

PRACTICE EXAM 7: STATIONARY ENGINEER APPRENTICE SIMULATION (100 QUESTIONS)

This practice exam contains 100 multiple-choice questions based on the U.S. Department of Labor stationary engineer apprenticeship work-process areas. Select the single best answer for each question. Because stationary engineer apprentice testing requirements vary by jurisdiction and employer, there is no single national time limit or passing score for this 100-question simulation; use the requirements of your local program for official testing.

1. Before servicing a motor-driven pump that could start automatically, what is the most appropriate first safety action?

- A. Isolate hazardous energy using the established lockout/tagout procedure.
- B. Place the selector switch in HAND and watch the motor.
- C. Open the discharge valve fully to remove pump load.
- D. Reset the overload relay and test the start circuit.

2. In a parallel electrical circuit, which quantity is the same across each branch?

- A. Current through every branch.
- B. Resistance of every branch.
- C. Voltage across the branch.
- D. Power consumed by every branch.

3. A 240-volt resistive heater has a resistance of 20 ohms. What current should it draw?

- A. 8 amperes.
- B. 12 amperes.
- C. 16 amperes.
- D. 24 amperes.

4. What is the primary purpose of a motor overload relay in a typical starter?

- A. Provide branch-circuit short-circuit protection for the feeder.
- B. Reverse motor rotation whenever phase sequence changes.
- C. Maintain control voltage during a complete power failure.
- D. Protect the motor from sustained overcurrent that can cause overheating.

5. A three-phase motor runs in the wrong direction after wiring work. What common correction reverses its rotation?

- A. Interchange any two incoming phase conductors at the motor circuit.
- B. Increase the overload setting on all three phases.
- C. Connect the equipment grounding conductor to a phase terminal.
- D. Lower the control-transformer secondary voltage to the starter.

6. A 240-volt single-phase load draws 10 amperes at unity power factor. Approximately how much real power does it use?

- A. 1.2 kilowatts.
- B. 4.8 kilowatts.
- C. 2.4 kilowatts.
- D. 24 kilowatts.

7. What is the main function of a transformer in a stationary plant electrical system?

- A. Convert alternating current directly into compressed-air pressure.
- B. Store electrical energy continuously as mechanical rotation.
- C. Measure insulation resistance without applying any test voltage.
- D. Change AC voltage level through electromagnetic induction.

8. Why are exposed conductive equipment parts normally bonded to the equipment grounding system?

- A. To increase normal operating current through metal enclosures.
- B. To provide a low-impedance fault path that supports rapid protective-device operation.
- C. To eliminate the need for overcurrent protection on feeders.
- D. To raise the voltage available to grounded control circuits.

9. A control circuit uses a normally open auxiliary contact wired around the START pushbutton. What is this contact commonly used for?

- A. Increasing motor torque by bypassing the overload heaters.
- B. Opening the disconnect switch during every normal stop.
- C. Reducing three-phase line voltage before it reaches the motor.
- D. Maintaining the starter coil circuit after the START button is released.

10. A fuse opens repeatedly immediately after a motor circuit is energized. What is the best troubleshooting approach?

- A. Install a much larger fuse so the motor can start normally.
- B. Bypass the fuse temporarily and observe which component overheats.
- C. Find and correct the electrical fault before replacing the fuse again.
- D. Reduce the equipment grounding conductor size to limit fault current.

11. What is the primary function of the evaporator in a vapor-compression refrigeration system?

- A. Reject heat while refrigerant condenses at high pressure.
- B. Absorb heat as refrigerant boils at low pressure.
- C. Raise refrigerant pressure by reducing its specific volume.
- D. Store liquid refrigerant during normal compressor unloading.

12. Which line normally carries low-pressure refrigerant vapor from the evaporator toward the compressor?

- A. The suction line.
- B. The liquid line.
- C. The hot-gas discharge line.
- D. The condenser drain line.

13. What is the main purpose of the condenser in a refrigeration system?

- A. Meter liquid refrigerant into the evaporator based only on time.
- B. Reject heat and condense high-pressure refrigerant vapor into liquid.
- C. Increase vapor pressure by mechanically compressing refrigerant.
- D. Absorb room heat while refrigerant boils at low pressure.

14. A thermostatic expansion valve primarily controls refrigerant flow to maintain which condition at the evaporator outlet?

- A. A target amount of superheat.
- B. A fixed compressor discharge pressure.
- C. A constant liquid-line subcooling value.
- D. A fixed condenser approach temperature.

15. In normal operation, what refrigerant condition should enter a reciprocating compressor suction connection?

- A. High-pressure liquid at condenser temperature.
- B. A saturated liquid-vapor mixture intentionally containing droplets.
- C. Low-pressure vapor with sufficient superheat to avoid liquid carryover.
- D. Subcooled liquid from the receiver outlet.

16. An air-cooled evaporator has very low airflow because its filter is blocked. What change is most likely?

- A. Suction pressure must rise because more heat enters the coil.
- B. Condenser pressure must fall to atmospheric pressure immediately.
- C. Liquid-line pressure becomes identical to evaporator pressure.
- D. Suction pressure may fall because the evaporator heat load is reduced.

17. The evaporator saturation temperature is 35°F and the suction-line temperature at the outlet is 45°F. What is the superheat?

- A. 5°F.
- B. 35°F.
- C. 80°F.
- D. 10°F.

18. The condensing saturation temperature is 110°F and the liquid-line temperature is 95°F. What is the liquid subcooling?

- A. 5°F.
- B. 95°F.
- C. 15°F.
- D. 205°F.

19. What is the usual purpose of a liquid receiver in a refrigeration system?

- A. Separate compressor motor windings from suction vapor.
- B. Provide storage volume for high-pressure liquid refrigerant.
- C. Increase evaporator airflow during high humidity conditions.
- D. Meter refrigerant directly according to room dry-bulb temperature.

20. Persistent bubbles in a liquid-line sight glass should be interpreted how?

- A. As a symptom requiring additional checks rather than automatic proof of low charge.
- B. As conclusive proof that the compressor valves are broken.
- C. As proof that the condenser contains no refrigerant at all.
- D. As a normal indication that always requires adding refrigerant.

21. Why is proper oil return important in a refrigeration piping system?

- A. Oil must remain permanently trapped in the evaporator to increase capacity.
- B. Oil should fill the liquid receiver to prevent refrigerant flashing.
- C. Oil replaces the need for refrigerant vapor returning through suction piping.
- D. The compressor requires adequate lubrication while excessive oil in heat exchangers reduces performance.

22. What operating effect can noncondensable gases have when trapped in the high side of a refrigeration system?

- A. They always lower head pressure below normal operating range.
- B. They convert the compressor into a positive-displacement liquid pump.
- C. They can increase condensing pressure and reduce condenser effectiveness.
- D. They eliminate the need for condenser airflow or cooling water.

23. An evaporator coil is heavily iced and airflow has fallen. What should be done before judging refrigerant charge?

- A. Add refrigerant immediately until suction pressure rises.
- B. Restore proper defrost and airflow, then evaluate system readings under stable conditions.
- C. Close the liquid-line valve permanently to stop icing.
- D. Increase the compressor overload setting to raise coil temperature.

24. A refrigeration compressor repeatedly starts and stops on the low-pressure control. Which condition should be investigated?

- A. Only excessive condenser airflow, because it always causes high suction pressure.
- B. Insufficient evaporator load, restricted refrigerant feed, or another cause of low suction pressure.
- C. A permanently closed discharge service valve used as a normal control method.
- D. A grounded equipment enclosure that increases refrigerant circulation.

25. What is the purpose of a pump-down control sequence on many refrigeration systems?

- A. Move refrigerant from the low side before stopping the compressor on low pressure.
- B. Force liquid refrigerant into the compressor crankcase before shutdown.
- C. Keep the evaporator fully flooded while the compressor remains off.
- D. Raise suction pressure continuously by opening the liquid solenoid wider.

26. During service of stationary refrigeration equipment, how should refrigerant that must be removed from the system generally be handled?

- A. Released outdoors slowly so system pressure reaches zero.
- B. Purged through the compressor discharge line into the mechanical room.
- C. Recovered using appropriate equipment instead of intentionally vented.
- D. Mixed with compressed air and discharged through the condenser fan.

27. Which description best distinguishes sensible cooling from latent cooling?

- A. Sensible cooling adds moisture; latent cooling raises dry-bulb temperature.
- B. Sensible cooling changes air pressure only; latent cooling changes fan speed.
- C. Sensible cooling occurs only in boilers; latent cooling occurs only in condensers.
- D. Sensible cooling lowers dry-bulb temperature; latent cooling removes moisture from the air.

28. What does relative humidity describe?

- A. The amount of water vapor present compared with the maximum possible at that temperature.
- B. The ratio of supply-air pressure to return-air pressure.
- C. The percentage of oxygen removed by an air-handling unit.
- D. The fraction of total airflow passing through a dirty filter.

29. Return air is 78°F and supply air is 58°F. What is the sensible temperature difference across the cooling system?

- A. 10°F.
- B. 58°F.
- C. 20°F.
- D. 136°F.

30. Using a planning value of 400 cfm per ton, approximately how much airflow is associated with a 5-ton cooling load?

- A. 800 cfm.
- B. 2,000 cfm.
- C. 1,250 cfm.
- D. 4,000 cfm.

31. What is the purpose of an air-side economizer when outdoor conditions are suitable?

- A. Use outdoor air for cooling to reduce mechanical refrigeration demand.
- B. Increase boiler pressure by routing outdoor air through the feedwater system.
- C. Bypass all ventilation requirements whenever outdoor air is cool.
- D. Operate only the condenser fan while keeping supply airflow stopped.

32. A heavily loaded air filter in an air-handling unit most directly tends to cause what?

- A. Lower pressure drop because dirt makes the filter more porous.
- B. Higher refrigerant charge because dust enters the compressor.
- C. Lower return-air temperature regardless of building load.
- D. Higher pressure drop and reduced airflow if fan operation does not compensate.

33. If indoor humidity is high while dry-bulb temperature is near setpoint, which cooling-system action can improve dehumidification?

- A. Maintain adequate coil moisture removal and avoid excessive short cycling.
- B. Raise supply-air temperature enough to prevent any condensation.
- C. Disable condensate drainage so water remains on the coil.
- D. Open heating valves fully while shutting off all cooling airflow.

34. Why must condensate from a cooling coil be drained reliably?

- A. To return refrigerant oil directly to the compressor crankcase.
- B. To increase fan static pressure by sealing the drain pan.
- C. To remove condensed moisture and prevent overflow or microbial problems in the air handler.
- D. To maintain boiler-water level through the HVAC condensate piping.

35. What does static pressure measurement in a duct system help evaluate?

- A. Refrigerant purity inside the liquid receiver.
- B. Boiler-water alkalinity at the feedwater pump.
- C. Electrical insulation resistance of the fan motor windings.
- D. Resistance to airflow and the pressure conditions the fan must overcome.

36. A fan delivers 10,000 cfm at 900 rpm. Assuming system conditions remain similar, what airflow is expected at 1,080 rpm using the fan affinity relationship that airflow varies directly with speed?

- A. 9,000 cfm.

- B. 12,000 cfm.
- C. 10,800 cfm.
- D. 14,400 cfm.

37. Chilled water enters a cooling coil at 44°F and leaves at 54°F. What is the water-side temperature rise?

- A. 10°F.
- B. 5°F.
- C. 44°F.
- D. 98°F.

38. Why is a thermostat deadband often used between heating and cooling commands?

- A. To force both heating and cooling valves fully open together.
- B. To prevent rapid switching or simultaneous fighting between heating and cooling.
- C. To eliminate all temperature sensing from the control sequence.
- D. To increase refrigerant pressure whenever room temperature is stable.

39. What is the main function of a variable-air-volume terminal box in a VAV system?

- A. Maintain boiler drum level by throttling feedwater flow.
- B. Store liquid refrigerant during compressor shutdown.
- C. Modulate zone supply airflow in response to load.
- D. Reverse condenser-water flow whenever room humidity rises.

40. What is a common reason to verify outdoor-air damper position during an HVAC complaint?

- A. The damper directly controls boiler safety-valve pressure.
- B. The damper determines compressor oil viscosity inside the crankcase.
- C. The damper replaces all return-air filtration when fully open.

D. An incorrect position can affect ventilation load, building pressure, temperature, and humidity.

41. What is a likely consequence of significant supply-duct leakage in an unconditioned space?

- A. Higher delivered airflow because leakage adds air to the terminal.
- B. Automatic improvement in zone humidity control under every condition.
- C. Higher boiler-water level caused by lost supply air.
- D. Reduced delivered airflow and wasted heating or cooling energy.

42. A cooling coil is coated with dirt on the air side. What operating effect is most likely?

- A. Improved heat transfer because dirt increases thermal conductivity.
- B. Zero pressure drop across the coil at all fan speeds.
- C. Reduced heat transfer and increased airside resistance.
- D. Higher refrigerant purity because dust absorbs moisture from the circuit.

43. What is the principal safety function of a low-water cutoff on a boiler?

- A. Stop burner operation when boiler water level becomes dangerously low.
- B. Increase firing rate when the gauge glass appears empty.
- C. Open the steam stop valve whenever feedwater pressure falls.
- D. Bypass flame safeguards during rapid load changes.

44. What is the purpose of a boiler safety valve?

- A. Maintain normal water level by admitting feedwater.
- B. Relieve steam pressure if it rises above the valve set pressure.
- C. Control burner fuel-air ratio during every firing stage.
- D. Remove dissolved oxygen from incoming makeup water.

45. Why is boiler blowdown performed?

- A. To remove concentrated dissolved and suspended solids from boiler water.
- B. To increase dissolved solids until steam becomes electrically conductive.
- C. To return flue gas directly to the feedwater tank.
- D. To supply lubrication oil to the boiler feed pump bearings.

46. What does furnace draft primarily help accomplish in a fired boiler?

- A. Maintain boiler-water hardness by circulating treatment chemicals.
- B. Measure steam dryness without using any instruments.
- C. Provide electrical grounding for the burner motor.
- D. Move combustion air and flue gases through the furnace and gas passages.

47. What is the main purpose of the boiler feedwater system?

- A. Inject fuel into the burner according to steam pressure.
- B. Remove soot from fireside heating surfaces continuously.
- C. Supply water to maintain the required boiler operating level.
- D. Increase steam pressure by restricting the safety valve outlet.

48. What is a primary purpose of a deaerator in a steam plant?

- A. Increase boiler-water hardness before the feed pump.
- B. Remove dissolved oxygen and other noncondensable gases from feedwater.
- C. Cool condensate as much as possible before returning it.
- D. Add combustion air directly to the burner register.

49. What is the function of a steam trap in a steam distribution or heating system?

- A. Raise boiler pressure by closing all condensate return paths.
- B. Supply makeup water directly into steam mains.
- C. Meter burner fuel according to return-line temperature.
- D. Discharge condensate and noncondensable gases while minimizing live-steam loss.

50. Why is the boiler gauge glass important to an operator?

- A. It provides a direct visible indication of water level in the boiler.
- B. It measures flue-gas oxygen percentage at the stack.
- C. It directly proves every low-water cutoff is functioning.
- D. It determines fuel heating value by observing flame color.

51. As steam pressure increases in a saturated steam system, what generally happens to saturation temperature?

- A. It decreases to the freezing point.
- B. It remains exactly constant at all pressures.
- C. It increases.
- D. It becomes unrelated to pressure.

52. A boiler receives 1,000,000 Btu/h of fuel energy and transfers 800,000 Btu/h to the useful steam output. What is the calculated efficiency?

- A. 20 percent.
- B. 80 percent.
- C. 50 percent.
- D. 125 percent.

53. If the burner flame signal is lost during firing, what should the burner management system normally do?

- A. Increase fuel flow until the flame detector sees a stronger signal.
- B. Shut off fuel promptly according to the flame-safeguard sequence.
- C. Bypass the detector and continue firing until steam demand falls.
- D. Open the boiler safety valve to prove burner operation.

54. What effect does heavy soot accumulation on boiler fireside surfaces usually have?

- A. It reduces heat transfer and can increase flue-gas temperature and fuel use.
- B. It improves heat transfer by adding a conductive coating.
- C. It lowers stack temperature to room temperature automatically.
- D. It chemically softens boiler water through the tube wall.

55. Why is returning hot, clean condensate to a boiler plant usually beneficial?

- A. It increases the amount of cold makeup water required.
- B. It forces boiler blowdown to its maximum possible rate.
- C. It adds suspended solids so the boiler can form protective scale.
- D. It reduces makeup-water, treatment, and heating requirements.

56. What does boiler priming or carryover describe?

- A. Complete removal of all moisture from steam inside the burner.
- B. Intentional draining of the boiler through the bottom blowdown valve.
- C. Water droplets or boiler-water contaminants being carried with the steam.
- D. Normal combustion-air preheating before the burner.

57. What is the purpose of refractory material in a boiler furnace?

- A. Conduct boiler water directly into the burner flame.
- B. Resist high temperature and protect or insulate furnace structural surfaces.
- C. Measure fuel pressure by changing color at a set value.

D. Replace all metal pressure parts of the boiler.

58. Why is scale on boiler-water-side heating surfaces undesirable?

- A. It improves heat transfer by making the surface rougher.
- B. It eliminates the need for boiler blowdown and water treatment.
- C. It increases steam purity by dissolving into the steam.
- D. It insulates the metal from water, reducing heat transfer and raising tube-metal temperature.

59. A centrifugal pump makes a gravel-like noise and shows unstable discharge pressure. What condition should be suspected?

- A. Perfect hydraulic balance at the best efficiency point.
- B. Excessive insulation resistance in the motor windings.
- C. Cavitation caused by inadequate suction conditions.
- D. Normal bearing operation after fresh lubrication.

60. For a centrifugal pump operating normally, which method is commonly used to reduce flow without changing pump speed?

- A. Throttle the discharge valve within an acceptable operating range.
- B. Throttle the suction valve until the pump begins cavitating.
- C. Close the suction isolation valve completely during operation.
- D. Loosen the shaft coupling to reduce transmitted torque.

61. Why is the correct type and amount of bearing lubricant important?

- A. More lubricant always lowers bearing temperature regardless of quantity.
- B. Any available oil or grease is interchangeable in all bearings.
- C. It forms a protective film while avoiding heat and churning from over-lubrication.
- D. Lubrication is unnecessary when a shaft is correctly aligned.

62. What is a common consequence of poor shaft alignment between a motor and driven machine?

- A. Lower mechanical stress because the coupling absorbs unlimited offset.
- B. Automatic correction of pump cavitation at the suction nozzle.
- C. Permanent reduction of motor current under every load condition.
- D. Increased vibration and loading on bearings, seals, and couplings.

63. A machine develops a new vibration after maintenance. What is the best first response?

- A. Run the machine faster until the vibration frequency disappears.
- B. Compare operating condition and measurements while checking alignment, looseness, balance, and assembly.
- C. Ignore the vibration if discharge pressure remains near normal.
- D. Add maximum grease to every bearing without checking condition.

64. What can excessive V-belt tension cause?

- A. Unnecessary radial load on motor and driven-equipment bearings.
- B. Improved bearing life because higher tension removes all shaft load.
- C. Automatic correction of pulley misalignment under load.
- D. Elimination of belt wear regardless of pulley condition.

65. What is the primary purpose of a mechanical seal on a pump shaft?

- A. Increase impeller diameter during high-load operation.
- B. Measure motor insulation resistance while the pump runs.
- C. Limit leakage where the rotating shaft passes through the pump casing.
- D. Control electrical phase sequence at the pump starter.

66. Why is intercooling used between stages of some multi-stage air compressors?

- A. To increase inlet air temperature before every compression stage.
- B. To reduce air temperature and the work required by later compression stages.
- C. To add lubricating oil directly to the compressed-air receiver.
- D. To reverse motor rotation between the first and second stages.

67. What does a rising gearbox oil temperature most reasonably call for?

- A. Drain all oil immediately and operate the gearbox dry.
- B. Increase gear load so the lubricant circulates faster.
- C. Ignore the change if the gearbox continues to rotate.
- D. Check oil level and condition, load, cooling, alignment, and bearing or gear condition.

68. Why must rotating couplings, belts, and similar power-transmission parts be properly guarded?

- A. To reduce the chance of personnel contacting moving pinch and entanglement hazards.
- B. To increase motor speed by reducing aerodynamic drag.
- C. To improve pump suction pressure by sealing the coupling.
- D. To eliminate the need for hazardous-energy control during maintenance.

69. On the pH scale, a value below 7 generally indicates what condition for an aqueous solution?

- A. Neutral.
- B. Alkaline.
- C. Acidic.
- D. Completely free of dissolved ions.

70. Why is excessive hardness undesirable in many boiler and heat-exchange water systems?

- A. Hardness always prevents every form of corrosion.
- B. Hardness minerals can form scale on heat-transfer surfaces.
- C. Hardness removes all suspended solids without filtration.
- D. Hardness guarantees lower conductivity as concentration increases.

71. What does electrical conductivity of water commonly indicate in plant treatment work?

- A. The water ability to conduct current, which generally increases with dissolved ionic material.
- B. The exact concentration of every individual chemical species.
- C. The mechanical condition of pump bearings without other testing.
- D. The amount of suspended dirt captured by an air filter.

72. What is the basic function of a sodium-cycle water softener?

- A. Remove dissolved oxygen by boiling the water at atmospheric pressure.
- B. Filter all dissolved salts through a coarse mechanical screen.
- C. Increase hardness so scale forms in the softener instead of the boiler.
- D. Exchange hardness ions such as calcium and magnesium for sodium ions.

73. What is reverse osmosis primarily used to do in water treatment?

- A. Add hardness minerals to improve boiler scaling.
- B. Remove only large debris with a coarse strainer basket.
- C. Increase dissolved oxygen before water enters a closed loop.
- D. Reduce dissolved salts by forcing water through a semipermeable membrane under pressure.

74. Why are corrosion inhibitors added to some closed water systems?

- A. To guarantee zero leakage from every mechanical joint.
- B. To reduce metal corrosion by modifying electrochemical conditions or forming protective films.
- C. To raise suspended solids until piping becomes internally insulated.

D. To replace all need for monitoring pH and water chemistry.

75. Why might a cooling-tower water program include a biocide?

- A. To control biological growth that can foul surfaces or create health and corrosion concerns.
- B. To increase mineral scale intentionally on heat-transfer surfaces.
- C. To replace the fan motor electrical overload protection.
- D. To eliminate all evaporation so concentration never changes.

76. Cooling-tower circulating water conductivity is 1,500 micromhos/cm and makeup-water conductivity is 300 micromhos/cm. Using conductivity ratio as an estimate, what are the cycles of concentration?

- A. 3 cycles.
- B. 4 cycles.
- C. 5 cycles.
- D. 6 cycles.

77. What does alkalinity in water mainly represent?

- A. The number of pump bearings requiring lubrication.
- B. The capacity of the water to neutralize added acid.
- C. The exact amount of dissolved oxygen in the water.
- D. The airflow resistance across an air-handling filter.

78. Why is dissolved oxygen undesirable in many boiler feedwater and closed heating systems?

- A. It always prevents corrosion by forming harmless gas pockets.
- B. It removes hardness scale without chemical treatment.
- C. It increases pump lubrication by dissolving into bearing oil.
- D. It can accelerate corrosion and pitting of ferrous metal surfaces.

79. Complete combustion of a hydrocarbon fuel requires an adequate supply of what reactant?

- A. Nitrogen only.
- B. Steam only.
- C. Oxygen.
- D. Lubricating oil.

80. What is one effect of operating a burner with far more excess air than necessary?

- A. More heated flue gas leaves the stack, which can reduce combustion efficiency.
- B. All stack heat loss is eliminated because extra air absorbs heat.
- C. Fuel heating value increases chemically inside the burner.
- D. The boiler no longer requires draft or flame safeguards.

81. If a strong natural-gas odor is detected in a mechanical room, what is the safest general response?

- A. Follow the emergency procedure, avoid ignition sources, and isolate or evacuate as directed.
- B. Operate electrical switches repeatedly to locate the leak by sound.
- C. Light a burner manually so the gas will be consumed.
- D. Ignore the odor until combustion equipment trips automatically.

82. Why may heavy fuel oil require heating before it is pumped or atomized?

- A. Heating raises viscosity so the oil becomes harder to move.
- B. Heating removes the need for any burner air supply.
- C. Heating converts the oil into electrical energy before combustion.
- D. Heating can lower viscosity so the fuel flows and atomizes more effectively.

83. Why should burner flame color not be used as the only indicator of combustion quality?

- A. Flame color directly measures every pollutant and efficiency value exactly.
- B. A bright flame always proves that excess air is zero.
- C. Different fuels and burners produce different appearances, while instruments provide more reliable combustion data.
- D. Flame color eliminates the need to monitor draft and fuel pressure.

84. A burner uses 1,000 cubic feet of gas with a stated heating value of 1,000 Btu per cubic foot. How much input energy is represented?

- A. 100,000 Btu.
- B. 1,000,000 Btu.
- C. 500,000 Btu.
- D. 2,000,000 Btu.

85. What information can a combustion analyzer provide that helps tune a burner?

- A. The exact internal bearing clearance of the induced-draft fan.
- B. The hardness breakthrough point of a water softener resin bed.
- C. The insulation resistance of every motor winding in the plant.
- D. Flue-gas measurements such as oxygen and carbon monoxide, depending on the instrument.

86. What does an increasing differential pressure across an air filter most commonly indicate?

- A. The filter is becoming cleaner as particles fill its pores.
- B. The fan motor insulation resistance is increasing.
- C. The filter is accumulating dirt and becoming more resistant to airflow.
- D. The chilled-water chemical concentration is falling.

87. What is the job of a damper actuator in an air-handling system?

- A. Measure refrigerant superheat at the evaporator outlet.

- B. Move the damper blade assembly in response to a control command.
- C. Lubricate fan bearings while the fan is running.
- D. Regulate boiler-water conductivity through blowdown.

88. A fan has 1.2 inches water column of positive pressure at its discharge and 0.4 inches water column of negative pressure at its inlet. Ignoring velocity-pressure differences, what is the pressure rise across the fan?

- A. 1.6 inches water column.
- B. 0.8 inches water column.
- C. 1.2 inches water column.
- D. 2.4 inches water column.

89. What is the goal of air balancing in a duct system?

- A. Close every balancing damper to maximize fan static pressure.
- B. Set all terminals to identical airflow regardless of room load.
- C. Adjust the system so required airflow is delivered to the intended branches and terminals.
- D. Increase refrigerant charge until each diffuser feels cold.

90. What occurs in the mixing section of many air-handling units?

- A. Outdoor air and return air are proportioned and mixed before further conditioning.
- B. Boiler steam is mixed directly with natural gas before combustion.
- C. Refrigerant liquid and compressor oil are blended for charging.
- D. Electrical phases are mixed to reduce motor voltage.

91. What symptom may indicate V-belt slip on an air-handling fan?

- A. Higher fan speed than the motor shaft without any special drive.
- B. Reduced fan speed or airflow with belt squeal, heat, or belt wear.

- C. Perfect airflow regardless of belt condition.
- D. Automatic increase in chilled-water flow through the coil.

92. After motor wiring work, an air-handling fan rotates backward. What is the likely system effect?

- A. The fan automatically produces more airflow because reverse rotation increases pitch.
- B. The filter differential pressure becomes zero regardless of airflow.
- C. Cooling-coil water flow increases because the fan direction changed.
- D. Airflow and pressure can be greatly reduced even though the motor is running.

93. What is the purpose of a fire or smoke damper installed in ductwork?

- A. Regulate refrigerant superheat at the evaporator outlet.
- B. Control boiler steam pressure during normal firing.
- C. Restrict fire or smoke spread through designated duct openings.
- D. Maintain fan bearing lubrication during an alarm.

94. A coil receives 10,000 cfm of air over a face area of 50 square feet. What is the average face velocity?

- A. 100 feet per minute.
- B. 200 feet per minute.
- C. 250 feet per minute.
- D. 500 feet per minute.

95. Why is an unobstructed return-air path important in a recirculating HVAC system?

- A. It increases boiler steam pressure by reducing room volume.
- B. It guarantees every room receives identical supply airflow.
- C. It eliminates the need for outdoor ventilation air.
- D. Provide a low-resistance path for air returning to the handler.

96. Where should a duct-mounted humidity sensor be evaluated if its reading seems implausible?

- A. At its actual sensing location while comparing it with a reliable reference and nearby air conditions.
- B. Only at the boiler gauge glass because humidity follows water level.
- C. By measuring motor winding resistance instead of air moisture.
- D. By adding refrigerant until the displayed humidity value changes.

97. A clean filter has a pressure drop of 0.4 inch water column and the same filter later measures 1.2 inches. How much did the pressure drop increase?

- A. 0.8 inch water column.
- B. 0.4 inch water column.
- C. 1.6 inches water column.
- D. 3.0 inches water column.

98. Why is insulation applied to cold supply-air ducts in warm humid spaces?

- A. To increase duct leakage so building pressure remains neutral.
- B. To raise fan bearing temperature above the dew point.
- C. To remove the need for a vapor barrier under all conditions.
- D. To reduce heat gain and help prevent condensation on the duct exterior.

99. What trend is most useful for detecting a developing air-handler fan bearing problem?

- A. A stable temperature and vibration trend at normal load.
- B. Lower filter pressure drop immediately after installing a clean filter.
- C. Increasing vibration or bearing temperature compared with the normal baseline.
- D. Unchanged mixed-air temperature during steady outdoor conditions.

100. What is a major advantage of using a variable-frequency drive on a suitable supply fan motor?

- A. It permanently eliminates the need for motor overcurrent protection.
- B. It can vary motor speed to match airflow demand and reduce unnecessary fan energy use.
- C. It converts the fan into a constant-volume device at every command.
- D. It removes the need to verify minimum airflow or system pressure limits.

Practice Exam 7: Answer Key and Explanations

1. A — Lockout/tagout prevents unexpected energization or release of stored energy while maintenance is being performed. A control switch or overload reset does not provide positive isolation from every hazardous energy source. The authorized worker should isolate, control stored energy, and verify deenergization before beginning service. Record normal readings for later comparison.

2. C — Parallel branches connect across the same two electrical nodes, so each branch has the same applied voltage. Branch current, resistance, and power can differ because each branch may contain a different load. This relationship helps technicians interpret branch measurements and identify abnormal voltage drops or open circuits. Use operating trends to confirm the diagnosis.

3. B — Ohm law gives current as voltage divided by resistance, so 240 divided by 20 equals 12 amperes. The other choices result from using the wrong arithmetic operation or an incorrect resistance relationship. A measured value far from 12 amperes would justify checking supply voltage, resistance, and connections. Follow the equipment procedure during corrective work.

4. D — An overload relay responds to sustained motor current conditions that can overheat windings and damage insulation. Short-circuit protection is normally provided by fuses or circuit breakers, not the overload element itself. Overload settings should match the motor and application rather than being increased simply to stop nuisance trips. Confirm the symptom under stable operating conditions.

5. A — Swapping any two phases changes the phase sequence and reverses the rotating magnetic field in a three-phase motor. Overload settings, grounding, and control voltage do not intentionally reverse the motor magnetic-field sequence. After correcting phase sequence, verify safe driven-equipment rotation before returning the machine to normal service. Compare measurements with the expected system relationship.

6. C — At unity power factor, single-phase real power is voltage times current: 240 times 10 equals 2,400 watts. Dividing by 1,000 converts watts to 2.4 kilowatts; the other answers reflect common factor-of-two or decimal errors. Comparing calculated power with nameplate and measured values can reveal abnormal loading or metering mistakes. Verify readings before changing components.

7. D — A transformer transfers alternating-current energy magnetically between windings and changes voltage according to its turns ratio. It does not create pneumatic pressure, act as a rotating energy-storage device, or replace insulation-testing instruments. Correct transformer identification is important because primary and secondary voltage ratings determine safe system connections. Record normal readings for later comparison.

8. B — Equipment grounding and bonding provide an effective fault-current path so protective devices can clear dangerous ground faults. The grounding path is not intended to carry normal load current, raise voltage, or replace required overcurrent protection. Loose bonding connections can leave enclosures energized without producing enough fault current for prompt clearing.

9. D — The auxiliary sealing or holding contact closes after the contactor energizes and keeps the coil circuit complete. It does not bypass overload protection, operate the disconnect, or reduce line voltage supplied to the motor. If the holding contact fails, the starter may drop out as soon as the START button is released.

10. C — Repeated fuse operation indicates an abnormal current condition that must be identified before the circuit is reenergized. Oversizing or bypassing protection can expose conductors and equipment to damaging fault energy rather than solve the cause. Check for short circuits, grounded conductors, locked loads, and correct protective-device sizing under approved procedures.

11. B — The evaporator absorbs heat from the cooled medium while low-pressure refrigerant boils and becomes vapor. Heat rejection occurs in the condenser, pressure rise occurs in the compressor, and storage is not the evaporator primary purpose. Evaporator performance therefore depends on heat transfer, refrigerant feed, and adequate airflow or fluid flow.

12. A — The suction line returns low-pressure vapor leaving the evaporator to the compressor inlet in a standard cycle. The liquid line carries high-pressure liquid, while the discharge line carries hot high-pressure vapor from the compressor. Recognizing line function helps technicians interpret temperature, pressure, insulation, and oil-return symptoms correctly. Verify readings before changing components.

13. B — The condenser rejects both the evaporator load and compressor-added heat, causing high-pressure vapor to condense to liquid. Metering occurs at the expansion device, compression occurs in the compressor, and heat absorption occurs in the evaporator. Poor condenser heat transfer commonly raises condensing pressure and increases compressor work. Record normal readings for later comparison.

14. A — A thermostatic expansion valve modulates refrigerant feed in response to evaporator outlet superheat and pressure conditions. It does not directly regulate compressor discharge pressure, liquid-line subcooling, or condenser approach temperature. Maintaining appropriate superheat helps use evaporator surface effectively while reducing the risk of liquid reaching the compressor. Use operating trends to confirm the diagnosis.

15. C — Compressors are designed to compress vapor, and sufficient suction superheat helps prevent damaging liquid refrigerant from entering. High-pressure or subcooled liquid belongs on the high side,

and deliberate liquid carryover can cause slugging or oil dilution. Suction condition should therefore be evaluated with both pressure-derived saturation temperature and measured line temperature.

16. D — Restricted airflow reduces heat transfer into the evaporator, often lowering evaporating temperature and suction pressure under load. It does not force suction pressure upward, equalize the system, or make condenser pressure collapse to atmospheric pressure. Before adding refrigerant to a low-suction system, verify airflow and evaporator load so the true cause is not missed.

17. D — Superheat equals measured vapor temperature minus saturation temperature at the same pressure: 45 minus 35 equals 10°F. Using only one temperature or adding the two values does not describe how far the vapor is above saturation. The measurement location and pressure-temperature reference must correspond for the calculated superheat to be meaningful.

18. C — Liquid subcooling equals condensing saturation temperature minus measured liquid temperature: 110 minus 95 equals 15°F. Adding the temperatures or using the line temperature alone does not measure how far liquid is below saturation. Subcooling should be interpreted with condenser loading, metering-device behavior, and the manufacturer charging procedure. Verify readings before changing components.

19. B — A receiver stores high-pressure liquid refrigerant and can accommodate changes in system charge distribution during operation or service. It does not provide airflow, meter refrigerant to the evaporator, or separate motor windings from suction vapor. Receiver level and piping arrangement must still allow solid liquid to reach the metering device when required.

20. A — Bubbles can result from low charge, flashing caused by pressure drop, low subcooling, or changing operating conditions. Therefore a sight glass alone cannot prove compressor damage, an empty condenser, or the need to add refrigerant. Confirm subcooling, pressures, load, line condition, and charging guidance before changing the refrigerant quantity. Use operating trends to confirm the diagnosis.

21. D — Compressor oil must circulate and return in a controlled manner so bearings and moving parts remain lubricated. Oil logged in evaporators or piping can reduce heat transfer, while oil filling receivers or replacing vapor flow is undesirable. Correct pipe sizing, velocities, traps where appropriate, and operating conditions support reliable oil return.

22. C — Noncondensables occupy condenser volume and add partial pressure without condensing at normal system conditions. This can elevate head pressure and reduce useful heat-transfer area rather than lower pressure or remove condenser load. A suspected noncondensable condition should be distinguished from dirty condensers, overcharge, and high ambient temperature. Confirm the symptom under stable operating conditions.

23. B — Ice blocks airflow and changes evaporator heat load, making suction pressure and temperature readings misleading for charge diagnosis. Adding refrigerant, closing liquid flow permanently, or altering overload protection does not correct the underlying airflow or defrost problem. After removing

ice and restoring airflow, reassess superheat, subcooling, pressures, and load. Compare measurements with the expected system relationship.

24. B — Repeated low-pressure cycling means suction pressure is reaching the controller cutout and then recovering enough to restart. Possible causes include low load, airflow problems, restricted feed, low charge, or control issues rather than unrelated grounding changes. Troubleshooting should determine why suction pressure falls instead of repeatedly resetting or bypassing the control.

25. A — A pump-down sequence closes liquid feed and allows the compressor to remove much of the low-side refrigerant before stopping. This reduces refrigerant migration and floodback risk rather than deliberately filling the crankcase or evaporator while off. Proper controls must still protect against short cycling and abnormal pressure conditions during the sequence.

26. C — EPA Section 608 generally prohibits intentional venting of regulated refrigerants and substitutes during service and requires proper recovery practices. Releasing refrigerant outdoors, into a mechanical room, or through a condenser fan is not an acceptable substitute for recovery. Technicians should follow the applicable recovery procedure, equipment requirements, and site safety controls.

27. D — Sensible heat changes air temperature without directly changing moisture content, while latent cooling removes water vapor by condensation. The concepts are not defined by fan speed, air pressure, boilers, or refrigerant condensers alone. Cooling-coil performance should therefore be evaluated for both temperature reduction and moisture removal when humidity control matters.

28. A — Relative humidity compares actual water-vapor condition with saturation at the same air temperature, expressed as a percentage. It is not a ratio of duct pressures, oxygen removal, or filter bypass airflow. Because saturation capacity changes with temperature, the same moisture content can produce a different relative humidity after heating or cooling.

29. C — The sensible temperature difference is return temperature minus supply temperature: 78 minus 58 equals 20°F. Using the supply temperature alone or adding the readings does not represent the change produced across the cooling system. The result should be interpreted with airflow and load because temperature difference alone does not determine total capacity.

30. B — Multiplying the stated planning value by capacity gives 400 cfm per ton times 5 tons, or 2,000 cfm. The distractors come from dividing or using unrelated multipliers rather than the value provided in the question. Actual design airflow can differ, so field diagnosis should use the equipment data and measured system requirements.

31. A — An air-side economizer increases suitable outdoor-air use to satisfy part or all of a cooling load without full mechanical cooling. It does not bypass ventilation rules, pressurize boiler systems, or stop the supply fan while claiming normal air delivery. Reliable economizer operation depends on sensors, dampers, controls, and appropriate outdoor-air conditions.

32. D — As particulate loading increases, filter resistance and differential pressure generally rise, which can reduce airflow through the system. Dirt does not make the media more porous, add refrigerant

charge, or guarantee a lower return-air temperature. Differential-pressure trend and actual airflow provide better maintenance evidence than changing filters solely by visual appearance.

33. A — Dehumidification requires air to contact a coil cold enough for moisture to condense and drain away during sufficient run time. Preventing condensation or disabling drainage defeats moisture removal, while indiscriminate heating does not correct the underlying control issue. Check coil temperature, airflow, run time, drainage, and ventilation moisture loads before changing controls.

34. C — Cooling coils condense water vapor from air, and that liquid must leave the drain pan through a properly arranged drain system. The condensate drain is not a refrigerant oil return, fan-pressure device, or boiler feedwater connection. Blocked drains can cause overflow, water damage, wet insulation, and undesirable biological growth around air-handling equipment.

35. D — Duct static pressure reflects pressure conditions associated with airflow resistance through filters, coils, dampers, and ductwork. It does not directly measure refrigerant purity, water chemistry, or motor insulation resistance. Comparing pressure readings at consistent locations helps locate restrictions and determine whether the fan is operating near its intended system point.

36. B — The speed ratio is 1,080 divided by 900, or 1.2; airflow changes directly with speed under the stated similarity assumption. Multiplying 10,000 cfm by 1.2 gives 12,000 cfm, while the other values use incorrect ratios or exponents. Real systems should also be checked for motor loading, pressure, and control limits after speed changes.

37. A — Water temperature rise through the coil equals leaving temperature minus entering temperature: 54 minus 44 equals 10°F. Using one reading alone or adding the temperatures does not measure the heat pickup across the coil. The temperature difference should be considered with water flow because both quantities influence the heat-transfer rate.

38. B — A deadband creates a neutral temperature range between heating and cooling responses, reducing unnecessary cycling and opposing commands. It does not require simultaneous heating and cooling, remove temperature sensing, or directly increase refrigerant pressure. Appropriate deadband and staging improve control stability while still allowing the system to respond when conditions move beyond the neutral range.

39. C — A VAV terminal regulates the quantity of conditioned supply air delivered to a zone as its load changes. It is not a boiler feedwater controller, refrigerant receiver, or condenser-water reversing device. Some boxes also provide reheat, but airflow modulation remains central to matching zone demand while maintaining stable system operation.

40. D — Outdoor-air damper position changes how much outside air enters the system, affecting thermal load, humidity, and building pressure relationships. It does not set boiler safety pressure, determine compressor oil viscosity, or eliminate the need for appropriate filtration. Compare commanded position with actual linkage or actuator response because a control signal alone does not prove movement.

41. D — Supply leakage sends conditioned air to locations where it is not intended, reducing useful delivery and wasting fan and conditioning energy. Leakage does not add air at the occupied terminal, guarantee better humidity control, or affect boiler-water level directly. Pressure testing, inspection, and airflow measurements can help distinguish duct leakage from fan or balancing problems.

42. C — Dirt adds thermal resistance to the coil surface and can obstruct airflow through the fin passages. It therefore tends to reduce heat-transfer effectiveness and raise airside pressure drop rather than improve conductivity or eliminate resistance. Cleaning should restore coil surface and drainage without damaging fins, coatings, sensors, or nearby electrical components.

43. A — A low-water cutoff protects the boiler from firing when heat-transfer surfaces may no longer be safely covered by water. Increasing firing, opening unrelated steam valves, or bypassing flame safeguards would increase risk rather than correct low water. Operators should respond according to procedure and determine the cause instead of automatically adding water to an overheated boiler.

44. B — A safety valve is a final pressure-relief device intended to prevent boiler pressure from exceeding its safe operating limit. Feedwater controls manage level, combustion controls manage fuel and air, and deaeration addresses dissolved gases. Safety valves must remain unobstructed and should never be used as routine operating pressure controls. Use operating trends to confirm the diagnosis.

45. A — Boiler evaporation leaves many dissolved and suspended impurities behind, so controlled blowdown removes concentrated water and helps maintain chemistry limits. Blowdown does not intentionally increase solids, route flue gas to feedwater, or lubricate pump bearings. Excessive blowdown wastes heat and water, while insufficient blowdown can promote scale, carryover, and deposits.

46. D — Draft establishes the pressure difference needed to move combustion air into the furnace and combustion products toward the stack. It does not control boiler-water hardness, directly measure steam quality, or serve as an electrical grounding path. Incorrect draft can contribute to unstable flames, poor combustion, furnace pressure problems, or excess air infiltration.

47. C — The feedwater system replaces water converted to steam or lost through blowdown and maintains the operating water level. Fuel systems handle combustion input, soot cleaning addresses fireside deposits, and safety valves must not be restricted. Reliable feedwater depends on adequate supply, pump condition, controls, check valves, and proper water treatment.

48. B — A deaerator heats and contacts feedwater to release dissolved gases, especially oxygen, which can contribute to corrosion. It does not intentionally increase hardness, maximize condensate cooling, or supply combustion air to the burner. Proper venting, temperature, pressure, and chemical treatment complement deaeration in protecting the feedwater and steam system. Verify readings before changing components.

49. D — Steam traps remove condensate and air from steam equipment while retaining useful steam as much as their design permits. Closing all return paths can waterlog equipment, while makeup water and

burner fuel control are separate functions. Failed-open traps waste steam; failed-closed traps can cause poor heat transfer, water hammer, or stalled equipment.

50. A — The gauge glass gives the operator a direct visual reference for boiler water level within its connected range. It does not measure stack oxygen, automatically prove every cutoff works, or determine fuel heating value. The glass and connections must be kept clear and checked according to procedure because plugged passages can create a false level indication.

51. C — For saturated water and steam, saturation temperature and saturation pressure are directly related along the saturation curve. Increasing pressure therefore raises boiling temperature rather than forcing it downward or leaving it constant. This relationship explains why steam tables or pressure-temperature references are used when evaluating saturated steam and condensate conditions.

52. B — Efficiency is useful output divided by input: 800,000 divided by 1,000,000 equals 0.80, or 80 percent. Twenty percent represents the difference rather than efficiency, while 50 and 125 percent do not follow the stated energy balance. Field boiler efficiency assessment also considers measurement accuracy, stack losses, blowdown, radiation, and operating load.

53. B — Flame safeguards are intended to prevent unburned fuel accumulation when a proven flame is absent during the firing sequence. Increasing fuel or bypassing detection could create an explosive mixture, and the safety valve is not a burner-proving device. A flame failure requires the prescribed shutdown, purge, inspection, and restart sequence rather than repeated manual resets.

54. A — Soot forms an insulating layer between hot combustion gases and heat-transfer surfaces, reducing the transfer of heat into boiler water. It does not improve conductivity, guarantee low stack temperature, or treat water through the tube wall. Combustion quality and fireside cleanliness should be maintained together because poor combustion often accelerates deposit formation.

55. D — Returned condensate is already heated and is often relatively clean, so it reduces the quantity of cold makeup water requiring treatment and heating. It does not intentionally increase blowdown, makeup demand, or scale-forming solids. A sound return system therefore conserves water, chemicals, and fuel while also supporting stable feedwater conditions.

56. C — Priming and carryover occur when boiler water or dissolved material leaves with the steam instead of remaining separated in the boiler. They are not blowdown, burner air preheating, or complete moisture removal from the steam path. High water level, sudden load changes, foaming, and poor water chemistry can contribute to carryover problems.

57. B — Refractory materials withstand furnace temperatures and protect structural surfaces while helping contain heat within the combustion space. They do not route boiler water into the flame, act as pressure gauges, or replace pressure-retaining metal components. Cracked or missing refractory can create hot spots, air leakage, heat loss, and damage to nearby components.

58. D — Scale has relatively poor thermal conductivity and acts as insulation between hot metal and boiler water. That raises metal temperature for the same heat duty and can reduce efficiency or

contribute to tube damage. Scale prevention depends on proper water treatment, blowdown control, makeup-water quality, and monitoring rather than accepting deposits as protective.

59. C — Cavitation occurs when local pressure falls enough for vapor bubbles to form and then collapse as pressure recovers. The resulting noise, vibration, and performance loss are not signs of ideal hydraulic balance or normal bearing operation. Check suction pressure, liquid temperature, strainers, valve position, piping losses, and available suction head before condemning the pump.

60. A — Discharge throttling increases system resistance and moves a centrifugal pump to a lower-flow operating point on its curve. Restricting suction can promote cavitation, closing suction stops proper operation, and loosening a coupling creates a mechanical hazard. For large or frequent flow changes, speed control may be more efficient if the system and motor permit it.

61. C — Correct lubricant separates moving surfaces, carries heat, and limits wear, but excessive grease can churn and raise temperature. Lubricants are not universally interchangeable, and alignment does not eliminate the need for proper lubrication. Follow bearing and equipment specifications for lubricant type, quantity, interval, contamination control, and relubrication procedure. Record normal readings for later comparison.

62. D — Misalignment imposes cyclic forces and unwanted loads on shafts, bearings, couplings, and seals as the equipment rotates. Flexible couplings can tolerate limited misalignment but cannot absorb unlimited offset without penalty, and alignment does not cure hydraulic cavitation. Precision alignment should be checked after installation, piping work, foundation changes, or unusual vibration trends.

63. B — A new vibration after maintenance suggests something changed in assembly, alignment, balance, fastening, or operating condition. Increasing speed, ignoring the symptom, or indiscriminately adding grease can worsen damage and obscure the cause. Use baseline data, frequency or amplitude measurements where available, inspection, and safe shutdown criteria to guide troubleshooting. Follow the equipment procedure during corrective work.

64. A — V-belts need enough tension to transmit torque without excessive slip, but too much tension increases radial bearing and shaft loads. High tension does not correct pulley alignment, eliminate belt wear, or improve bearing life without limit. Inspect sheave condition, alignment, belt match, and manufacturer tension guidance rather than tightening until slip merely disappears.

65. C — A mechanical seal creates controlled sealing surfaces around the rotating shaft to limit process-fluid leakage from the pump casing. It does not change impeller diameter, test electrical insulation, or control motor phase sequence. Seal life depends on alignment, clean sealing surfaces, correct flush or cooling arrangements, and avoiding dry operation or excessive vibration.

66. B — Intercooling removes heat from compressed air before it enters the next stage, reducing specific volume and subsequent compression work. It does not intentionally heat the air, lubricate the receiver, or reverse the drive motor between stages. Effective coolers and moisture separation also reduce discharge temperatures and the amount of water carried farther into the air system.

67. D — A temperature increase can indicate excessive load, poor lubrication, contamination, cooling problems, misalignment, or developing mechanical damage. Running dry or adding load increases risk, while ignoring a trend may allow a preventable failure to progress. Compare temperature with normal history and inspect the lubrication system and mechanical condition under safe procedures.

68. A — Guards separate people from rotating shafts, couplings, belts, and pinch points that can catch clothing or body parts. They do not improve hydraulic suction, increase motor speed, or replace lockout/tagout when maintenance exposes hazardous motion or stored energy. Guards should be secure during operation and removed only under the required safe maintenance controls.

69. C — A pH below 7 is acidic, 7 is neutral under standard reference conditions, and values above 7 are alkaline. pH does not directly state that water contains no dissolved ions, and it should not be confused with hardness or conductivity. Plant treatment decisions should use calibrated testing and the limits established for the particular water system.

70. B — Calcium and magnesium hardness can precipitate under suitable conditions and form deposits that interfere with heat transfer and flow. Hardness does not prevent all corrosion, replace filtration, or guarantee lower conductivity. Softening, chemical treatment, blowdown, and makeup-water control are selected according to system pressure, temperature, materials, and required water quality.

71. A — Conductivity measures how readily water conducts electric current and often tracks the overall concentration of dissolved ions. It does not identify every specific ion or directly diagnose mechanical bearings or air filters. Because temperature and water composition affect the reading, conductivity is most useful when measured consistently and trended against established operating limits.

72. D — A conventional sodium ion-exchange softener replaces calcium and magnesium hardness ions with sodium as water passes through the resin. It does not mechanically screen dissolved salts, perform thermal deaeration, or intentionally increase hardness. Regeneration restores resin capacity, and hardness testing confirms whether the unit is producing acceptable softened water before downstream use.

73. D — Reverse osmosis uses pressure to move water through a membrane that rejects much of the dissolved ionic material. It is different from coarse straining, intentional hardness addition, or oxygenation of a closed system. Pretreatment, membrane pressure, recovery, fouling control, and product-water quality all affect how well an RO system performs in service.

74. B — Corrosion inhibitors are chemicals selected to reduce electrochemical attack on system metals, often by promoting protective surface conditions. They cannot guarantee leak-free joints, should not create heavy suspended solids, and do not eliminate the need for testing. Correct inhibitor concentration, pH, oxygen control, makeup rate, and compatible metallurgy should be monitored together.

75. A — Warm recirculating cooling water can support biological growth, so an appropriate biocide program helps control organisms and associated fouling. Biocides do not replace electrical protection, stop evaporation, or intentionally form mineral scale. Treatment selection and handling must follow the

site program, chemical instructions, water conditions, and applicable safety requirements. Follow the equipment procedure during corrective work.

76. C — Estimated cycles of concentration equal circulating-water conductivity divided by makeup-water conductivity: 1,500 divided by 300 equals 5. The other answers result from incorrect division or subtraction rather than the stated conductivity-ratio method. This estimate assumes conductivity behaves as a suitable concentration tracer and should be checked against the actual treatment program and water chemistry.

77. B — Alkalinity describes the acid-neutralizing capacity contributed by species such as bicarbonate, carbonate, and hydroxide depending on water conditions. It is not a measurement of dissolved oxygen, mechanical bearings, or filter pressure drop. Alkalinity interacts with pH, hardness, and treatment chemistry, so operators should interpret it within the specific boiler or cooling-water program.

78. D — Dissolved oxygen participates in corrosion reactions and can produce localized pitting in steel piping, vessels, and heat-transfer equipment. It does not reliably prevent corrosion, remove hardness scale, or lubricate pump bearings. Deaeration, oxygen scavenging where appropriate, minimizing air ingress, and maintaining proper chemistry are common elements of oxygen-corrosion control. Verify readings before changing components.

79. C — Hydrocarbon combustion requires oxygen to oxidize carbon and hydrogen and release useful heat under controlled burner conditions. Nitrogen largely passes through as a diluent, while steam and lubricating oil are not substitutes for combustion oxygen. Burner systems therefore meter fuel and combustion air so a stable flame receives enough oxygen without excessive wasted air.

80. A — Excess air beyond that needed for safe complete combustion increases the mass of gas heated and discharged through the stack. It does not increase the fuel inherent heating value, eliminate stack loss, or remove the need for draft and flame safeguards. Combustion should be tuned using appropriate measurements rather than minimized by flame appearance alone.

81. A — A suspected fuel-gas leak can create fire or explosion hazards, so established emergency actions and ignition-source control take priority. Operating switches, lighting a flame, or waiting for an automatic trip can introduce ignition or delay protective action. Personnel should follow the facility emergency plan and only trained, authorized workers should perform leak isolation or testing.

82. D — Many heavier fuel oils become less viscous as temperature rises, improving pumping, straining, and atomization at the burner. Heating does not eliminate combustion-air requirements or convert fuel directly to electricity, and it generally does not increase viscosity. Fuel temperature should remain within the equipment and fuel specifications to avoid poor atomization, coking, or handling problems.

83. C — Flame appearance can provide useful qualitative information, but it varies with fuel type, burner design, viewing conditions, and operating load. Color alone cannot quantify oxygen, carbon monoxide, efficiency, draft, or fuel pressure and may hide unsafe conditions. Use combustion instruments, flame safeguards, and manufacturer operating criteria together with visual observation.

84. B — Input energy equals fuel quantity multiplied by the stated heating value: 1,000 cubic feet times 1,000 Btu per cubic foot. That gives 1,000,000 Btu; the other answers use incorrect multipliers or divide when the relationship requires multiplication. Actual delivered energy depends on measured fuel quantity and the applicable fuel-heating-value basis.

85. D — A combustion analyzer samples flue gas and can report values such as oxygen, carbon monoxide, carbon dioxide, and calculated efficiency parameters depending on model. It does not directly measure bearing clearances, water-softener exhaustion, or motor insulation resistance. Combustion data should be interpreted with draft, flame stability, fuel pressure, load, and equipment specifications.

86. C — As a filter captures particulate, resistance commonly increases and produces a larger pressure difference between upstream and downstream locations. That trend does not directly indicate motor insulation or chilled-water chemistry, and loading does not make the filter hydraulically cleaner. Use the specified final resistance and actual system airflow rather than replacing filters solely by calendar time.

87. B — A damper actuator converts an electrical, pneumatic, or other control signal into mechanical motion that positions the damper. It does not measure refrigerant superheat, provide bearing lubrication, or regulate boiler-water conductivity. Troubleshooting should compare the control command, actuator motion, linkage condition, and actual blade position instead of assuming signal equals movement.

88. A — Pressure rise equals discharge pressure minus inlet pressure: 1.2 minus negative 0.4 equals 1.6 inches water column. Subtracting magnitudes incorrectly gives 0.8, while the other values do not follow the stated pressure relationship. Use consistent reference signs and tap locations so fan pressure measurements can be compared accurately with design data.

89. C — Air balancing measures and adjusts branch and terminal flows so the distribution system delivers the design or required airflow. Closing all dampers, forcing identical flow everywhere, or changing refrigerant charge does not achieve proper distribution. Balancing should be performed with fans, filters, dampers, and controls in appropriate operating condition so adjustments remain meaningful.

90. A — The mixing section combines controlled amounts of return and outdoor air before the air passes through filters, coils, or other components. It does not mix boiler fuel, refrigerant charge, or electrical phases. Damper leakage, failed actuators, or incorrect sensors can change the mixed-air condition and create heating, cooling, humidity, or pressurization problems.

91. B — A slipping belt loses motion between the driver and driven sheave, which can reduce fan speed and produce heat, noise, glazing, or wear. Slip cannot make a conventional belt-driven fan outrun its drive ratio or guarantee airflow, and it does not directly control chilled-water flow. Check tension, alignment, belt match, sheave condition, and load.

92. D — Many centrifugal and propeller fans are designed for a specific rotation, and reverse rotation can severely reduce airflow and developed pressure. It does not automatically increase fan performance, eliminate filter resistance, or directly increase water flow through a coil. Verify fan rotation after electrical work and before relying on motor-running status as proof of air delivery.

93. C — Fire and smoke dampers are life-safety components intended to restrict the movement of fire, smoke, or both through designated duct locations. They are not refrigeration metering devices, boiler pressure controls, or bearing lubricators. Their operation, access, testing, and reset requirements should follow the applicable building system design and maintenance program.

94. B — Average face velocity equals airflow divided by face area: 10,000 cfm divided by 50 square feet equals 200 feet per minute. The distractors result from incorrect division factors or unrelated multipliers rather than the stated airflow-to-area relationship. Face velocity influences pressure drop, heat transfer, moisture carryover, and how uniformly air crosses the coil.

95. D — Return paths let conditioned-space air flow back to the air handler so the supply fan can move its intended circulation volume. Obstruction can alter building pressure and reduce airflow, but a return path does not guarantee identical supply or replace ventilation requirements. Check grilles, doors, dampers, duct restrictions, and return fan operation when pressure complaints occur.

96. A — A questionable humidity sensor should be compared with a trustworthy reference under the same air conditions at or near its sensing location. Boiler level, motor resistance, and refrigerant addition do not validate an air-humidity measurement. Also inspect sensor placement, contamination, calibration, wiring, signal scaling, and whether stratification or outside-air leakage affects the reading.

97. A — The increase is the new differential pressure minus the clean value: 1.2 minus 0.4 equals 0.8 inch water column. The other values use one reading alone, add the readings, or apply an unrelated multiplier. Compare the result with the filter and system replacement criteria while also confirming airflow and pressure-tap condition.

98. D — Insulation limits unwanted heat transfer into cold supply air and helps keep the exterior surface temperature above the surrounding air dew point. It does not intentionally increase leakage, heat bearings, or eliminate the need for appropriate vapor control. Damaged insulation or vapor barriers can allow condensation, wet materials, energy loss, and corrosion of concealed duct surfaces.

99. C — Developing bearing defects often reveal themselves through changes in vibration, temperature, noise, or lubricant condition compared with established normal behavior. Stable readings are less suggestive of a developing bearing fault, while filter and mixed-air conditions describe other systems. Trend consistent measurement locations and operating loads so changes are meaningful instead of comparing unrelated conditions.

100. B — A variable-frequency drive changes motor frequency and speed, allowing fan output to follow changing system demand rather than relying only on throttling. A VFD does not eliminate electrical protection, force constant volume, or remove operating limits. Control sequences should maintain required ventilation, pressure, coil airflow, and stable operation while taking advantage of reduced fan speed.