

PRACTICE EXAM 8: STATIONARY ENGINEER APPRENTICE SIMULATION (100 QUESTIONS)

This independently created practice exam contains 100 questions based on stationary-engineer apprenticeship competencies. Select the single best answer for each question. There is no single national Stationary Engineer Apprentice written-test time limit or passing score; individual apprenticeship programs and jurisdictions may use different selection and examination requirements.

1. What is the primary reason a boiler operator must maintain the water level within the normal operating range?

- A. To keep heating surfaces safely covered with water
- B. To increase stack draft above design conditions
- C. To eliminate the need for boiler blowdown
- D. To raise steam pressure without added firing

2. What is the main function of a low-water cutoff on a fired boiler?

- A. Increase feedwater flow whenever steam pressure rises
- B. Open the safety valve before the set pressure is reached
- C. Reduce combustion air when stack temperature increases
- D. Stop burner firing when water level becomes unsafe

3. A boiler is producing 18,000 Btu/h of useful heat from 24,000 Btu/h of fuel input. What is the thermal efficiency?

- A. 60%
- B. 75%
- C. 80%

D. 90%

4. A boiler produces steam at 12,000 lb/h for 2.5 hours at a steady rate. Approximately how many pounds of steam are produced?

- A. 24,000 lb
- B. 32,500 lb
- C. 30,000 lb
- D. 36,000 lb

5. Which boiler device is intended to prevent pressure from rising above a safe limit by automatically releasing steam?

- A. Feedwater regulator
- B. Steam separator
- C. Forced-draft fan
- D. Safety valve

6. What is the purpose of an economizer in a steam-boiler plant?

- A. Recover flue-gas heat to warm incoming feedwater
- B. Cool combustion gases before they enter the furnace
- C. Separate moisture from steam leaving the boiler drum
- D. Reduce feedwater pressure before the boiler inlet

7. What is a common effect of heavy soot deposits on boiler fireside heating surfaces?

- A. Improved heat transfer and lower fuel consumption
- B. Lower furnace temperature with unchanged efficiency
- C. Reduced heat transfer and higher flue-gas temperature
- D. Increased feedwater quality and lower dissolved solids

8. Why is boiler blowdown performed?

- A. To increase steam pressure during peak demand
- B. To control dissolved and suspended solids in boiler water
- C. To remove oxygen directly from incoming combustion air
- D. To lubricate internal feedwater-pump components

9. Which statement best distinguishes a typical firetube boiler from a typical watertube boiler?

- A. Firetube units pass water through tubes surrounded only by steam
- B. Watertube units contain no drums or headers in normal designs
- C. Firetube units pass hot gas through tubes surrounded by water
- D. Watertube units cannot operate above atmospheric pressure

10. What is the principal purpose of a deaerator in a boiler feedwater system?

- A. Remove dissolved gases such as oxygen from feedwater
- B. Increase dissolved oxygen before water enters the boiler
- C. Lower feedwater temperature to improve combustion efficiency
- D. Add suspended solids so sludge settles in the boiler

11. As pressure on liquid water increases, what happens to its saturation temperature?

- A. The saturation temperature decreases
- B. The saturation temperature increases
- C. The saturation temperature remains fixed
- D. The water immediately becomes superheated steam

12. What is the main operational reason for supplying some excess air to a boiler burner?

- A. Guarantee zero heat loss through the boiler stack
- B. Reduce oxygen in flue gas to exactly zero percent
- C. Replace the need for burner flame-safeguard controls
- D. Promote complete combustion despite imperfect fuel-air mixing

13. In boiler operation, what does furnace draft describe?

- A. The hardness level of makeup water entering the boiler
- B. The pressure relationship that moves combustion air and flue gas
- C. The electrical current drawn by the forced-draft motor
- D. The steam quality leaving a separator downstream

14. A boiler has normal firing rate but an unusually high stack temperature. Which condition should be investigated first?

- A. Excessively low feedwater hardness
- B. A fully open steam stop valve
- C. Fouled heat-transfer surfaces
- D. A recently lubricated fan bearing

15. A boiler receives 50 million Btu/h of fuel energy and delivers 40 million Btu/h as useful steam energy. What is its efficiency?

- A. 70%
- B. 75%
- C. 90%
- D. 80%

16. Why is water carryover from a boiler into the steam line undesirable?

- A. It can send moisture and dissolved solids into downstream equipment
- B. It always increases steam superheat above design temperature
- C. It permanently lowers boiler-water conductivity to zero
- D. It eliminates the need for traps and separators downstream

17. What is the compressor's primary function in a vapor-compression refrigeration system?

- A. Raise refrigerant vapor pressure and move it through the system
- B. Lower liquid refrigerant pressure before the evaporator
- C. Reject heat from refrigerant to condenser air or water
- D. Store liquid refrigerant during normal low-load operation

18. What occurs in the condenser of a normal vapor-compression refrigeration cycle?

- A. Refrigerant absorbs space heat and boils at low pressure
- B. Refrigerant pressure drops through a throttling restriction
- C. Refrigerant rejects heat and condenses toward a liquid state
- D. Refrigerant vapor is mechanically compressed to higher pressure

19. What is the primary job of a thermostatic expansion valve or similar metering device?

- A. Increase refrigerant pressure before it enters the condenser
- B. Remove noncondensable gases from the refrigeration circuit
- C. Pump compressor oil directly into the evaporator coil
- D. Reduce refrigerant pressure and regulate flow into the evaporator

20. What is the evaporator designed to do in a refrigeration system?

- A. Reject heat as high-pressure refrigerant condenses
- B. Absorb heat as low-pressure refrigerant boils
- C. Compress vapor to the system high-side pressure

D. Store liquid refrigerant after the condenser

21. What does refrigerant superheat indicate at an evaporator outlet?

- A. Liquid temperature below the saturation temperature at that pressure
- B. Vapor temperature above the saturation temperature at that pressure
- C. Condenser pressure below the evaporator pressure during operation
- D. The amount of oil dissolved in refrigerant entering the compressor

22. What does liquid-line subcooling represent?

- A. Liquid temperature below saturation temperature at the measured pressure
- B. Vapor temperature above saturation temperature at the measured pressure
- C. The pressure drop across the compressor discharge valve
- D. The difference between room dry-bulb and wet-bulb temperature

23. A direct-expansion system has abnormally low suction pressure and an evaporator starved of refrigerant. Which condition is most consistent with that symptom?

- A. Excessive refrigerant feed flooding the evaporator
- B. Severely fouled condenser causing very high head pressure only
- C. Restricted refrigerant flow through the metering path
- D. Compressor motor turning off while all pressures equalize

24. Which condition commonly causes abnormally high condensing pressure in an air-cooled refrigeration system?

- A. Excessive evaporator airflow with a clean coil
- B. Low outdoor temperature with normal fan operation
- C. A fully open suction service valve
- D. Restricted condenser airflow or a dirty condenser coil

25. What is the purpose of a liquid receiver in a refrigeration system that uses one?

- A. Separate oil from compressor discharge gas at high pressure
- B. Prevent liquid refrigerant from entering the suction line directly
- C. Measure evaporator superheat and modulate compressor speed
- D. Store liquid refrigerant and help provide liquid to the metering device

26. Persistent bubbles in a liquid-line sight glass can indicate which condition, assuming the system normally should show a solid liquid column?

- A. Guaranteed compressor mechanical failure
- B. Flash gas or insufficient liquid reaching the sight glass
- C. Excessive oil pressure at the compressor bearings
- D. A completely flooded evaporator under every load condition

27. What is the purpose of a suction accumulator in a refrigeration system?

- A. Reduce the chance of liquid refrigerant entering the compressor
- B. Store condensed liquid on the high-pressure side of the system
- C. Increase discharge pressure by restricting compressor outlet flow
- D. Remove heat from condenser water before it reaches a cooling tower

28. What is the main purpose of an oil separator installed in the compressor discharge line?

- A. Meter liquid refrigerant into the evaporator according to superheat
- B. Reduce suction pressure before vapor enters the compressor crankcase
- C. Remove entrained oil from hot discharge gas and return it appropriately
- D. Store liquid refrigerant when the condenser is under low load

29. Where should the sensing bulb of a thermostatic expansion valve normally sense refrigerant condition?

- A. On the liquid receiver at the condenser inlet connection
- B. On the compressor discharge line before the condenser
- C. At the evaporator outlet or suction line leaving the evaporator
- D. Inside the condenser-water leaving header

30. A refrigeration load is 36,000 Btu/h. Using 12,000 Btu/h per ton, what is the load in refrigeration tons?

- A. 2 tons
- B. 4 tons
- C. 6 tons
- D. 3 tons

31. A chiller removes 420 kW of heat while using 105 kW of compressor power. What is its coefficient of performance, COP, for this simplified calculation?

- A. 3.0
- B. 4.0
- C. 4.5
- D. 5.0

32. Why are both refrigerant pressure and temperature useful when diagnosing a vapor-compression system?

- A. Together they help identify saturation condition, superheat, or subcooling
- B. Pressure alone always identifies refrigerant state without temperature
- C. Temperature alone proves refrigerant charge quantity in every system
- D. Neither measurement is useful unless the compressor is stopped

33. Which heat load changes air temperature without directly changing its moisture content?

- A. Latent heat
- B. Condensation load
- C. Sensible heat
- D. Dehumidification load

34. What does relative humidity describe?

- A. The amount of water vapor present relative to the maximum possible at that temperature
- B. The exact mass of dry air moving through a duct each minute
- C. The difference between supply-air and return-air static pressure
- D. The percentage of oxygen remaining after a burner completes combustion

35. What happens when a surface temperature falls below the dew point of surrounding air?

- A. Air automatically becomes completely dry
- B. The surface must rise above room temperature
- C. All sensible heat transfer immediately stops
- D. Water vapor can condense on the surface

36. Why does cooling air below its dew point across a cooling coil also dehumidify the air?

- A. The coil chemically destroys water vapor in the airstream
- B. Moisture condenses on the cold coil and drains away
- C. The fan separates moisture by centrifugal force alone
- D. The refrigerant absorbs only latent heat and no sensible heat

37. Which condition can cause an evaporator or cooling coil to ice even when refrigerant charge is correct?

- A. Excessive airflow across a clean coil
- B. Insufficient airflow across the coil

- C. A properly operating condensate trap
- D. Normal return-air temperature and filter condition

38. What is the purpose of a thermostat deadband in a heating and cooling control sequence?

- A. Force heating and cooling outputs to operate at the same time
- B. Increase humidity whenever room temperature reaches setpoint
- C. Prevent rapid switching between heating and cooling around the setpoint
- D. Eliminate the need for temperature sensors in occupied zones

39. What is the function of the reversing valve in a typical air-source heat pump?

- A. Increase compressor motor voltage during cold outdoor conditions
- B. Drain condensate from the indoor coil during cooling operation
- C. Meter outdoor ventilation air into the occupied building
- D. Change refrigerant flow direction so indoor and outdoor coils exchange roles

40. In a closed chilled-water loop, what is the main purpose of an expansion tank?

- A. Accommodate water-volume changes and help stabilize system pressure
- B. Remove all dissolved minerals from the circulating water
- C. Increase pump speed whenever a control valve closes
- D. Cool condenser water before it reaches the cooling tower

41. What is the primary purpose of a cooling tower in a water-cooled chiller system?

- A. Cool supply air directly before it enters occupied spaces
- B. Raise refrigerant pressure before the condenser
- C. Remove hardness from boiler makeup water
- D. Reject condenser-water heat to the outdoor environment

42. A chilled-water system uses $Q = 500 \times \text{gpm} \times \Delta T$ for Btu/h. At 240 gpm and a 12°F temperature difference, what is the heat-transfer rate?

- A. 1,200,000 Btu/h
- B. 1,440,000 Btu/h
- C. 1,680,000 Btu/h
- D. 2,400,000 Btu/h

43. In normal cooling operation, how should chilled-water return temperature compare with chilled-water supply temperature after serving a load?

- A. Return water should generally be warmer than supply water
- B. Return water should always be colder than supply water
- C. Supply and return must always be exactly the same temperature
- D. Return water must be at the refrigerant condensing temperature

44. What is condenser water in a typical water-cooled chiller plant used to do?

- A. Carry cooling directly from the evaporator to room diffusers
- B. Supply boiler feedwater to a steam drum
- C. Carry heat from the chiller condenser to the cooling tower
- D. Provide lubricating oil to the compressor bearings

45. What is the main function of a variable-air-volume, VAV, terminal box?

- A. Modulate supply airflow to a zone in response to load
- B. Compress refrigerant vapor before the condenser
- C. Maintain boiler drum water level during steaming
- D. Store chilled water during off-peak operation

46. When an air-side economizer is enabled under suitable outdoor conditions, what does it primarily use to reduce mechanical cooling?

- A. Hot condenser water routed through the supply duct
- B. Additional compressor stages operating at higher pressure
- C. Cool outdoor air introduced through controlled dampers
- D. Boiler steam injected into the mixed-air plenum

47. An air handler mixes 30% outdoor air at 90°F with 70% return air at 75°F. Ignoring heat gains, what is the mixed-air temperature?

- A. 78.0°F
- B. 82.5°F
- C. 85.5°F
- D. 79.5°F

48. A chilled-water coil has normal water flow but poor cooling and very low air movement. Which check is most appropriate first?

- A. Increase chilled-water temperature above return-air temperature
- B. Inspect filters, fan operation, and air-side restrictions
- C. Close the supply fan discharge damper completely
- D. Disable all zone temperature sensors before testing

49. What does an increasing pressure drop across an HVAC filter usually indicate?

- A. The fan is producing no airflow through the duct
- B. The filter is becoming cleaner during operation
- C. The duct system has lost all static pressure
- D. The filter is becoming loaded and more restrictive

50. According to the basic fan affinity relationship, what happens to airflow if fan speed increases while the system and fan geometry remain similar?

- A. Airflow increases approximately in proportion to fan speed
- B. Airflow decreases approximately in proportion to fan speed
- C. Airflow remains exactly constant regardless of fan speed
- D. Airflow changes only if motor voltage also changes proportionally

51. What is static pressure in an air-distribution system most useful for evaluating?

- A. The moisture content of supply air leaving a cooling coil
- B. Resistance the fan must overcome to move air through the system
- C. The electrical insulation resistance of the fan motor
- D. The refrigerant saturation temperature inside the evaporator

52. What is the primary purpose of a volume-control damper in a duct system?

- A. Increase refrigerant pressure entering a condenser
- B. Remove dissolved oxygen from boiler feedwater
- C. Regulate or balance airflow through a duct path
- D. Protect a pump from loss of suction pressure

53. Why is outdoor air intentionally introduced into many occupied-building air systems?

- A. Provide ventilation and dilute internally generated contaminants
- B. Guarantee lower indoor humidity in every weather condition
- C. Eliminate all need for filtration and air cleaning
- D. Keep supply-air temperature equal to outdoor temperature

54. What is return air in a typical recirculating HVAC system?

- A. Air discharged outdoors from a combustion appliance flue
- B. Fresh air entering the building directly from outdoors
- C. Air brought back from conditioned spaces toward the air handler
- D. Compressed air supplied to pneumatic tools in a plant

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

- A. Higher delivered airflow at every downstream diffuser
- B. Automatic correction of room pressurization problems
- C. Lower fan power with no effect on system performance
- D. Reduced delivered airflow and wasted fan or conditioning energy

56. What is a common effect of excessive belt tension on a belt-driven supply fan?

- A. Improved bearing life with no disadvantages
- B. Increased bearing and shaft loading
- C. Elimination of pulley alignment requirements
- D. Automatic reduction of motor current to zero

57. Why is proper sheave alignment important on a belt-driven fan?

- A. It increases refrigerant subcooling in the cooling coil
- B. It reduces belt wear, vibration, and side loading
- C. It removes dissolved solids from chilled water
- D. It guarantees constant duct static pressure without controls

58. A fan bearing is running hotter than normal shortly after relubrication. Which maintenance error should be considered?

- A. A correctly installed clean filter

- B. Normal outdoor-air damper operation
- C. Overlubrication of the bearing
- D. Proper alignment of the fan sheaves

59. What is the purpose of testing and balancing an air-distribution system?

- A. Adjust and verify airflow so design distribution is achieved
- B. Raise refrigerant pressure until every zone receives equal cooling
- C. Increase boiler firing rate to compensate for low airflow
- D. Eliminate the need for dampers, registers, and terminal devices

60. What is the main function of a supply-air diffuser?

- A. Measure motor insulation resistance at the air handler
- B. Reduce liquid refrigerant pressure before the evaporator
- C. Remove scale from a boiler tube during operation
- D. Distribute conditioned air into a space with an intended pattern

61. What is the purpose of a fire or smoke damper in an air-distribution system?

- A. Continuously balance normal supply airflow in every occupied zone
- B. Increase fan airflow whenever a filter becomes dirty
- C. Limit the spread of fire or smoke through duct openings when required
- D. Maintain compressor oil pressure during a power failure

62. Which HVAC action directly increases moisture removal from humid air at a cooling coil?

- A. Maintain the coil surface below the entering-air dew point
- B. Raise the coil surface above the entering-air dry-bulb temperature
- C. Bypass all air around the coil while keeping the fan on
- D. Heat the air first and avoid any contact with a cold surface

63. Air moves through a duct at an average velocity of 900 ft/min. If the duct area is 2.5 ft², what is the airflow?

- A. 1,800 cfm
- B. 2,250 cfm
- C. 2,700 cfm
- D. 3,600 cfm

64. A fan delivers 6,000 cfm at 900 rpm. Using the proportional fan-flow law, what airflow is expected at 1,080 rpm with the same system and fan geometry?

- A. 6,600 cfm
- B. 7,800 cfm
- C. 8,100 cfm
- D. 7,200 cfm

65. A 120-volt circuit has a 24-ohm resistive load. Using Ohm's law, what current flows?

- A. 5 A
- B. 4 A
- C. 6 A
- D. 8 A

66. A single-phase resistive load operates at 230 V and draws 12 A. Ignoring power factor effects, what electrical power does it use?

- A. 2,300 W
- B. 3,120 W
- C. 3,600 W
- D. 2,760 W

67. In a simple series circuit, which quantity is the same through each component?

- A. Voltage drop
- B. Resistance
- C. Current
- D. Power consumption

68. In an ideal parallel circuit connected to one source, which quantity is the same across each branch?

- A. Branch current
- B. Voltage
- C. Branch resistance
- D. Branch power

69. What is the function of a motor contactor?

- A. Use an electrically operated mechanism to switch power to a motor load
- B. Provide mechanical lubrication to the motor bearings during starting
- C. Convert alternating current directly into compressed air
- D. Measure refrigerant pressure and open a liquid-line valve

70. What is the primary purpose of a motor overload relay?

- A. Protect personnel from every possible electrical shock condition
- B. Raise line voltage when the motor starts under heavy load
- C. Reverse motor rotation whenever current rises above normal
- D. Protect the motor from sustained overcurrent that can cause overheating

71. What is the basic purpose of a fuse or circuit breaker in a power circuit?

- A. Increase current whenever a motor begins to slow down
- B. Interrupt excessive fault current before conductors or equipment are damaged
- C. Maintain constant room temperature without a controller
- D. Reduce refrigerant pressure ahead of the evaporator

72. What does a transformer primarily change in an AC electrical system?

- A. Frequency from 60 Hz to any desired value without electronics
- B. Mechanical shaft speed through a belt-and-sheave arrangement
- C. Voltage and current relationship through electromagnetic induction
- D. Refrigerant saturation pressure through throttling

73. A 4–20 mA control signal represents 0–100% of a command. What percentage command is represented by 12 mA?

- A. 40%
- B. 50%
- C. 60%
- D. 75%

74. In a PID control loop, which action responds to the accumulated error over time?

- A. Integral action
- B. Proportional action
- C. Derivative action
- D. Manual reset only

75. Why must many centrifugal pumps be primed before starting if they are not self-priming?

- A. The motor requires water inside its windings before electrical power is applied
- B. The discharge valve must contain compressed air to create suction pressure

- C. The pump bearings can operate only when flooded with process liquid
- D. The casing and suction path need liquid so the impeller can develop pumping action

76. What is pump cavitation?

- A. Normal air cooling of the motor during steady full-load operation
- B. A controlled increase in discharge pressure caused by closing a bypass valve
- C. Formation and collapse of vapor bubbles where local liquid pressure becomes too low
- D. The intentional mixing of grease and oil inside a bearing housing

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

- A. Limit leakage where the rotating shaft passes through the pump casing
- B. Increase pump speed whenever system resistance rises
- C. Prevent all vibration from reaching the pump foundation
- D. Measure differential pressure across the pump impeller

78. What does available NPSH primarily relate to in centrifugal-pump operation?

- A. Electrical power margin above the motor nameplate rating
- B. Discharge-valve travel remaining before full open position
- C. Bearing grease quantity remaining before the next service interval
- D. Suction-side pressure margin above the liquid vapor-pressure condition

79. A pump suction gauge reads 28 psi and its discharge gauge reads 72 psi at the same elevation. What is the approximate differential pressure?

- A. 36 psi
- B. 50 psi
- C. 44 psi
- D. 100 psi

80. Using 2.31 ft of water head per psi, what head corresponds to a 35 psi pressure difference?

- A. 70.00 ft
- B. 80.85 ft
- C. 75.60 ft
- D. 92.40 ft

81. What is the purpose of proper bearing lubrication in rotating machinery?

- A. Increase shaft misalignment so seals seat more tightly
- B. Eliminate the need to monitor vibration or temperature
- C. Prevent any possible electrical fault in the drive motor
- D. Reduce friction and wear while carrying the intended load

82. Why is shaft coupling alignment important between a motor and driven pump?

- A. Misalignment can increase vibration, bearing load, and seal wear
- B. Misalignment always increases pump efficiency at part load
- C. Alignment removes the need for a flexible coupling entirely
- D. Alignment guarantees the pump will never cavitate

83. A centrifugal pump delivers 500 gpm at 1,750 rpm. Using the proportional flow-speed law, what flow is expected at 1,400 rpm with the same system assumption?

- A. 350 gpm
- B. 450 gpm
- C. 400 gpm
- D. 625 gpm

84. What is the purpose of a check valve in a pump discharge line?

- A. Continuously throttle pump flow to maintain exact design pressure
- B. Permit flow in the intended direction while limiting reverse flow
- C. Remove entrained air from the pump casing before every start
- D. Measure motor current and trip the starter on overload

85. Why is hardness in boiler or heat-exchanger water a concern?

- A. Hardness always removes existing corrosion products from metal
- B. Hardness guarantees lower conductivity at every concentration
- C. Hardness minerals can form scale on heat-transfer surfaces
- D. Hardness prevents deposits by keeping solids permanently dissolved

86. What does a sodium-cycle water softener primarily remove from makeup water?

- A. Calcium and magnesium hardness ions
- B. All dissolved oxygen and carbon dioxide
- C. Every dissolved salt regardless of ion type
- D. Suspended oil droplets by mechanical filtration only

87. A water sample has a pH of 7.0 under standard interpretation. How is it described?

- A. Strongly acidic
- B. Strongly alkaline
- C. Fully demineralized
- D. Neutral

88. What does electrical conductivity of water generally indicate?

- A. The exact concentration of one specific mineral only
- B. The water's ability to carry current due largely to dissolved ions
- C. The amount of suspended dust trapped in an air filter

D. The mechanical condition of a pump coupling

89. Cooling-tower circulating water conductivity is 1,800 $\mu\text{S}/\text{cm}$ and makeup conductivity is 450 $\mu\text{S}/\text{cm}$. Using the simple conductivity ratio, what are the cycles of concentration?

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

90. Why is dissolved oxygen undesirable in many boiler feedwater systems?

- A. It always prevents scale from forming on hot surfaces
- B. It raises steam pressure without additional heat input
- C. It eliminates the need for deaeration and chemical treatment
- D. It can accelerate localized corrosion of ferrous metal surfaces

91. What is the purpose of an oxygen-scavenging chemical in boiler-water treatment?

- A. Increase calcium hardness so protective scale forms rapidly
- B. Raise suspended solids until the boiler water becomes cloudy
- C. React with residual dissolved oxygen after mechanical removal steps
- D. Replace all blowdown by converting dissolved solids to steam

92. What is alkalinity most closely associated with in water treatment?

- A. Amount of oxygen dissolved in water at saturation
- B. Capacity to neutralize added acid and resist pH change
- C. Total suspended solids captured by a filter screen
- D. Electrical resistance of a motor winding to ground

93. Why are biocides used in cooling-water treatment programs?

- A. Control biological growth that can cause fouling and health or equipment concerns
- B. Increase mineral scale so heat-transfer surfaces remain protected
- C. Eliminate the need for blowdown by stopping evaporation
- D. Raise water temperature before it enters the cooling tower

94. What does stoichiometric combustion air mean?

- A. Any airflow above the maximum capacity of the burner fan
- B. The theoretical amount of air needed for complete combustion of a specified fuel
- C. The air required only to cool the burner housing after shutdown
- D. Outdoor ventilation air supplied to occupied spaces during heating

95. If flue-gas oxygen is higher than expected while combustion is otherwise complete, what does that often suggest?

- A. The burner is operating with no combustion air at all
- B. Fuel heating value has increased to an infinite value
- C. More excess air is passing through the combustion process than needed
- D. The boiler water level is necessarily below the gauge glass

96. Which combustion product is a key warning sign of incomplete combustion when carbon-based fuel is burned?

- A. Nitrogen from incoming air
- B. Water vapor from hydrogen combustion
- C. Excess oxygen in the flue gas
- D. Carbon monoxide

97. Why should flame appearance alone not be used as the only basis for burner adjustment?

- A. Flame appearance always gives an exact fuel-air ratio without instruments
- B. A visible flame proves carbon monoxide cannot be present
- C. Flame color directly measures boiler-water dissolved solids
- D. Appearance can be misleading, so combustion measurements and safe operating data are also needed

98. What is the main purpose of a fuel-gas pressure regulator in a burner gas train?

- A. Create combustion draft by exhausting flue gas from the stack
- B. Maintain suitable downstream gas pressure as upstream conditions or flow change
- C. Measure boiler-water conductivity and control surface blowdown
- D. Increase electrical frequency supplied to the burner motor

99. What is the effect of closing a combustion-air damper too far while fuel flow remains high?

- A. The mixture always becomes leaner with more excess oxygen
- B. Fuel flow automatically becomes zero in every burner design
- C. The mixture can become fuel-rich and combustion can become incomplete
- D. Stack heat loss must decrease without any safety consequence

100. A burner uses 80 standard cubic feet per hour of gas with a heating value of 1,000 Btu per standard cubic foot. What is the fuel heat input rate?

- A. 80,000 Btu/h
- B. 60,000 Btu/h
- C. 90,000 Btu/h
- D. 100,000 Btu/h

Practice Exam 8: Answer Key and Explanations

1. **A** — Maintaining proper water level keeps heat-transfer surfaces covered so metal temperature stays controlled. A dangerously low level can expose heated surfaces and cause severe overheating, while an excessively high level can carry water into the steam system. Level is therefore a basic boiler-protection variable, not merely a production setting. Confirm the indication before making an operating adjustment.
2. **D** — A low-water cutoff is a protective control that interrupts burner operation when water falls below a safe level. Continuing to fire with exposed heating surfaces can overheat pressure parts. The device does not regulate normal pressure, draft, or feedwater flow; those functions belong to other boiler controls and equipment. Use related instrument readings to verify the diagnosis first.
3. **B** — Thermal efficiency equals useful heat output divided by fuel heat input. Dividing 18,000 by 24,000 gives 0.75, or 75 percent. The other choices would imply either a lower or higher useful-output fraction than the stated numbers support. This calculation is an energy balance, not a combustion-air measurement. Check the actual operating condition before changing setpoints.
4. **C** — Total steam production equals the steady mass-flow rate multiplied by operating time. At 12,000 pounds per hour for 2.5 hours, production is 30,000 pounds. The distractors reflect using two hours, adding instead of multiplying, or overstating the duration. Units also confirm the setup because hours cancel. A trend is more useful than one isolated reading.
5. **D** — The safety valve is the pressure-relief device that opens automatically when boiler pressure reaches its set condition, allowing steam to escape and limiting further pressure rise. A feedwater regulator controls level, a steam separator removes entrained moisture, and a forced-draft fan supplies combustion air. None substitutes for pressure relief. Verify the cause before making a corrective change.
6. **A** — An economizer transfers residual heat from hot flue gas to incoming feedwater. Preheating the water reduces the amount of fuel energy the furnace must add to reach steaming conditions, improving overall plant efficiency. It is a heat-recovery surface; it does not serve as a steam separator, pressure reducer, or combustion-gas cooler for its own sake.
7. **C** — Soot acts as an insulating layer between hot combustion gases and the metal heating surface. As deposits build, less heat reaches the water or steam, so more energy leaves with the flue gas and stack temperature can rise. Soot does not improve water chemistry, and it generally increases rather than decreases fuel use.
8. **B** — Blowdown removes a controlled portion of concentrated boiler water and replaces it with lower-solids feedwater. This limits dissolved-solids concentration, sludge accumulation, foaming, and carryover. Excessive blowdown wastes heat and treated water, while insufficient blowdown allows contaminants to concentrate. It is therefore a water-quality control, not a pressure-control method. Safe troubleshooting starts with confirming the observed condition.
9. **C** — In a firetube boiler, hot combustion gases travel through tubes while water surrounds the tube surfaces in the shell. Watertube boilers reverse that basic arrangement, carrying water or steam-water

mixture inside tubes exposed to hot gases outside. Specific designs vary, but this heat-transfer-path distinction is the fundamental comparison used by operators.

10. A — A deaerator heats and contacts feedwater so dissolved gases, especially oxygen, are released and vented before the water enters the boiler system. Removing these gases helps reduce oxygen-related corrosion in feedwater lines and boiler components. The device typically heats rather than cools feedwater and does not intentionally add dissolved or suspended contaminants.

11. B — Water boils when its vapor pressure matches the surrounding pressure. Raising the pressure therefore requires a higher temperature before saturation and boiling occur. This is why pressurized boilers can produce saturated steam at temperatures above the atmospheric boiling point. Increased pressure does not automatically create superheated steam; additional heating beyond saturation is required.

12. D — Real burners do not mix every fuel molecule with exactly the theoretical amount of oxygen, so a controlled amount of excess air helps complete combustion. Too little air can increase carbon monoxide and unburned fuel, while too much air carries unnecessary heat up the stack. Excess air supplements mixing; it does not replace burner safety controls.

13. B — Draft is the pressure difference that causes combustion air to enter the furnace and flue gas to move through boiler passes and the stack. Natural, forced, or induced draft arrangements create and control this movement. Draft is therefore an airflow and gas-flow condition, not a measure of water chemistry, motor current, or steam moisture.

14. C — With firing rate unchanged, elevated stack temperature can indicate that heat is not transferring efficiently from combustion gas into the boiler water or steam. Fouling or soot on heat-transfer surfaces is a common cause. Feedwater hardness, steam-stop position, and recent bearing lubrication do not directly explain a persistent loss of heat to the stack.

15. D — Boiler efficiency for this simplified energy balance is useful steam energy divided by fuel energy input. Forty million divided by fifty million equals 0.80, or 80 percent. The remaining 20 percent represents losses in this simplified example. The answer follows directly from the stated energy rates rather than from steam pressure or feedwater temperature.

16. A — Carryover means boiler water droplets leave with the steam. Those droplets can contain dissolved solids and can cause deposits, water hammer, erosion, or poor process performance downstream. High water level, foaming, or excessive steaming rate can contribute. Carryover does not create superheat, purify the boiler water, or make downstream condensate-handling equipment unnecessary.

17. A — The compressor draws low-pressure refrigerant vapor from the evaporator and compresses it to a higher pressure so it can reject heat in the condenser. The metering device creates the pressure drop, the condenser rejects heat, and a receiver stores liquid. Compression also raises vapor temperature as part of the refrigeration cycle.

18. C — The condenser receives hot, high-pressure refrigerant from the compressor and transfers heat to air or water. As heat leaves, the refrigerant desuperheats and condenses toward liquid at the high-side pressure. Evaporation occurs in the evaporator, throttling occurs at the metering device, and mechanical compression occurs in the compressor. Compare related measurements before deciding on corrective action.

19. D — The metering device creates the high-side to low-side pressure drop and controls refrigerant flow into the evaporator. Lower pressure permits the refrigerant to boil at a lower temperature and absorb heat. It does not compress vapor, purge noncondensables, or serve as an oil pump. Proper feeding is essential for stable evaporator operation.

20. B — In the evaporator, low-pressure refrigerant absorbs heat from the air, water, or process being cooled. That heat causes liquid refrigerant to boil and become vapor. Heat rejection belongs to the condenser, compression belongs to the compressor, and bulk liquid storage belongs to a receiver when the system design includes one.

21. B — Superheat is the number of degrees a refrigerant vapor is above its saturation temperature at the measured pressure. At an evaporator outlet, adequate superheat helps indicate that liquid has boiled off before vapor reaches the compressor. Subcooling applies to liquid below saturation temperature. Pressure direction and oil concentration are different measurements.

22. A — Subcooling is the amount by which liquid refrigerant temperature is below the saturation temperature corresponding to its pressure. It helps confirm that a solid column of liquid is available to the metering device. Superheat describes vapor above saturation, while compressor pressure drop and room psychrometric temperature differences are separate diagnostic quantities.

23. C — A restriction in the liquid line or metering device can limit refrigerant entering the evaporator, leaving it starved and reducing suction pressure. Excessive feed tends toward flooding rather than starvation. A dirty condenser primarily raises condensing pressure, and a stopped compressor eventually allows system pressures to move toward equalization instead of maintaining a running low-suction condition.

24. D — The condenser must reject both evaporator heat and compressor-added heat. Dirty fins, blocked airflow, or failed condenser fans reduce heat rejection, causing condensing temperature and pressure to rise. High evaporator airflow or an open suction service valve does not create the same direct restriction to condenser heat transfer, and cool outdoor air usually lowers head pressure.

25. D — A receiver is a high-side vessel that stores liquid refrigerant downstream of the condenser and provides a reserve so the liquid line can feed the metering device. An oil separator performs discharge-gas oil separation, a suction accumulator protects against liquid return, and superheat sensing is performed by controls such as a thermostatic expansion valve system.

26. B — Bubbles can indicate that some refrigerant has flashed to vapor before the metering device or that the liquid line is not completely filled. Possible causes include low charge or excessive pressure

drop, depending on system design. A sight glass alone does not prove compressor failure, oil-pressure trouble, or a flooded evaporator, so other measurements must confirm the diagnosis.

27. A — A suction accumulator is installed in the low-side suction line to separate and temporarily hold liquid refrigerant so primarily vapor returns to the compressor. This reduces the risk of liquid slugging or dilution of compressor oil. A receiver stores high-side liquid, while discharge restriction and condenser-water cooling are unrelated functions.

28. C — An oil separator removes oil droplets carried out with compressor discharge gas and provides a path for oil return according to the system design. Keeping excessive oil out of heat exchangers supports heat transfer and lubrication control. Metering refrigerant, reducing suction pressure, and storing condensed liquid are functions of other components.

29. C — A thermostatic expansion valve regulates evaporator feeding based largely on outlet superheat, so its sensing bulb is attached to the suction line leaving the evaporator in a location specified by the manufacturer. A bulb on the receiver, discharge line, or condenser-water header would not represent evaporator outlet vapor condition and would drive incorrect valve control.

30. D — Refrigeration tons are found by dividing the heat-removal rate by the stated 12,000 Btu per hour per ton. Thirty-six thousand divided by twelve thousand equals three tons. The other options correspond to different loads. Because the conversion is supplied in the stem, no additional property table or refrigerant data is required.

31. B — For refrigeration, COP is cooling effect divided by the work input when both are expressed in consistent power units. Dividing 420 kW by 105 kW gives 4.0. A COP above one is normal because the compressor moves heat rather than converting all input power directly into cooling. The other values do not match the stated ratio.

32. A — Refrigerant saturation temperature is tied to pressure, while the actual measured temperature shows whether the refrigerant is at saturation, superheated, or subcooled. Using both readings therefore reveals more than either one alone. Charge amount cannot be proven from temperature alone, and useful operating measurements are routinely taken with the compressor running.

33. C — Sensible heat changes dry-bulb temperature and can be detected by an ordinary temperature measurement. Latent heat involves a phase change of moisture and changes humidity without necessarily producing the same direct dry-bulb effect. Condensation and dehumidification are latent processes because water vapor is removed from the air as liquid. The operating evidence should support the proposed diagnosis.

34. A — Relative humidity compares the actual water-vapor content or vapor pressure with the saturation value possible at the same temperature. Because the saturation capacity changes with temperature, relative humidity can change even when moisture content stays constant. It is not an airflow, static-pressure, or combustion measurement, although all may be important in building operation.

35. D — The dew point is the temperature at which the air becomes saturated for its existing moisture content. If a surface is colder than that point, water vapor adjacent to the surface can condense into liquid. This is why cooling coils and cold pipes may sweat. Condensation does not make the entire air mass dry or stop sensible heat transfer.

36. B — When air contacts a coil colder than its dew point, some water vapor condenses on the coil surface and is removed as condensate. The coil also reduces air temperature, so both sensible and latent cooling can occur. The process is physical condensation, not chemical destruction or fan separation, and refrigerant can absorb both load components.

37. B — Low airflow reduces the heat delivered to the coil while refrigeration continues removing heat. Coil surface temperature can then fall below freezing, causing condensate to freeze and further restrict airflow. A dirty filter, failed fan, or closed damper can contribute. Excessive airflow and a functioning condensate trap do not create this low-load freezing mechanism.

38. C — A deadband creates a small temperature range in which neither heating nor cooling is aggressively driven, reducing short cycling and preventing the two systems from fighting each other near the setpoint. Simultaneous heating and cooling wastes energy unless a specific process requires it. Deadband still depends on valid temperature sensing and control logic.

39. D — The reversing valve redirects refrigerant so the two heat exchangers trade evaporator and condenser roles between heating and cooling modes. The compressor continues to create the pressure difference, while the refrigerant path changes. The valve does not boost motor voltage, drain condensate, or control building ventilation air, which are separate system functions.

40. A — Water volume changes as temperature changes, and a closed hydronic system needs a compressible space to accept that expansion and maintain workable pressure. The expansion tank provides that function and establishes a pressure reference point in many systems. It is not a water softener, pump-speed controller, or condenser-water heat-rejection device.

41. D — A cooling tower rejects heat carried by condenser water from the chiller to the outdoor environment, largely through evaporation plus sensible heat transfer. It does not normally deliver conditioned air to occupied spaces or compress refrigerant. Water treatment may be associated with tower operation, but the tower itself is fundamentally a heat-rejection device.

42. B — Using the formula provided, multiply 500 by 240 gpm and then by the 12°F temperature difference. The result is 1,440,000 Btu per hour. The alternative values come from using different flow or temperature factors. This simplified hydronic calculation is useful for checking whether measured water flow and temperature change are consistent with expected load.

43. A — Chilled water leaves the chiller at a lower temperature, absorbs heat from building coils, and returns warmer. The supply-return temperature difference reflects heat pickup when flow is established. Equal temperatures can indicate little load, mixing, or a measurement issue. Return water is not tied directly to refrigerant condensing temperature, which is a separate circuit condition.

44. C — Condenser water circulates between the chiller condenser and the cooling tower, carrying rejected heat away from the refrigerant. Chilled water, by contrast, carries cooling between the evaporator and building loads. Boiler feedwater and compressor lubrication are separate systems. Keeping these loops conceptually separate is essential when interpreting temperatures, pressures, and pump operation.

45. A — A VAV terminal adjusts the amount of conditioned supply air delivered to a zone, commonly using a modulating damper and sometimes reheat. The central air handler may maintain duct pressure while each box responds to local demand. Refrigerant compression, boiler level control, and chilled-water storage are unrelated functions performed by different equipment.

46. C — An air-side economizer increases suitable outdoor-air intake and reduces return-air recirculation so cool outdoor air can satisfy part or all of the cooling load. Dampers and controls manage the mixture while mechanical cooling can be reduced. Hot condenser water, increased compressor staging, or steam injection would add heat rather than provide free cooling.

47. D — For a simple sensible mixing calculation, weight each air temperature by its airflow fraction. Thirty percent of 90°F is 27, and seventy percent of 75°F is 52.5; their sum is 79.5°F. The result must lie between the two entering temperatures and closer to 75°F because return air is the larger fraction.

48. B — If water flow is normal but air movement is very low, the first diagnostic path is the air side: filters, fan, belts, dampers, and coil cleanliness. Increasing chilled-water temperature would reduce cooling, while closing the discharge damper worsens airflow. Disabling sensors removes useful information without correcting the physical restriction or fan problem.

49. D — As dust accumulates in a filter, resistance to airflow generally rises, producing a larger pressure difference between the upstream and downstream sides at comparable airflow. A differential-pressure reading is therefore useful for maintenance decisions. A loaded filter does not mean airflow is necessarily zero, and it certainly does not become cleaner as pressure drop increases.

50. A — For a geometrically unchanged fan operating on the same system, the first fan law states that airflow varies approximately in direct proportion to rotational speed. Thus increasing speed tends to increase airflow. Pressure and power follow different relationships. Motor voltage may affect available speed or torque, but voltage itself is not the governing airflow relationship.

51. B — Static pressure represents the potential energy or pressure component associated with overcoming resistance in ducts, filters, coils, dampers, and terminal devices. Comparing static pressures helps assess system restriction and fan operating conditions. It is not a humidity measurement, an electrical insulation test, or a refrigerant property, even though those may be checked during broader troubleshooting.

52. C — A volume-control damper changes the effective flow area and resistance of a duct branch so airflow can be regulated or balanced. Automatic dampers may also respond to controls. The device is part of the air-distribution system and has no direct role in refrigerant compression, boiler-water deaeration, or pump suction protection.

53. A — Outdoor air is introduced primarily for ventilation so contaminants generated indoors are diluted and removed through the exhaust or relief path. Depending on weather, outdoor air can increase or decrease heating, cooling, and humidity loads, so it does not always reduce humidity. Ventilation also does not eliminate filtration or require supply air to match outdoor temperature.

54. C — Return air is air collected from conditioned spaces and routed back toward the air-handling unit, where some may be exhausted and the rest mixed with outdoor air for recirculation. It is distinct from outdoor ventilation air, flue gas, and industrial compressed air. Understanding these paths is important when diagnosing temperature, pressure, and air-quality problems.

55. D — Supply-duct leakage allows conditioned air to escape before reaching intended zones. The system may then deliver less airflow, operate longer, and waste heating, cooling, and fan energy. Leakage can also disrupt building pressure relationships. It does not reliably increase downstream airflow or automatically correct pressurization, and any fan-power change does not make the lost air harmless.

56. B — Overtightened belts place unnecessary radial load on motor and fan bearings and can accelerate bearing wear or shaft problems. Belts need enough tension to transmit torque without slipping, but more is not always better. Correct sheave alignment and manufacturer-recommended tension remain necessary, and excessive tension does not automatically reduce motor current.

57. B — Misaligned sheaves force belts to track sideways, increasing edge wear, vibration, and uneven loading on bearings and shafts. Proper alignment helps belts transmit power smoothly and last longer. Sheave alignment is a mechanical maintenance issue; it does not directly change refrigerant subcooling, water chemistry, or automatically regulate duct static pressure.

58. C — Too much grease can churn inside a bearing housing, increasing friction and temperature, particularly after relubrication. The correct lubricant type, quantity, and procedure matter as much as having lubricant present. A clean filter, normal damper operation, and proper sheave alignment are desirable conditions and are less consistent with a temperature rise immediately after greasing.

59. A — Testing and balancing measures actual airflow and adjusts dampers, terminals, fan settings, or related devices so the distribution approaches design requirements. The goal is not merely total fan volume; each branch and zone must receive appropriate flow. Refrigerant pressure and boiler firing are different systems, and balancing often depends on properly positioned dampers and terminals.

60. D — A diffuser delivers supply air to the occupied space and shapes its throw, spread, and mixing pattern so conditioned air is distributed effectively. It is a terminal air-distribution device. Electrical insulation testing, refrigerant metering, and boiler scale removal are unrelated tasks performed with different equipment and procedures. Confirm the indication before making an operating adjustment.

61. C — Fire and smoke dampers are protective devices used to restrict passage of fire, smoke, or both through duct penetrations or smoke-control pathways when their designed activation conditions occur. They are not ordinary balancing dampers, dirty-filter compensators, or refrigeration lubricating devices. Their inspection and operation should follow the system design and applicable facility procedures.

62. A — For moisture to condense from an airstream, the cooling surface must be below the air dew point. Water vapor then condenses and can drain from the coil. A warmer-than-air coil cannot dehumidify by condensation, and bypassing the coil prevents contact. Heating alone may lower relative humidity but does not remove moisture from the air.

63. B — Airflow in cubic feet per minute equals average velocity in feet per minute multiplied by duct cross-sectional area in square feet. Multiplying 900 by 2.5 gives 2,250 cfm. The units reduce correctly to cubic feet per minute. The other answers would require a different measured velocity, area, or an incorrect arithmetic step.

64. D — Under the stated fan-law assumption, airflow changes in direct proportion to speed. The speed ratio is 1,080 divided by 900, which equals 1.2. Multiplying 6,000 cfm by 1.2 gives 7,200 cfm. This ideal relationship is useful for estimating changes, although real systems may shift because resistance and control conditions also change.

65. A — Ohm's law gives current as voltage divided by resistance. Dividing 120 volts by 24 ohms produces 5 amperes. The other choices do not satisfy $V = I \times R$ for the stated values. In actual troubleshooting, the circuit must also be assessed for safe isolation and whether the load behaves as the simplified resistive model assumes.

66. D — For the simplified resistive load stated, electrical power equals voltage multiplied by current. Multiplying 230 volts by 12 amperes gives 2,760 watts. The distractors result from different current or voltage assumptions. Real alternating-current loads may require power factor in the calculation, but the stem explicitly removes that additional factor. Use related instrument readings to verify the diagnosis first.

67. C — A series circuit provides only one current path, so the same current passes through each component. Individual voltage drops depend on component resistance, and the resistances themselves may differ. Power also varies with voltage drop and resistance. This relationship helps troubleshoot open circuits because one interruption stops current throughout the entire series path.

68. B — Each parallel branch is connected across the same two source nodes, so the voltage across every branch is the same in the ideal circuit. Current depends on each branch resistance, and power therefore can differ as well. Recognizing this relationship helps an operator predict whether a branch problem should affect voltage or only that branch's current path.

69. A — A contactor is an electrically operated switch designed to make and break power to a load such as a motor, usually under command from a lower-power control circuit. It may work with overload protection but does not itself lubricate bearings, produce compressed air, or sense refrigerant pressure. Its contacts and coil serve distinct power and control roles.

70. D — An overload relay is intended to protect a motor from excessive current over time that can overheat the windings. It is commonly coordinated with a contactor and short-circuit protection. It is not a complete shock-protection device, a voltage booster, or an automatic reversing device. Different protective components address different electrical hazards and fault types.

71. B — Fuses and circuit breakers provide overcurrent protection by opening a circuit when current exceeds their intended protective range under fault or overload conditions, depending on device type and coordination. They do not increase motor current, control room temperature, or meter refrigerant. Proper device selection must match the electrical system and protected equipment.

72. C — A transformer transfers AC energy magnetically between windings and changes voltage according to the turns relationship, with a corresponding inverse current relationship in an ideal device. It does not mechanically change shaft speed, throttle refrigerant, or freely convert frequency. Frequency conversion generally requires other equipment, while transformer operation depends on alternating magnetic flux.

73. B — The usable signal span is 16 mA, from 4 to 20. A 12 mA signal is 8 mA above the 4 mA zero point. Eight divided by sixteen equals 0.50, so the command is 50 percent. Subtracting the live-zero value is essential; dividing 12 directly by 20 would give the wrong scaling.

74. A — Integral action sums or accumulates control error over time and changes the output until persistent offset is reduced. Proportional action responds to present error, while derivative action responds to the rate of change of error. Excessive integral can contribute to overshoot or windup, so tuning must match the dynamics of the controlled process.

75. D — A centrifugal pump impeller is designed to impart energy to liquid. If the casing and suction path are filled with air, the pump may not create enough pressure difference to lift and move liquid, so priming is required for many installations. Priming does not involve flooding motor windings, pressurizing discharge air, or necessarily lubricating bearings with process fluid.

76. C — Cavitation occurs when local pressure falls low enough for liquid to vaporize, forming bubbles that later collapse as pressure recovers. Collapse can create noise, vibration, erosion, and reduced performance. It is a hydraulic condition linked to suction and internal pressure, not normal motor cooling, routine discharge control, or an acceptable lubrication practice.

77. A — A mechanical seal controls leakage along the rotating shaft where it exits the pump casing. Its stationary and rotating faces operate with a very small controlled interface, supported by the seal design and fluid conditions. The seal does not regulate pump speed, eliminate all vibration, or measure differential pressure, although leakage patterns can provide diagnostic clues.

78. D — Net positive suction head available represents the suction-side energy or pressure margin above the liquid's vapor-pressure requirement, expressed as head. Adequate margin helps prevent vapor formation at the pump inlet and impeller eye. It is a hydraulic suction concept, not an electrical loading, valve-position, or lubrication-quantity measurement. Check the actual operating condition before changing setpoints.

79. C — Differential pressure across the pump is discharge pressure minus suction pressure when the gauges are referenced comparably. Subtracting 28 psi from 72 psi gives 44 psi. Adding the two pressures would be incorrect, and the other distractors do not match the stated readings. Differential pressure is useful when evaluating developed head and operating point.

80. B — The conversion is supplied in the question: multiply the 35 psi pressure difference by 2.31 feet of water per psi. The product is 80.85 feet of head. The unit psi cancels in the stated conversion relationship. This converts pressure difference to equivalent water head; it does not by itself determine flow or pump efficiency.

81. D — Correct lubrication forms the intended film or contact condition that reduces friction, controls wear, and supports bearing life. Too little, too much, contaminated, or incorrect lubricant can all create problems. Lubrication cannot correct misalignment, replace vibration and temperature monitoring, or prevent every electrical fault in the motor or starter. A trend is more useful than one isolated reading.

82. A — A coupling transmits torque between shafts, and excessive angular or offset misalignment creates additional forces that can increase vibration and loading on bearings, seals, and coupling elements. Proper alignment supports reliable operation but does not guarantee hydraulic performance. Cavitation depends mainly on suction and liquid conditions, and many systems still require flexible couplings after alignment.

83. C — Under the stated proportional affinity-law assumption, flow varies directly with pump speed. The speed ratio is 1,400 divided by 1,750, which equals 0.8. Multiplying 500 gpm by 0.8 gives 400 gpm. Real systems can deviate because the operating point also depends on the system curve and control-valve positions. Verify the cause before making a corrective change.

84. B — A check valve is a self-acting valve intended to allow flow in one direction and close when flow attempts to reverse. On pump discharge, it can help prevent reverse flow when the pump stops. It is not a precision throttling device, an automatic priming system, or an electrical overload-protection component.

85. C — Calcium and magnesium hardness can precipitate under suitable temperature and concentration conditions, forming scale on heat-transfer surfaces. Scale acts as thermal insulation and can contribute to overheating or efficiency loss. Hardness does not automatically remove corrosion products or guarantee low conductivity. Treatment aims to prevent harmful precipitation and manage the resulting solids appropriately.

86. A — A sodium-cycle softener uses ion exchange to replace hardness ions such as calcium and magnesium with sodium ions. This reduces scale-forming hardness but does not remove all dissolved salts or gases. Oxygen removal is handled by deaeration or chemical treatment, while oil and suspended material require other separation or filtration methods.

87. D — On the conventional pH scale, a value of 7 is described as neutral, while lower values are acidic and higher values are alkaline. Neutral pH does not mean the water contains no dissolved minerals or salts. Water-treatment decisions therefore use pH together with conductivity, hardness, alkalinity, treatment residuals, and other measurements relevant to the system.

88. B — Water conductivity increases as the concentration and mobility of dissolved ions increase, so it is often used as an overall indicator of dissolved ionic content or concentration trend. It does not identify

one particular ion by itself. Filter dust loading and coupling condition are mechanical or air-system issues and cannot be inferred directly from a water conductivity reading.

89. A — For the simplified estimate given, cycles of concentration equal circulating-water conductivity divided by makeup-water conductivity when both are measured comparably. Dividing 1,800 by 450 gives four cycles. The ratio helps indicate concentration by evaporation, although actual treatment control should also consider water chemistry, blowdown, drift, leakage, and the limitations of conductivity as a surrogate.

90. D — Dissolved oxygen can participate in electrochemical corrosion and contribute to pitting of steel surfaces, especially in feedwater and condensate systems. Mechanical deaeration and appropriate chemical treatment are commonly used to control it. Oxygen does not provide useful pressure energy, prevent scale, or remove the need for treatment; uncontrolled oxygen is itself a corrosion concern.

91. C — An oxygen scavenger is used to react with residual dissolved oxygen that remains after mechanical deaeration or other removal steps, reducing its corrosion potential. The specific chemical and control target depend on the plant treatment program. The objective is not to increase hardness, create suspended solids, or eliminate the need to control dissolved-solids concentration through blowdown.

92. B — Alkalinity represents the acid-neutralizing capacity of water, mainly from bicarbonate, carbonate, hydroxide, and related species depending on conditions. It influences buffering and water-treatment chemistry but is not the same as pH. Dissolved oxygen, suspended solids, and motor insulation resistance are separate measurements requiring different tests and interpretations. Safe troubleshooting starts with confirming the observed condition.

93. A — Cooling-water systems can support bacteria, algae, and other biological growth because they contain water, nutrients, air, and suitable temperatures. Biocides are used as part of a controlled program to limit that growth and resulting fouling or other risks. They do not intentionally build mineral scale, stop evaporation, or replace concentration control through blowdown.

94. B — Stoichiometric or theoretical air is the calculated amount containing enough oxygen to react completely with a specified fuel under ideal chemistry. Real burners normally require some excess air because mixing is imperfect. Combustion air is distinct from burner-cooling air or building ventilation air, even when all may ultimately come from the outdoor environment.

95. C — Oxygen remaining in flue gas generally indicates that more oxygen entered than was consumed by combustion. A higher-than-expected value can therefore point to excessive excess air, leakage, or a measurement issue, depending on the system. It does not indicate zero air, determine fuel heating value by itself, or prove anything about boiler water level.

96. D — Carbon monoxide forms when carbon-containing fuel is not fully oxidized to carbon dioxide, so elevated CO is an important indicator of incomplete combustion and potentially unsafe burner conditions. Nitrogen largely passes through from combustion air, and water vapor is a normal product of

hydrogen combustion. Excess oxygen may accompany poor tuning but is not itself an incomplete-combustion product.

97. D — Flame appearance can provide useful clues, but color and shape vary with burner type, fuel, viewing conditions, and operating rate. Reliable adjustment therefore uses appropriate combustion measurements, draft information, manufacturer guidance, and stable operating data. A visually acceptable flame does not prove correct excess air or zero carbon monoxide, and it reveals nothing about boiler-water solids.

98. B — A gas pressure regulator reduces and controls downstream fuel pressure within its intended operating range despite reasonable changes in inlet pressure or flow demand. Stable pressure supports consistent burner operation. Draft equipment moves combustion gases, conductivity controls water treatment, and electrical drives control motor power; none performs the regulator's fuel-pressure function.

99. C — Closing the air damper reduces combustion airflow. If fuel flow does not decrease correspondingly, the mixture becomes richer and may produce unstable flame, soot, carbon monoxide, or unburned fuel. Burner safeguards and controls are designed to manage safe sequencing, but an operator should not assume fuel will automatically fall to zero or that reduced stack loss makes the condition safe.

100. A — Fuel heat input equals volumetric fuel-use rate multiplied by heating value when both are expressed on compatible standard-volume bases. Multiplying 80 standard cubic feet per hour by 1,000 Btu per standard cubic foot gives 80,000 Btu per hour. This is fuel input, not useful boiler output; efficiency losses would reduce delivered heat.