

Competency Requirements –2009

Certified Appliance Professional (C.A.P.)

Major Appliance Service Technician

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Core Knowledge

1.0 Basic Electrical Skills

- 1.1 Explain the difference between matter and energy and their relationship.
- 1.2 Demonstrate an understanding of positive and negative charges.
- 1.3 Describe atoms, electrons, and electron flow.
- 1.4 List examples of magnetism, magnetic forces and the effect of magnetic forces on electrons.
- 1.5 Solve math problems involving voltage, current and resistance.
- 1.6 List various methods to create voltage and how resistance affects the flow of current.
- 1.7 Compare battery types and list benefits of each.
- 1.8 Compare direct and alternating current.
- 1.9 Calculate circuit values using Ohm's Law and Kirchoff's Law.
- 1.10 Describe the difference between series, parallel, and combination circuits.
- 1.11 Compare fuses, fuse types, and circuit breakers.
- 1.12 Describe voltage and power transmission and how the average home is wired.
- 1.13 Compare wire sizes and their relationship to current carrying capabilities.
- 1.14 Describe proper house wiring and how an improper power supply affects the operation of devices (i.e. motors, solenoids, warp switches, etc.).
- 1.15 Properly splice wires, attach wire terminals, and make other connections.
- 1.16 Explain how utility companies bill for power consumed.
- 1.17 Explain the difference between capacitance and induction.
- 1.18 Draw a circuit of a basic DC power supply.
- 1.19 Describe voltage rectification and current filtration
- 1.20 Identify various types of switches and other circuit control devices.
- 1.21 Compare electronic components and how they are used to replace switches and other circuit control devices (triacs/diacs/transistors/diodes).
- 1.22 Compare electromagnetic devices, including transformers, motors, and solenoids.
- 1.23 Identify the various types of motors, motor starting, and motor protection devices.
- 1.24 Describe "black box" electronic devices and how inputs and outputs can be used to diagnose most electronic control boards.
- 1.25 Read and understand electrical diagrams and schematics.
- 1.26 Demonstrate the use of schematic and ladder diagrams to diagnosis circuit problems.

2.0 Basic Mechanics

- 2.1 Describe Gravity/Elasticity/Pneumatics/Hydraulics.
- 2.2 Describe the use of Bearings, Seals and Drive couplings.
- 2.3 Explain the differences of universal joints, linkages and levers mechanisms, and cam assemblies.
- 2.4 Recognize various hinges/ latches/fastening devices and their uses.
- 2.5 Describe the use of a Counter Balance.
- 2.6 Compare various drive systems including belt, direct, gear, and variable speed.
- 2.7 Describe the use of a Flywheel application.
- 2.8 Explain the use of Clutches/Brakes/ Transmissions.
- 2.9 Describe Torque.
- 2.10 Describe the use of drums bearings, drum rollers and glides.
- 2.11 Demonstrate an understanding of heat, heat transfer, and explain how heat is measured.
- 2.12 Compare British Thermal Units, calories, sensible and latent heat.

3.0 Appliance Tools and Equipment

- 3.1 Demonstrate the use of basic hand tools.
- 3.2 Properly use a multi-meter, am-meter, and other test equipment in the diagnosis of electrical circuits problems.
- 3.3 Differentiate between shorted, open, and non-functioning circuits.
- 3.4 Demonstrate the use of soldering techniques and recognize an improper solder joint.
- 3.5 Demonstrate the use of basic diagnostic principles.
- 3.6 Accurately localize circuit faults to an individual component(s), replace the faulty component(s), and retest the circuits to insure fault is corrected.
- 3.7 Describe various types of thermometers (Laser, Digital and Mercury) used in the servicing of appliances.
- 3.8 Describe the purpose of a Wattmeter.
- 3.9 Explain the use of leak detection devices for CO and combustible gases.
- 3.10 Describe the use of a manometer.
- 3.11 Describe the use of refrigeration tools including gauges, leak detectors, vacuum pump, psychrometer, recovery pump, and recovery storage principles.
- 3.12 Explain the safety procedures in transporting, storage and use of a torch in the repair of appliances.
- 3.13 Bend copper and aluminum tubing.
- 3.14 Cut tubing and pipes with hacksaws or tubing cutter.
- 3.15 Braze tubing.
- 3.16 Cut to size and join plastic (PVC) pipe.

4.0 Appliance Handling and Servicing Practices

- 4.1 Explain proper lifting techniques.
- 4.2 Describe floor protection when moving an appliance for service.
- 4.3 Explain the proper procedures to be followed in removing built-in appliances for service.
- 4.4 Describe the proper use of an appliance hand truck when moving an appliance up and down stairs including safety procedures.
- 4.5 List the precautions that must be taken to protect appliances before moving occurs.
- 4.6 Describe various laws governing appliance disposal. (Freon removal, door removal, etc.)
- 4.7 Describe proper disposal procedures for mercury, refrigerants, batteries, chemicals and oils.

5.0 Safety

- 5.1 Explain the purpose of using Safety Belts.
- 5.2 Describe different types of Ladders and safety procedures in the use of each type.
- 5.3 Explain the need for Grounding (human).
- 5.4 Describe the use of different types of Fire extinguishers.
- 5.5 Explain Spontaneous Combustion.
- 5.6 Describe Current Leakage.
- 5.7 Describe Vehicle/Work area safety procedures.
- 5.8 Describe DOT and EPA regulations that impact transportation and proper handling of chemicals such as refrigerants, acetylene, nitrogen, etc..
- 5.9 Describe Personal Safety and Work Practices (Using insulated tools, protective clothing.).
- 5.10 Describe safety procedures to be utilized when using Pressurized Fluids.
- 5.11 Describe proper Cylinder Handling/Transportation in service vehicle.
- 5.12 Describe the need for pressure Regulators.
- 5.13 Explain the use of Cleaning Chemicals/MSDS.
- 5.14 Recognize safety Markings (i.e. tag outs, warning signs, MSDS, OSHA requirements).
- 5.15 Describe the use of available safety equipment such as ventilators, fire extinguishers, gloves, etc..
- 5.16 Describe the use of Shut-off devices (Circuit Breakers, gas and water valves, etc.).
- 5.17 Explain safe Protection against High Voltage.

6.0 Basics of house wiring

- 6.1 Explain Power Transmission.
- 6.2 Draw a basic House wiring diagram including distribution panels and circuit breakers sizes.
- 6.3 Explain the use of Wire sizes, circuit design, switching devices, receptacles and lighting circuits.

- 6.4 Describe Grounding requirements and personal electrical safety.
- 6.5 Describe a Ground Fault Circuit Interrupter, (GFCI's).
- 6.6 Explain the need for National Electric Codes.
- 6.7 Know when to call an electrician.
- 6.8 Properly splice, connect, and join wires using approved devices.

7.0 Basic Principles of Plumbing and Water Supply

- 7.1 Describe a domestic Water supply and the use of different pipe sizes.
- 7.2 Describe a domestic Drain system including proper venting.
- 7.3 Cut and thread iron pipe.
- 7.4 Solder copper tubing.
- 7.5 Describe the purpose of Back Flow Preventors.
- 7.6 Use a Compression Fitting on Aluminum pipe.
- 7.7 Properly connect PVC pipe.
- 7.8 Describe different drains and traps.
- 7.9 Explain National Plumbing Codes and existence of licensing and permit requirements in all communities served.
- 7.10 Explain Safety procedures to be used when working with water supplies.
- 7.11 Explain the need for Water testing procedures especially for Dishwashers.
- 7.12 Explain Water Filter systems in relation to appliances-(Example: Reverse Osmosis).
- 7.13 Explain the cause of Noisy pipes and the use of Water Hammer Arresters.

Cooling Products

8.0 Basic Refrigeration

- 8.1 Describe basic safety procedures used when servicing refrigeration products.
- 8.2 Identify refrigeration Terminology and Definitions.
- 8.3 Identify refrigeration Components.
- 8.4 Describe refrigeration Component Function.
- 8.5 Explain Temperature/Pressure Relationship and Use of PT Chart.
- 8.6 Explain the difference between Heat Loads and Cooling Loads.
- 8.7 Describe the theory of Electronic Cooling.
- 8.8 Explain Atmospheric Pressure and the use of gauges.
- 8.9 Draw a Basic Refrigeration System.
- 8.10 Explain Metering Devices and how they work.
- 8.11 Describe the use and Sizing of Compressors/Cross-Referencing/Types/High Pressure Dome/Low Pressure Dome.
- 8.12 Describe the different Styles of Refrigerators.
- 8.13 Describe Condenser Types.
- 8.14 Explain the reason for Evaporator Locations.
- 8.15 Describe the purpose of a Heat Exchanger.
- 8.16 Explain the function of a Filter Drier.

9.0 Refrigerant handling and recovery

- 9.1 Describe federal EPA Laws and Regulations Associated with these laws.
- 9.2 Describe the difference between Passive and Active Recovery.
- 9.3 Describe the difference between Recovery, Recycling and Reclaiming.
- 9.4 Describe a Retrofit.
- 9.5 Explain the purpose of Refrigerant Oils and explain the differences between mineral based lubricants and synthetic lubricants used in refrigeration systems. Explain the importance of avoiding cross-contamination.
- 9.6 Describe the differences and uses of CFC/HCFC/HFC.

10.0 Refrigerator/Sealed system Repair

- 10.1 Describe the Theory of operation of a domestic refrigerator.
- 10.2 Demonstrate Sealed System Diagnostic procedures for Restriction/Partial-Restriction/Non-Condensable/Inefficient Compressor/Low Charge/Over-Charge.
- 10.3 Explain the different Leak Detection Methods/Procedures.

- 10.4 Properly access a sealed System and properly remove access port upon completion.
- 10.5 Explain Dehydration.
- 10.6 Explain Triple Evacuation.
- 10.7 Describe different Methods of Charging/Procedures associated with each.
- 10.8 Describe different Methods of Defrost/Components Associated with and Function of each.
- 10.9 Describe different Temperature Sensing Methods.
- 10.10 Explain different Air Distribution methods (inside and outside of box).
- 10.11 Properly use a wiring Schematic and ladder diagram to diagnose electrical problems.
- 10.12 Describe different Oil-Cooling Methods.
- 10.13 Explain the purpose of Perimeter or Yoder Loops.

11.0 Air conditioning and Dehumidifier Principles

- 11.1 Describe the Theory of operation of a domestic window air conditioner.
- 11.2 Describe the differences between air conditioning and dehumidifying.

12.0 Ice Machines, Freestanding and Undercounter

- 12.1 Explain the Theory of operation used in most domestic ice makers.
- 12.2 Explain how Water is Distributed into the icemaker.
- 12.3 Describe proper procedures for Cleaning and Sanitizing icemakers.
- 12.4 Identify the components and Control Circuits of a domestic icemaker.

13.0 Wine Coolers

- 13.1 Explain the theory of operation of a Wine Cooler.

Cleaning Products

14.0 Top Loading Washers

- 14.1 Explain theory of operation for top loading washers.
- 14.2 Properly install a top loading washer.
- 14.3 Explain how incoming water is distributed from inlet to tub.
- 14.4 Describe the operation of a Water Level Control.
- 14.5 Explain the function of a Water Temperature Control.
- 14.6 Compare Direct/Neutral Drain Systems.
- 14.7 Describe different brake systems used in top loading washers.
- 14.8 Describe the Methods of Counter Balance.
- 14.9 Outline the different Water Filtration Methods.
- 14.10 Describe the use of Clutch Systems.
- 14.11 Explain the operation of Electric water valves.
- 14.12 Explain Operating Principles Associated with the Transmission.
- 14.13 Describe the different drive methods.
- 14.14 Demonstrate ability to use a Cam Chart.
- 14.15 Demonstrate ability to Interpret Schematic.
- 14.16 List Cleanability problems and corrections i.e. Detergent usage, water temperature and hardness, loading procedures, fabric softener, bleach etc

15.0 Front Loading Washers

- 15.1 Describe the basic operation of a front loading washer, including installation requirements.
- 15.2 Explain Differences from vertical washing systems.
- 15.3 Describe the operation of Water fill and level control.
- 15.4 Outline the operation of the Temperature Control.
- 15.5 Describe method of Drain Systems.
- 15.6 Explain Braking System methods.
- 15.7 Describe Methods of Counter Balance.
- 15.8 Describe Water Filtration Methods.

- 15.9 Describe Drive systems.
- 15.10 Explain the operation of Electronic controls.
- 15.11 Explain the use of DC motors.
- 15.12 Using cycle sequence, wiring, schematic and ladder diagrams to troubleshoot electrical failures.
- 15.13 Describe the need for Door Seals.

16.0 Dryers (Gas and Electric)

- 16.1 Describe proper Installation and venting requirements.
- 16.2 Explain Theory of operation of Gas/Electric dryers.
- 16.3 Explain Combustion principles and the operation of Gas valves and burner assemblies..
- 16.4 Describe the operation of Electric heating elements.
- 16.5 Describe Drum drive systems.
- 16.6 Electrical power and relationship to heating elements.
- 16.7 Describe Troubleshooting procedures used in gas burner systems.
- 16.8 Describe Air handling, distribution and venting (blowers, fans, seals).
- 16.9 Outline the purpose of Electrical and thermal safety devices.
- 16.10 Use timer sequence, schematic, ladder and wiring diagrams to troubleshoot electrical failures.
- 16.11 Describe Glow Bar ignition systems.

17.0 Combination Washer/Dryer (Combine washer and dryer skill standards for this category)

- 17.1 Explain Theory of operation.

18.0 Dishwashers

- 18.1 Explain dishwasher Theory of operation.
- 18.2 Describe Installation requirements.
- 18.3 Explain Water distribution from inlet to tub including wash cycle and draining.
- 18.4 Explain Water hardness/temperature/detergent and wetting agents and how they affect washing performance.
- 18.5 Describe the operation of Timers, mechanical and electronic types.
- 18.6 Identify and explain Option, float and selector switches.
- 18.7 Identify and explain Water system components and controls (fill valves, drain hoses, check valves, siphon breaks, etc.).
- 18.8 Explain the purpose of Pumps, spray arms, food choppers, motors, filtering systems and sumps.
- 18.9 Describe the Dispensing systems.
- 18.10 Describe Drying systems used in dishwashers.
- 18.11 Explain the use of Door seals and latching mechanisms.
- 18.12 Use schematic, wiring, timer sequence, cycle option and other diagrams and charts to diagnose dishwasher failures.

Convenience Products

19.0 Water Heaters and Dispensers

- 19.1 Describe the theory of operation of domestic hot water heaters.
- 19.2 Describe Plumbing and installation requirements of hot water dispensers.
- 19.3 Describe the Safety devices used in water heaters.
- 19.4 Water hardness and conditioning.
- 19.5 Explain the Combustion process in gas hot water heaters.
- 19.6 Explain requirements for Venting, (direct and chimney).
- 19.7 Describe the operation of Gas valves, thermocouples.
- 19.8 Explain the operation of electric Heating elements and thermostats.
- 19.9 Explain the filtering system methods (i.e. reverse osmosis, carbon, rust and chemical removal).
- 19.10 Describe the operation of Isolation and Check Valves.
- 19.11 Describe the operation of Pressure Relief Valves.

20.0 Disposers

- 20.1 Explain the basic operation of a food waste disposal, including continuous feed, batch feed and installation requirements.
- 20.2 Describe the operation of reversing switches.
- 20.3 Describe the operation of motor and grinding mechanisms.

21.0 Exhaust Hoods, Venting and Air Movement

- 21.1 Explain the basic operation of range top venting systems.
- 21.2 Describe the basic Installation requirements and limitations of range top venting system.
- 21.3 Describe the operation of Re-circulating, Direct vent and Down-flow type venting.
- 21.4 Describe the purpose of Filters used in venting systems.
- 21.5 Describe the operation of Motors and Blowers used in venting systems.
- 21.6 Explain the purpose of the various Switches and Controls used with venting systems.

22.0 Central Vacuums

- 22.1 Describe the basic operation of a central vacuum system including bag and bag less types.
- 22.2 Demonstrate an understanding of system design and installation.
- 22.3 Describe the operation of motors and controls used in central vacuum systems.
- 22.4 Describe the operation of motorized and power accessories for vacuum systems.

23.0 Trash Compactors

- 23.1 Explain the basic operation of a trash compactor.
- 23.2 Describe the operation of ram drive systems.
- 23.3 Describe the operation of electrical and mechanical controls (cycle selector and option switches).
- 23.4 Explain the operation of reversing and interlocking switches.

24.0 Ironers

- 24.1 Describe the basic operation of ironing systems including Dry Press and Steam press.

Cooking Products

25.0 Gas Cooking Principles

- 25.1 Describe the safe and proper servicing of gas appliances.
- 25.2 Explain the properties of natural gas and liquefied petroleum (LP) including their chemical composition, heating value, specific gravity, limits of flammability and their burning speed.
- 25.3 Describe the pressure requirements of natural gas and LP, including valves and their adjustment (normal and high altitude applications), gas flow regulation and how to measure gas pressure.
- 25.4 Demonstrate how to correct lifting burner flames, flashback, extinction pop, floating flames, port loading, and yellow tipping of flames. Primary and secondary air supplies.
- 25.5 Describe the operation of combustion including how primary, secondary, and excess air affects combustion and Carbon Monoxide production and how to differentiate between complete and incomplete combustion.
- 25.6 Describe the operation of burners (atmospheric and power), burner components (including fixed and adjustable orifices), input and output ratings, and gas flow rates.
- 25.7 Describe the operation of gas ignition systems and controls (standing pilot, glow bar, electronic spark for both oven and surface burner systems).
- 25.8 Describe leak detection and the proper use of leak detection equipment.
- 25.9 Explain proper product installation and how state and local regulations may impact product installations.
- 25.10 Describe gas conversion (LP to natural gas, natural gas to LP).
- 25.11 Describe the operation of timers, electronic range controls, and range clocks that are used in gas ranges, ovens, and cook-tops.
- 25.12 Describe the operation of electrical controls for gas ranges (thermostats, flame proving sensors, thermostatic protection devices, selector switches).

- 25.13 Describe the operation of oven cleaning, including types of oven and range top surfaces, locking mechanisms and their associated controls.
- 25.14 Describe convection gas ranges and oven cooking principles and their components (fans, controls).
- 25.15 Describe down-draft gas ranges and cook-tops, including installation and venting requirements.
- 25.16 Describe venting and ventilation, including natural draft action, power vents, and draft hoods and how to measure for Carbon Monoxide.
- 25.17 Explain temperature limitation and proper test procedure for product surface temperatures and associated cabinet temperatures as regulated by UL and AGA.
- 25.18 Use electrical schematics, technical drawings, switch position charts and wiring diagrams of gas ranges, ovens and cook tops in electrical trouble-shooting.

26.0 Electric Cooking Principles

- 26.1 Describe the safe and proper servicing of electric cooking appliances.
- 26.2 Describe the operation of electrical controls (thermostats, selector switches, infinite switches, heat relays, heat sensors, oven temperature protection, electronic range and oven controls).
- 26.3 Describe the operation of heating elements of electric ranges, ovens, and cook-tops (oven and surface elements).
- 26.4 Describe the operation of Control/Safety systems associated with self-clean cycle.
- 26.5 Describe oven cleaning, including types of oven and range top surfaces, locking mechanisms and their associated controls.
- 26.6 Calibrate Oven Temperature controls.
- 26.7 Describe the operation of the overheat protection system used on smooth-top ranges.
- 26.8 Describe the purpose of seals, heat shields, insulation and gaskets in gas and electric ranges and ovens and their impact on performance and surface temperatures.
- 26.9 Explain down-draft electric ranges and cook-tops, including installation and venting requirements.
- 26.10 Use electrical schematics, technical drawings, switch position charts and wiring diagrams of electric ranges, ovens and cook-tops and how they are used in electrical troubleshooting.

27.0 Microwave Cooking Principles

- 27.1 Describe the safe and proper servicing of microwave appliances.
- 27.2 Describe the operation of safety interlock systems used in microwaves, i.e. Primary and Secondary Interlocks and Monitor switches.
- 27.3 Explain high voltage power supplies and safety precautions necessary to properly service high voltage and current supplies.
- 27.4 Describe microwave oven controls (electro-mechanical and electronic timers, and humidity, weight and temperature sensors).
- 27.5 Describe the operation of microwave generation systems, microwave propagation, and microwave distributions systems (magnetrons, waveguide, stirrer blades, and carousels).
- 27.6 Use electrical schematics, technical drawings, and wiring diagrams, switch position charts of microwave ovens and how they are used in electrical trouble-shooting.
- 27.7 Describe survey meters, leakage, emission standards and door adjustments.
- 27.8 Describe the operation of combination conventional, convection and microwave ovens.
- 27.9 Describe proper venting and exhaust provisions and filter panels.

28.0 Induction Cooking

- 28.1 Describe the safe and proper servicing of induction ranges.
- 28.2 Describe the operation of basic induction range principles, including installation requirements.
- 28.3 Describe the operation of electrical controls used with induction range systems.
- 28.4 Explain Cookware selection for use with an induction range.
- 28.5 Use electrical schematics, technical drawings, switch position charts and wiring diagrams of induction ranges and how they are used in electrical trouble-shooting.

29.0 Convection Cooking

- 29.1 Describe convection electric ranges and oven cooking principles and their components (fans, controls).
- 29.2 Explain the principles of High Velocity Convection Cooking.