified. The *EPA* often makes changes to the regulations and does require the technician to keep-up with any changes they make.

3. If you only work on R-410a systems, would you need to get EPA Section 608 certified?

- No. Not by federal law. The *EPA* mandates that technicians should be certified in the use and proper handling of refrigerants that are depleting to the ozone layer. HFC refrigerants do not deplete the ozone layer thus you are not required to get *EPA* Section 608 certified to work on these units or to buy HFC refrigerants. (Check your *state laws as some states do require 608 certification to purchase refrigerants and equipment))*

4. Since you are not required to be EPA certified, do you have to follow EPA Section 608 rules and regulations about recovering, venting and working with refrigerants.

- Yes. Everyone in the U.S. must always follow all regulations of the Clean Air Act even though you're not required to become certified. A technician still must follow all the proper service practices including recovery, reclamation and venting.

5. HFC-410a refrigerants do not deplete the ozone layer but it does have a higher "Global Warming Potential" than R-22. True or False?

- True. HFC-410a does not contain chlorine and does not deplete our stratospheric ozone layer but HFC-410a *does* have a slightly higher Global Warming Potential (*GWP*) than R-22 but when you factor in the energy savings that you get from such an efficient air conditioner, the "Total Equivalent Warming Impact (*TEWI*) is much less than R-22 units.

6. Does the newer R-410a equipment use the same type and size of metering devices as existing R-22 systems?

- No. HFC-410a will be using its own size and specially made line of metering devices designed for use with HFC-410a refrigerants only.

7. Which metering device should you look for when buying R-410a equipment?

- Usually, evaporators made with the *TXV* would be more expensive and work better over a range of applications and different loads. But due to the increase in equipment prices, many manufacturers are sticking to the fixed-orifice and capillary-tube type devices to keep costs down for us. The fixed-orifice and capillary-tube type HFC-410a systems will work just fine in apartments as long as the system is installed, maintained and serviced properly.

  ** It really just depends on the manufacturer as to which design models will use what type of devices and how much money you are willing to spend for better equipment.

8. What exactly is HFC-410a?

- HFC-410a is a binary (*two-part*) near-azeotropic refrigerant. It contains R-32, R-125 refrigerants. Its mix consists of (*50- 50 wt%*). R-32 is difluoromethane, (*CF2H2*) and R-125 is pentafluoroethane, (*C2F5H*). HFC-410A has shown to have a 5-6% higher Energy Efficiency Rating (EER) than R-22 refrigerant.

9. What is HFC-410a called if you buy it at the supply house?

- It may be labeled R-410a, Suva 9000®, Puron®, Suva 410A®, Genetron AZ20®, Forane 410A® or Klea 66®. It’s all the same, it’s just named differently by the different manufacturers.

10. What is the date manufactures must quit making R-22 split-system equipment?

- January 1, 2010

11. When leak testing an R-410a system, what methods do you use to find leaks?

- An "*HFC specific*" leak detector. You can still use soap bubbles and even pressurize the system with dry nitrogen.

12. What is the maximum amount of nitrogen pressure you can apply to an HFC-410a system?

- Read your manufacturers nameplate on the equipment itself. It will have a high and low-side test pressure stamped on the plate. Never exceed the low-side test pressure value.
- It is recommended that if the stamped value is unknown, never exceed 150 psig.

13. When leak testing a R-410a system, can you just use compressed air?

- *No*. Never use any type of compressed air or oxygen inside of a refrigerant system. This could be very dangerous and can cause an explosion that can severely injure or kill someone. Putting air or oxygen in a HFC-410a system that is pressurized above one atmosphere (14.7 psig), may cause a severe reaction that could result in an explosion. The dangers of explosion are even greater with the new HFC-410a units.

14. What size and type of vacuum pump should you use with R-410a systems?

- Use a standard two-stage vacuum pump that is capable of achieving a 500 micron vacuum. The larger in size (horsepower) the pump, of course the faster results.

15. Are you required by law to have a dedicated vacuum pump for use with R-410a systems?

- No. As long as you thoroughly clean-up the vacuum pump and change the oil, you can use the same vacuum pump for both R-22 and R-410a systems.
- Most technicians *should* used a vacuum pump dedicated to HFC-410a to save time and the expense of cleaning up the pump and changing out the oil between applications.
- It would be cheaper in the long run to purchase a dedicated vacuum pump for HFC-410a.

16. Do R-410a systems use the same copper line brazing methods as used on R-22 systems?

- Yes. The only problem is, 97% of all technicians working in the field today are doing it all wrong anyway to begin with. In the field, we find technicians slapping a copper fitting or drier on a copper refrigerant line and then just brazing them together. In reality, technicians should be using a pressure of 2 or 3 psi of dry nitrogen gas though the lines when brazing

them to prevent oxidation on the interior of the refrigerant lines.

- ** Preventing oxidation in HFC systems is more important than for older R-22 systems.

17. Why is it important to use the proper copper line brazing methods?

- Not using 2-3 psi of dry nitrogen though the lines when you are brazing will cause billions of tiny flakes of carbon to fall off of the copper piping. These carbon bits then circulate with the refrigerant and oil throughout the entire system. When these bits of carbon go though the metering device, they can block the entrance and lead to reduced cooling and even start contaminating the oil enough to cause salts to form.

18. What type of solder do you use on R-410a systems?

- HFC-410a and R-22 systems are not soldered. They are brazed using Mapp® gas or acetylene using 5% or 15% sil-phos® silver brazing rods.

19. What type of safety rating does R-410a refrigerant have?

- HFC-410a is rated as a A1. It's a fairly safe refrigerant. All tests have concluded that R-410A can be handled safely when the proper personal protection equipment (*PPE*) is used and when appropriate safety guidelines are followed.

20. What would happen if you breathed R-410a refrigerant?

- No refrigerant made should ever be inhaled. HFC-410a would make you dizzy, you would have slurred speech. If you breathed enough of it you would die of oxygen deprivation. (*Asphyxia*)

21. What type of safety equipment (PPE) should you use when working with R-410a refrigerant and equipment?

- R-410a will require the use of gloves and goggles if working in open areas. Respirators and refrigerant sensor alarms would be required in equipment rooms.

- The Polyol Esters oil used with HFC-410a is very irritating to your skin and can cause a burning sensation. The Polyol Esters can also damage rubber roofing materials.

22. Are R-410a compressors the same as used in R-22 equipment?

- No. All the manufacturers are using newly redesigned compressors that have much thicker walls than the compressors used in vapor/compression R-22 equipment.

- You should never try to use any R-22 compressors, driers or equipment with HFC-410a

systems.

23. Is it ok to "*Mix and Match*" evaporator and condenser SEER or tonnage rating?

- According to the Department of Energy, all central air conditioning systems sold and installed in the United States, must be certified that they meet federal efficiency, capacity and several other standards.
- *DOE* has suggested that anyone who installs uncertified "*mix and matched*" systems (*condensing units and evaporators*) might be someone who has violated the law by selling or installing uncertified units. *DOE* is most interested in keeping manufactures and installers from "*mix and matching*" units. *(Many states also prohibit installing mix and matched systems).*

24. Can R-410a refrigerant be retrofitted or put into existing R-22 systems?

- No. It would be extremely dangerous to attempt. HFC-410a operates at a much higher pressure than R-22 equipment can handle and it would be a potential hazard that could injure or kill someone. ** Never put HFC-410a into an R-22 system.

25. Can R-410a condensing units be installed on existing R-22 evaporators?

- No. HFC-410a needs its own special coil design, metering devices, driers and oil.
- In some very rare instances, it perhaps may be possible to perform a retrofit on some very newly installed evaporators (*2006 models forward*) that are rated at 235 psi and stamped for use with R-22 or R-410a refrigerant, but for the majority, it will be impossible to retrofit any R-22 system to work with R-410a.

26. Can R-410a evaporator units be installed on existing R-22 condensing units?

- No. The R-22 compressor and condenser unit coils are not made to withstand the pressures of HFC-410a and it should *never* be attempted.
- Use systems labeled for use with R-410a.

27. You need to replace an existing R-22 system with a new R-410a system; can you use the same copper refrigerant lines?

- Sometimes. One of the most important things to think about when replacing an entire R-22 system and retrofitting to a new HFC-410a system *will* be the copper refrigerant lines.
- Most HFC systems will require a much larger suction and liquid lines than would be installed on existing R-22 systems. If your existing lines are the correct diameter and wall

thickness as required for your new R-410a system, you of course do not have to install new lines as long as you clean them up properly.

28. When you replace an older R-22 system with a newer R-410a system, would the diameter of the copper refrigerant lines be the same for one, two and three story apartment building installations?

- Probably not. Refrigerant line diameter will be determined by how many feet of liquid and suction-line you have between the evaporator and condenser. The longer the distance, the larger in diameter the lines need to be. You will have to read your manufacturers installation guide to find this information.

29. What happens if you install a new R-410a system on undersized refrigerant lines?

- You will have a decreased efficiency and loss of capacity. The liquid would back-up into the condenser and your evaporator will be starved for refrigerant. It will shorten the life of the system as the compressor will be damaged from the loss of refrigerant and oil flowing though it dissipating the heat of compression.
- Plus, your unit will not achieve the proper *SEER* ratings as stamped on the system.

30. How do you clean existing R-22 copper lines to use with an R-410a system?

- On small residential systems, using flushes of dry nitrogen should get rid of the traces of contamination, mineral or alkyl benzene oils in the lines.

31. What type of oil does HFC-410a use?

- Oils used with R-410a are Polyol Esters (*POE*) oils. There are many different *POE* oils used in refrigeration so make sure that you buy the correct *POE* oil according to the compressors manufacturer. All *POE* oils are not the same!

32. Can alkyl benzene and mineral oils mix with the newer Polyol Esters oils?

- Not really. They do say that when replacing a mineral or alkyl benzene based oil you *could* leave 1- 5% of the old oil in the system. However, best service practices say remove all you can.
- You should never mix Polyol Esters oils with any other oils including other Polyol Esters.

33. Does R-410a have the same operational pressure gauge readings as R-22 systems?

- Not even close. R-410a systems operate at much higher pressures and temperatures as

compared to R-22 systems. R-22 low-side may be 68 psig and the R-410a system would be closer to 130 psig. R-410a high-side pressure may be around 418 psig as compared to R-22 with a 260 psig pressure reading.

34. How much higher are the pressures of R-410a equipment compared to R-22 systems?

- The pressures of R-410a equipment are about 40 to 70% higher than current R-22 systems.

35. Will an R-410a high-side outlet at the compressor be hotter than in an R-22 system?

- No. R-22 systems usually have around 230 (+ -) degrees Fahrenheit normal temperature and up to 400 degrees Fahrenheit if the condenser is dirty or on a hot day with a high heat load. A system containing R-410a refrigerant will have a *slightly* lower temperature at the compressor outlet but it will have higher compressor efficiency.

36. What type pressure switches are required for R-410a equipment?

- R-410a low pressure cut-out is set at 50 psig and the high pressure cut-out is set at 600 psig. The resetting for the high pressure switch is usually around 500 psig.

37. What type of compressor IPR`s are required for R-410a equipment?

- The HFC-410a compressors Internal Pressure Relief (*IPR*) is around 550-625 psig compared to R-22 at 375-450.

38. Is the superheat calculated the same for R-410a and for R-22 equipment?

- Yes. HFC-410a units will be charged with the same type of superheat method but using its own superheat charging chart usually posted with the schematic.

39. Is the sub cooling calculated the same for R-410a and for R-22 equipment?

- Yes. HFC-410a units will be charged with the same type of sub cooling method but using its own sub cooling charging chart usually posted with the schematic.

40. What is the color of R-410a cylinders?

- The cylinder color for R-410a is rose/pink. (*light reddish-pink*)

41. What temperature range must you keep HFC-410a cylinders within?

- The cylinder should never be warmed with a temperature higher than 90 degrees. Never heat the cylinder with a flame source. Do not allow the cylinder to reach temperature more

than 125 degrees Fahrenheit during transport, storage or use.

- Cylinders should never be stored inside a vehicle. You can store HFC-410a cylinders in the back of your truck provided they are upright and chained and never exceed 125 degrees. HFC-410A at 125 degrees exerts a cylinder pressure of 450 psig.

42. If you need to "*top-off*" a system containing R-410a, is there anything special that you need to do?

- Yes. HFC-410a equipment can be "*topped-off*" but it cannot be accomplished using the same method of charging as we currently do with R-22 systems.
- R-410a systems need to be topped off though the suction line and it must be throttled-in as a liquid using a special throttling device.

43. R-410a refrigerant does fractionate, do you have to worry about this when charging a system?

- Not really. HFC-410a is a near-azeotropic mixture and *must* be throttled-in the system as a liquid every time you install or repair an HFC-410a system.
- HFC-410a is really very close to an azeotropic since it only has a 0.3 or less degree of fractionation. This amount is so small, fractionation will not matter in the slightest as long as the initial charge and "*top-off*" charge is applied properly.

44. If an R-410a refrigerant system has a leak, do you need to worry about fractionation and it ruining the complete refrigerant charge?

- Not really. HFC-410a, it's so close to an azeotropic refrigerant that even a leaky system will not separate the refrigerants enough to impact its ability to do work. However, the refrigerant *must* always be throttled-in the system as a liquid or it *may* fractionate.

45. You have a 3- ton R-410a refrigerant system that leaks all the time. Are you required by law to fix this leak?

- No. You are not required by federal law to fix leaks in small equipment that contain 50 or less pounds of refrigerant.
- Your company most likely would prefer you to fix leaking units because refrigerants are starting to get expensive and it costs your company money in time and labor every time you have to go recharge a leaking system .Plus, a system that has a leak can be damaged mechanically or you can destroy the refrigerant and oil.

46. Do you have to keep records on R-410a refrigerant systems?

- No. The *EPA* only requires record logs kept on *EPA* Section 608 systems that contain over 50 pounds of refrigerant.
- The smaller spit-systems we work on only hold about 3-pounds of refrigerant per ton of cooling. A five-ton air conditioner would only contain about 15 pounds of refrigerant.

47. Does R-410a use the same pressure/temperature chart as R-22 refrigerant does?

- No. HFC-410a refrigerant uses its own pressure/temperature chart but it's read exactly like the "*type*" charts you would use for R-22 systems.

48. Does R-410a systems use the same driers as are used on R-22 systems?

- No. HFC-410a equipment requires special thick walled driers that must be used.
- Using R-22 driers on HFC-410a systems would create an extreme hazard. It may explode immediately injuring the technician or explode later on injuring someone unaware and just walking by.
- Driers are required to be rated at 600 psig for use with HFC-410a systems.

49. Are HFC-410a driers replaced the same way R-22 driers are?

- Yes. R-410a driers must be removed from the system using a pipe cutter. You should never use a torch to heat and remove driers to prevent moisture from contaminating the system. If you remove a drier with a torch, you will be converting all moisture that was captured by that drier to a gas vapor that will enter the refrigerant piping and system.

50. Where is the liquid-line drier on the R-410a system?

- The liquid-line drier is located on the inside of the condenser unit. This drier needs to be replaced each and every time the system is opened to the atmosphere.
- Never add an additional liquid line drier to the exterior of the condenser if the unit has a drier located inside the cabinet.

51. What type of recovery cylinder is required for R-410a equipment?

- Recovery cylinders must be *DOT* stamped with 4BA400 or 4BW400 to be used with R-10a. Never use standard *DOT* recovery or storage cylinders rated at 300 psig.

52. What type of recovery device is required for R-410a?

- A dedicated recovery devices just need to be rated for use with HFC-410a refrigerants.

53. What rating should R-410a manifold service gauges have?

- Gauges used with R-410A are required to have a high-side service rating of 800 psig. The low-side is required to have a rating of 250 psig with a 550 psig low-side retard. The manifold gauge hoses used for R-410a are required to have a service rating of 800 psig.
- Hoses used with HFC-410a equipment are required to have a rating of 800 psig.

54. Does over-charging the HFC-410a system effect operation?

- Yes. A system with a fixed-bore or capillary-tube metering device will have excess refrigerant in both the evaporator and condenser. As a result, both the high and low-side system pressures will be higher. The *sub cooling* will be higher and the *superheat* will be lower because the refrigerant vapor will not have gained very much sensible heat.
- A system with a *TXV* metering device will have a flooded condenser along with higher than normal high-side pressure and a high sub cooling reading. However, since the *TXV* is a constant superheat device, you can expect to see suction pressure and superheat operating in the normal range.

55. Does under-charging the HFC-410a systems effect operation?

- Yes. It will *not* operate as efficiently, it will *not* perform to its stamped ratings and the equipment could be damaged. The compressor relies on the flow of refrigerant and oil through the system to help dissipate the heat of compression. Without a fully charged system, this heat cannot be carried away and the compressor will overheat. Undercharging causes too much flash gas to enter the metering device which causes low evaporator temperatures, excessive superheat, and an evaporator starved for refrigerant. It will also cause higher compression ratios and loss of cooling capacity.

56. What types of compressors are used in HFC-410a systems?

- The choice of manufacturers appears to be the scroll compressor for use with HFC-410a systems. They seem to be more efficient and highly durable. Many "*high-end*" residential central heat pumps and standard split-system R-22 air conditioners already employ a scroll compressor instead of the standard rotary, reciprocating, and wobble-plate compressors traditionally used.