

PRACTICE EXAM 16: RED SEAL STEAMFITTER/PIPEFITTER SIMULATION (130 QUESTIONS)

1. A steamfitter finds a steam trap that is hot at the inlet, cold at the outlet, with condensate backing up into the equipment upstream. The most accurate diagnosis is that the trap has:
- A. Failed open, allowing live steam to blow continuously through to the return line
 - B. Failed closed, holding back condensate so it floods the equipment ahead of it
 - C. Lost its prime, causing it to discharge intermittently in short cyclic bursts
 - D. Reached normal operating equilibrium with the condensate fully subcooled inside
2. A pump must deliver 4 L/s against a total dynamic head of 30 m. Using the approximate formula for water power ($\text{kW} = \text{flow in L/s} \times \text{head in m} \times 0.00981$), the hydraulic power required is about:
- A. 0.12 kW, far too small to register on any practical motor selection for this duty
 - B. 1.18 kW, found by multiplying the flow, head, and the constant together for water
 - C. 11.8 kW, found by multiplying flow and head without applying the constant factor
 - D. 118 kW, an industrial-scale figure unrelated to this modest flow and head duty
3. A welder qualified on a 6G coupon may also weld in which of the following positions without further testing?
- A. Only the 6G inclined fixed position, since each position requires separate qualification
 - B. Only the flat (1G) position, because 6G qualification is limited to downhill progression
 - C. All positions, because 6G is the all-position pipe test that covers flat, vertical, and overhead
 - D. Only horizontal-rolled (2G) joints, since the inclined coupon excludes overhead work entirely

4. A hydronic system gauge reads 100 kPa at the highest point. To keep that point above atmospheric and prevent air ingress, the fill pressure at a basement boiler 15 m below must be set to at least about:

- A. 100 kPa, since the fill pressure should match the desired pressure at the highest point
- B. 47 kPa, found by subtracting the column head from the desired top-of-system pressure
- C. 247 kPa, the top pressure plus the roughly 147 kPa head of the 15 m water column
- D. 1500 kPa, found by multiplying the elevation in metres by one hundred for the head

5. A steamfitter troubleshoots a centrifugal pump that delivers reduced flow, vibrates, and makes a sound like gravel passing through it. The most likely cause is:

- A. The discharge valve has been left fully open, running the pump far below its design head
- B. The motor is running in reverse, so the impeller is moving liquid against its design vanes
- C. The mechanical seal has failed, allowing air to be drawn into the high-pressure discharge
- D. Cavitation, as vapour bubbles form at the impeller eye and collapse with the gravel-like noise

6. A boiler's flue-gas analysis shows high oxygen and low carbon dioxide. This combustion condition indicates:

- A. Insufficient combustion air, producing carbon monoxide and unburned fuel in the flue
- B. A correctly tuned burner operating at its peak combustion efficiency for the fuel used
- C. A cracked heat exchanger drawing room air into the combustion gas sample stream
- D. Excess air diluting the flue gas, lowering efficiency by carrying heat up the stack

7. A pipefitter calculates the rolling-offset travel where the true offset (hypotenuse of set and roll) is 500 mm and the offset fitting angle is 45° . The travel equals the true offset times 1.414, giving about:

- A. 354 mm, found by dividing the true offset by the 45° constant rather than multiplying
- B. 707 mm, found by multiplying the 500 mm true offset by the 45° constant of 1.414
- C. 500 mm, equal to the true offset because at 45° the travel and offset are identical

D. 1000 mm, found by doubling the true offset to account for both legs of the triangle

8. A steamfitter must select a trap for a steam main drip point on a long horizontal main subject to water hammer. The most suitable trap is generally an:

- A. Inverted bucket trap, valued for its durability and resistance to water hammer on mains
- B. Thermostatic bellows trap, chosen for its rapid air-venting on the modulating equipment
- C. Float and thermostatic trap, selected for delicate low-pressure heating coil applications
- D. Fixed-orifice trap, used because it continuously meters condensate without any moving part

9. A pipefitter must determine the correct support spacing for insulated chilled-water pipe. A key additional consideration over bare pipe is that the support must:

- A. Be spaced twice as far apart because insulation stiffens the pipe against sagging loads
- B. Include a load-bearing insulation shield or saddle so the insulation is not crushed
- C. Be made of bare copper to provide a sacrificial anode protecting the steel pipe above
- D. Allow the chilled pipe to rotate freely so condensation drains away from the contact point

10. A steamfitter reviews a relief-valve nameplate showing a set pressure and a "CRN." The CRN confirms that the valve:

- A. Has been hydrostatically tested to twice its set pressure at the manufacturer's facility
- B. Is a design registered with the provincial authority for pressure-retaining service in Canada
- C. Carries a corrosion-resistant nickel coating suitable for outdoor marine environments
- D. Was calibrated to relieve at a constant rate regardless of the upstream system pressure

11. A pipefitter finds that a newly installed long copper hot-water line is making loud ticking and creaking sounds as it heats. The most likely cause is:

- A. Thermal expansion of the copper binding in tight hangers or penetrations as it grows

- B. Air trapped in the line collapsing as it is compressed by the rising water temperature
- C. Cavitation in the circulating pump transmitting noise along the rigid copper tubing run
- D. Water hammer from a fast-closing valve installed at the far end of the copper line run

12. A steamfitter must calculate the condensate load of a steam coil that transfers 300 kW, given the latent heat of the steam is approximately 2000 kJ/kg. The condensate rate is about:

- A. 600 kg/s, found by multiplying the heat transfer by the latent heat of the steam used
- B. 6.0 kg/s, found by multiplying the 300 kW load by a factor of fifty for the latent heat
- C. 0.15 kg/s (about 540 kg/h), found by dividing the 300 kW by the 2000 kJ/kg latent heat
- D. 1.5 kg/s, found by dividing the heat load by the latent heat and then multiplying by ten

13. A pipefitter troubleshoots a TXV refrigeration system that is short of capacity, with high superheat and a starved evaporator. A likely cause is:

- A. The TXV is overfeeding, flooding the evaporator and returning liquid to the compressor
- B. A restriction such as a plugged filter-drier or a TXV stuck nearly closed, starving the coil
- C. The condenser fan has failed, raising head pressure and overcharging the liquid receiver
- D. The compressor valves are leaking, raising the suction pressure above the design point

14. A steamfitter must size an expansion tank. The required acceptance volume depends primarily on the:

- A. Diameter of the largest pipe in the system and the number of fittings installed in it
- B. Colour and material of the boiler jacket and the location of the tank in the building
- C. System water volume and the temperature range over which the water expands and contracts
- D. Speed of the circulating pump and the total number of heating zones it must serve

15. A pipefitter encounters a flanged joint that leaks only when the system is hot but seals when cold. The most likely cause is:

- A. The bolts were over-torqued cold, crushing the gasket so it cannot seal at any temperature
- B. Differential thermal expansion relaxing the bolt load, or a gasket unrated for the temperature
- C. The gasket is too thick, so it extrudes outward only when the system cools and contracts
- D. The flange faces are perfectly parallel, which prevents sealing until thermal distortion occurs

16. A steamfitter calculates pipe expansion and must provide an expansion loop. For a given pipe growth, a larger loop:

- A. Increases the stress in the pipe because the longer legs add weight to the run
- B. Has no effect on stress, since loop size is chosen only for available space reasons
- C. Requires thicker pipe walls to resist the greater bending forces of the larger loop
- D. Reduces the bending stress because the longer legs flex more easily to absorb movement

17. A pipefitter must isolate a process line for hot work and chooses positive isolation. The method providing the highest assurance against leakage is:

- A. A blind (blank) flange or spectacle blind bolted in to physically block the line completely
- B. A single gate valve closed and locked out at the boundary of the work area for the job
- C. A double-block arrangement of two ball valves with the space between them left pressurized
- D. A control valve driven fully closed by its actuator and left under automatic control

18. A steamfitter notices that a two-pipe steam system's radiators fill with steam but the condensate will not drain. The most likely cause is:

- A. The supply valves are closed, preventing steam from displacing the condensate downward
- B. The radiators are pitched toward the supply end, trapping condensate at the far end
- C. The steam pressure is too low to push condensate through the open return piping system
- D. The radiator traps have failed closed, blocking condensate from leaving the radiators

19. A pipefitter must determine the bolt stretch needed for a flange. Using a hydraulic tensioner instead of a torque wrench primarily improves:

- A. The speed of assembly, since tensioners apply full load to every bolt in a single pull
- B. The accuracy of bolt preload by stretching the bolt directly rather than relying on friction
- C. The corrosion resistance of the bolts by avoiding the thread lubricant a wrench requires
- D. The gasket thickness tolerance by allowing thinner gaskets than a torque wrench permits

20. A steamfitter reads that a steam system carries "superheated steam at 400 °C and 4000 kPa." Compared to saturated steam, this superheated steam:

- A. Contains entrained moisture that must be removed by a separator before reaching the turbine
- B. Is at a lower temperature than saturated steam at the same pressure in the boiler drum
- C. Holds additional sensible heat above saturation and carries no liquid water with it
- D. Will condense immediately on entering any pipe because of its elevated temperature level

21. A pipefitter troubleshoots a hydronic zone that overheats while others are correct. With a balancing valve present, the likely cause is:

- A. The zone's thermostat is set lower than the others, calling for less heat than supplied
- B. The expansion tank is undersized, forcing excess water through the overheating zone
- C. The zone's balancing valve is set too far open, passing more than its design flow rate
- D. The circulating pump is oversized, which would affect all zones equally rather than one

22. A steamfitter must select the correct gasket bolt-up for a raised-face flange. The gasket must:

- A. Cover the raised face within the bolt circle so compression is confined to the seating area
- B. Extend across the full flange face including the bolt holes to seal the bolts against leakage
- C. Be installed dry with no surface preparation so it bonds permanently to the flange faces

D. Be thicker than the raised-face height so the flanges never make metal-to-metal contact

23. A pipefitter calculates that a 90° long-radius elbow has a centre-to-face dimension of 1.5 times the nominal diameter. For a 100 mm pipe, that dimension is about:

A. 150 mm, found by multiplying the 100 mm nominal size by the factor of one and one half

B. 100 mm, equal to the nominal pipe size because the elbow radius matches the diameter

C. 67 mm, found by dividing the nominal size by the long-radius factor of one and one half

D. 300 mm, found by multiplying the nominal diameter by three for a long-radius fitting

24. A steamfitter must commission a boiler and verify the low-water fuel cutoff. The correct test method is to:

A. Raise the steam pressure until the safety valve lifts, confirming the cutoff at high pressure

B. Increase the firing rate to maximum and watch for the burner to modulate down on its own

C. Lower the water level under controlled conditions and confirm the burner shuts off on cutoff

D. Add water rapidly to overflow the boiler and confirm the high-level alarm sounds correctly

25. A pipefitter must determine why a buried steel gas line failed a pressure test with a slow drop. After ruling out fittings, a likely cause specific to buried pipe is:

A. A coating holiday and corrosion pinhole, or a backfill rock that damaged the pipe wall

B. Thermal expansion of the buried pipe stretching the joints until they begin to weep

C. The test gauge reading low because underground temperatures are colder than the surface

D. Soil pressure squeezing the pipe closed, which would raise rather than lower the reading

26. A steamfitter notes a steam separator installed ahead of a turbine. Its function is to protect the turbine by:

A. Reducing the steam pressure to the value the turbine inlet governor is set to accept

- B. Superheating the steam further so no condensation can occur within the turbine stages
- C. Metering the steam mass flow to the turbine for accurate load and efficiency calculation
- D. Removing entrained water droplets so dry steam reaches the blades and avoids erosion

27. A pipefitter must select threaded rod for a hanger supporting a 4 kN load with a safety factor of 5. The rod must have a minimum breaking strength of:

- A. 0.8 kN, found by dividing the load by the safety factor to get the working load needed
- B. 4 kN, equal to the load itself because the safety factor applies only to the hanger spacing
- C. 20 kN, found by multiplying the 4 kN load by the safety factor of five for the breaking strength
- D. 9 kN, found by adding the safety factor to the load rather than multiplying the two values

28. A steamfitter troubleshoots a hot-water system where the relief valve discharges every time the boiler fires. After confirming the expansion tank is good, the next likely cause is:

- A. A fill valve or backflow preventer feeding the system above the relief setting, overpressuring it
- B. The circulating pump running backward, which would reduce rather than raise the pressure
- C. The boiler aquastat set too low, which would prevent the water from heating at all
- D. An air vent stuck open at the high point, which would lower the pressure by venting water

29. A pipefitter must explain why a steam line is pitched in the direction of flow with drip legs at intervals. This arrangement ensures that:

- A. The steam velocity stays high enough to atomize the condensate into a fine mist in the flow
- B. Condensate drains to the drip legs and traps before it can be swept into a water-hammer slug
- C. The pipe expands only in the direction of pitch, simplifying the placement of the anchors
- D. Air is carried along with the steam to the drip legs where it vents to the atmosphere

30. A steamfitter calculates that doubling the flow through a fixed pipe roughly quadruples the friction head loss. This relationship means friction loss varies approximately with the:

- A. Square of the flow rate, so small increases in flow cause large increases in head loss
- B. Square root of the flow rate, so head loss rises slowly as the flow rate is increased
- C. Inverse of the flow rate, so head loss falls as the flow through the pipe is increased
- D. Cube of the pipe diameter, independent of how the flow rate through the pipe changes

31. A pipefitter must select a valve that gives tight shutoff and quick quarter-turn operation for an on/off water service. The best choice is a:

- A. Globe valve, because its disc-and-seat design seals tightly for frequent throttling duty
- B. Gate valve, because its wedge provides quarter-turn isolation in large-diameter lines
- C. Ball valve, because its bore rotates a quarter turn to give fast, tight on/off shutoff
- D. Needle valve, because its fine-pitch stem allows precise flow metering in small lines

32. A steamfitter troubleshoots a deaerator that is not removing oxygen effectively. A likely cause is:

- A. The feedwater is entering too cold, which would improve oxygen removal rather than impair it
- B. The vent is closed too tightly, which would not affect the oxygen content of the water
- C. Insufficient steam or a low operating temperature, so the water is not heated enough to scrub gases
- D. The water level is too low, which only affects pump suction and not the gas removal

33. A pipefitter must determine the correct response to a small natural-gas leak detected by smell at a threaded union. The first action is to:

- A. Apply leak-detection solution and tighten the union while the line remains pressurized
- B. Open nearby windows and continue working while monitoring the strength of the odour
- C. Use a lighter near the joint to pinpoint the exact location of the escaping gas flow
- D. Shut off the gas, remove ignition sources, and repair before restoring the supply

34. A steamfitter must explain why condensate return lines are sized larger than the condensate volume alone would suggest. The extra capacity accommodates:

- A. The thermal expansion of the steel return piping as it heats from the hot condensate
- B. The sediment and scale that accumulate in the return line and reduce its effective bore
- C. Flash steam that forms in the return line, which occupies far more volume than the liquid
- D. The reverse flow of steam that periodically backs up through the return during shutdowns

35. A pipefitter calculates the velocity of water in a 50 mm bore pipe (area $\approx 0.00196 \text{ m}^2$) at a flow of $0.004 \text{ m}^3/\text{s}$. The velocity is about:

- A. 2.0 m/s, found by dividing the volumetric flow rate by the cross-sectional area of the bore
- B. 0.5 m/s, found by multiplying the flow rate by the area rather than dividing the two values
- C. 8.0 m/s, found by dividing the area by the flow rate and then inverting the result obtained
- D. 0.008 m/s, found by multiplying the flow and area together as the product of the two

36. A steamfitter must protect a glycol hydronic system from a specific hazard glycol introduces. Compared to plain water, glycol solutions:

- A. Eliminate the need for an expansion tank because glycol does not expand when it is heated
- B. Conduct electricity, requiring the system to be bonded and grounded more thoroughly
- C. Reduce heat-transfer capacity and increase viscosity, requiring pump and flow adjustments
- D. Raise the boiling point so high that relief valves are not required on the closed system

37. A pipefitter troubleshoots a steam trap station where the trap discharges live steam continuously. Before condemning the trap, the fitter should verify that the:

- A. Upstream strainer or trap internals are not held open by debris lodged on the valve seat
- B. Condensate return line is colour-coded correctly to match the facility piping standard
- C. Steam main is pitched away from the trap so condensate cannot reach it at all times

D. Trap is rated for a higher pressure than the system so it never reaches its discharge point

38. A steamfitter must determine the correct PPE when opening a steam line that has been isolated and is cooling. Even after isolation, the fitter must:

- A. Wear only safety glasses, since an isolated line presents no further thermal hazard
- B. Assume residual pressure and heat remain, using gloves, face protection, and standing clear
- C. Open the highest flange first so any trapped steam vents upward away from the worker
- D. Loosen all bolts simultaneously to release any residual pressure as quickly as possible

39. A pipefitter must explain why an air-bound hydronic circuit shows a hot supply but a cold return. The trapped air:

- A. Increases the flow so rapidly that the return water has no time to release its heat
- B. Blocks circulation through that loop, so water sits without carrying heat to the return
- C. Improves heat transfer at the supply while insulating the return side of the circuit
- D. Raises the system pressure, forcing the pump to deliver more flow than the loop needs

40. A steamfitter calculates the heat output of a hot-water coil: flow 0.5 kg/s, temperature drop 20 °C, water specific heat 4.18 kJ/kg·°C. The output is about:

- A. 10 kW, found by multiplying only the flow rate and the temperature drop together
- B. 84 kW, found by multiplying the flow, temperature drop, and specific heat then doubling
- C. 41.8 kW, found by multiplying flow × temperature drop × specific heat for the heat rate
- D. 4.18 kW, equal to the specific heat alone regardless of the flow or temperature drop

41. A pipefitter must select a method to join thick-wall carbon steel pipe for high-pressure steam. The preferred method is:

- A. Butt welding with a qualified procedure, giving a full-strength joint for high-pressure service

- B. Threaded connections sealed with PTFE tape, which simplify field assembly of heavy pipe
- C. Grooved mechanical couplings, chosen for their speed and flexibility on the heavy wall
- D. Soldered joints, selected because solder flows easily into the thick-wall pipe clearance

42. A steamfitter troubleshoots a boiler that trips on low water shortly after each startup, then resets. A likely cause specific to startup is:

- A. The economizer is recovering too much heat, cooling the feedwater below its setpoint
- B. The safety valve is lifting at startup, releasing steam faster than the boiler can replace
- C. The operating control differential is too wide, allowing the pressure to swing excessively
- D. Shrinkage of the boiler water level as cold feedwater and rapid steaming disturb the level

43. A pipefitter must determine why a copper joint failed to sweat properly, leaving a gap the solder did not fill. The most likely cause is:

- A. The joint was overheated, which always improves capillary action and solder flow into gaps
- B. The solder used had too low a melting point for the size of the joint being assembled
- C. Too much flux was applied, which increases the capillary draw of solder into the fitting
- D. The surfaces were not cleaned or fluxed properly, so the solder could not wet and flow in

44. A steamfitter calculates the static pressure at the base of a 40 m vertical water column. Using about 9.8 kPa per metre, the pressure is approximately:

- A. 40 kPa, equal to the height of the column in metres without the head conversion factor
- B. 4 kPa, found by dividing the height by ten rather than multiplying by the head factor
- C. 392 kPa, found by multiplying the 40 m height by the 9.8 kPa per metre head factor
- D. 3920 kPa, found by multiplying the height by ninety-eight instead of by nine point eight

45. A pipefitter must explain the purpose of a Hartford loop's connection height relative to the boiler. The loop's equalizing connection is made:

- A. At the very bottom of the boiler so condensate returns with the least possible resistance
- B. Above the top of the boiler so the entire steam space is vented through the return line
- C. At a random height since the loop's protective function does not depend on its elevation
- D. Just below the normal water line so a return-line break cannot drain the boiler below that point

46. A steamfitter troubleshoots a pump that loses prime each time it stops. The most likely cause is:

- A. A leaking foot valve or check valve allowing the suction line to drain back when stopped
- B. The discharge pressure being too high for the pump to restart against the system head
- C. The motor spinning too fast on restart, throwing the liquid out before prime is established
- D. The impeller being trimmed too small to hold the liquid in the casing during shutdown

47. A pipefitter must size a pressure-reducing valve for a steam service. The most important parameters are the:

- A. Colour of the downstream piping and the brand of the upstream isolation valve fitted
- B. Inlet and outlet pressures and the required flow capacity through the valve at those conditions
- C. Ambient temperature of the room and the total length of pipe downstream of the valve body
- D. Number of elbows in the run and the type of insulation applied to the reduced-pressure main

48. A steamfitter must explain why a steam trap's discharge is piped to a return at lower pressure. The pressure differential across the trap is what:

- A. Prevents the trap from ever opening, since equal pressures are required for it to discharge
- B. Drives the condensate out of the trap and through to the lower-pressure return line
- C. Superheats the condensate so it cannot flash into steam in the downstream return line
- D. Cools the trap body so the thermostatic element can sense the condensate temperature

49. A pipefitter calculates that a relief valve must relieve 500 kg/h but the installed valve is rated for 300 kg/h. The installation is:

- A. Acceptable, because relief valves are conservatively rated and 300 kg/h provides ample margin
- B. Acceptable only if a second identical valve is added in series downstream of the first one
- C. Unacceptable, because the valve cannot relieve the required capacity and the system can overpressure
- D. Acceptable if the set pressure is raised so the valve discharges at a higher flow rate when it lifts

50. A steamfitter must explain why nitrogen is used to purge tubing during brazing of a refrigeration system. The nitrogen:

- A. Displaces oxygen so no internal oxide scale forms inside the tubing during heating
- B. Adds moisture to the joint, which helps the brazing alloy flow more readily into the gap
- C. Raises the pressure inside the tube so leaks are revealed by escaping gas during brazing
- D. Cools the joint rapidly after brazing so the filler metal solidifies more quickly in place

51. A pipefitter troubleshoots a check valve that allows reverse flow. The most likely mechanical cause is:

- A. The valve is installed with the flow arrow pointing in the correct forward direction of flow
- B. The valve spring is too stiff, which would hold the disc closed against forward flow instead
- C. The downstream pressure is lower than the upstream, which is the normal forward condition
- D. Debris is holding the disc off its seat, or the disc or seat is worn so it cannot seal fully

52. A steamfitter must determine the correct action when a confined-space gas test shows 19.0% oxygen. This reading indicates:

- A. An oxygen-deficient atmosphere below the safe minimum, so entry is unsafe without ventilation
- B. A normal, safe oxygen level identical to ordinary outdoor air for unrestricted entry
- C. An oxygen-enriched atmosphere requiring removal of all combustible materials before entry

D. A reading that can be ignored because oxygen content has no bearing on confined-space safety

53. A pipefitter must explain why a globe valve creates more pressure drop than a gate valve. The globe valve's:

- A. Tortuous S-shaped flow path forces the fluid to change direction, adding resistance to flow
- B. Straight-through bore matches the pipe diameter, giving it the lowest possible pressure drop
- C. Quarter-turn ball provides an unobstructed opening that minimizes the resistance to flow
- D. Wedge disc lifts entirely clear of the flow path when open, leaving no obstruction at all

54. A steamfitter calculates that a system needs a pump with 25 m head, but the available pump produces 40 m at the required flow. The correct action is to:

- A. Install the pump as is and let it run at 40 m, since extra head is always beneficial to flow
- B. Reject the pump entirely, because a pump must never exceed the exact head the system needs
- C. Run two such pumps in series to further increase the head well beyond the system requirement
- D. Use the pump and add a balancing valve or trim the impeller to drop the excess head to design

55. A pipefitter must explain the danger of trapped pressure when breaking a flanged joint. Even a closed upstream valve may leave:

- A. No pressure at all, so the joint can always be opened safely once the valve is closed
- B. Only cold water, which presents no hazard regardless of how the joint is finally opened
- C. A vacuum that pulls the flanges together, making the joint impossible to separate by hand
- D. Residual or trapped pressure that can spray hot fluid, so the joint is cracked open cautiously

56. A steamfitter troubleshoots an inverted bucket trap that blows live steam continuously. The most likely cause is that the trap has:

- A. Lost its water prime, so the bucket sank and cannot close the valve against the steam

- B. Become flooded with excess condensate, which would close the valve rather than open it
- C. Cooled below the condensate temperature, sealing the valve permanently against the seat
- D. Reached its rated capacity, which causes it to modulate smoothly rather than blow through

57. A pipefitter must determine the correct slope to drain a 60 m steam main at 1 in 240. The total fall over the run is:

- A. 60 mm, found by dividing the run length by the slope ratio numerator only
- B. 600 mm, found by dividing the run length by the slope ratio without unit conversion
- C. 1440 mm, found by multiplying the run by the slope denominator of two hundred forty
- D. 250 mm, found by dividing the 60 000 mm run by the slope denominator of two hundred forty

58. A steamfitter must explain why a centrifugal pump should be started against a closed discharge valve (for low-specific-speed pumps). Starting closed:

- A. Increases the flow surge through the system, helping to clear air from the discharge line
- B. Damages the pump by deadheading it, so it must always be started fully open instead
- C. Has no effect on the starting current, since pump load is independent of the valve position
- D. Minimizes the starting power demand because a closed valve corresponds to the lowest power draw

59. A pipefitter must select tubing and a joining method for a fuel-oil supply line. A suitable choice is:

- A. PVC pipe with solvent-cemented joints, chosen for its low cost and easy field assembly
- B. Galvanized steel with the zinc coating intact on the inside to resist the fuel oil corrosion
- C. Black steel pipe with welded or properly rated threaded joints suitable for the fuel service
- D. Soft copper with flared joints, selected because fuel oil cannot attack copper under any condition

60. A steamfitter troubleshoots a hydronic system that is noisy with constant gurgling. After confirming the fill pressure is adequate, the likely cause is:

- A. The expansion tank is too small, which would cause pressure spikes rather than gurgling noise
- B. The pump is undersized, which would reduce flow rather than create the gurgling sound heard
- C. Air entrained in the system circulating with the water, requiring purging at the high points
- D. The boiler temperature is set too low, which would reduce output but not cause the noise

61. A pipefitter must explain why a steam system's safety valve is sealed and cannot be field-adjusted. The seal ensures that:

- A. The valve can be reset by the operator to a higher pressure during peak demand periods
- B. The valve discharge is directed safely, which is the only purpose the seal actually serves
- C. The valve relieves at a slower rate, extending the time available to respond to overpressure
- D. The set pressure cannot be tampered with, preserving the certified overpressure protection

62. A steamfitter calculates that a boiler produces 1000 kg/h of steam and the feedwater pump must replace it. Allowing for blowdown, the feedwater rate should be:

- A. Slightly more than 1000 kg/h to replace both the steam produced and the blowdown losses
- B. Exactly 1000 kg/h, since the steam produced equals the feedwater with no other losses
- C. Half of 1000 kg/h, because condensate return supplies the remaining feedwater needed
- D. Far below 1000 kg/h, since most of the steam condenses and returns within the boiler shell

63. A pipefitter must explain why dielectric unions are required between copper and steel in a heating system. Without isolation, the dissimilar metals form a:

- A. Stronger mechanical joint that resists vibration better than isolated connections do
- B. Thermal break that prevents heat from transferring across the pipe at the connection
- C. Galvanic cell in the presence of water, corroding the more anodic metal over time
- D. Pressure boundary that fails immediately upon the first thermal cycle of the system

64. A steamfitter troubleshoots a TXV system flooding the compressor with liquid. The symptom set is low superheat and frosted suction line. The likely cause is:

- A. The TXV is overfeeding refrigerant, allowing liquid to leave the evaporator unevaporated
- B. The TXV is starving the evaporator, which would raise the superheat rather than lower it
- C. The condenser is undersized, which would raise head pressure but not flood the suction
- D. The compressor is oversized, which would reduce the suction pressure below the design point

65. A pipefitter must determine why a pressure test passed at low pressure but failed when raised to full test pressure. The most likely explanation is:

- A. A joint or component that seals at low pressure but leaks once the higher pressure stresses it
- B. The gauge becoming more accurate at higher pressure, revealing a leak that was always present
- C. The water compressing at high pressure, which would raise rather than drop the test reading
- D. The pipe expanding elastically, which seals leaks tighter as the internal pressure increases

66. A steamfitter must explain why steam mains are warmed slowly through bypass warm-up valves. Slow warm-up:

- A. Raises the steam velocity quickly to blow condensate clear of the main in one rapid surge
- B. Allows the main to reach pressure faster by admitting full steam through the large main valve
- C. Pressurizes the main to test its strength before the system is placed into normal service
- D. Lets condensate drain and the metal heat gradually, avoiding thermal shock and water hammer

67. A pipefitter calculates the area ratio of a 100 mm pipe reducing to a 50 mm pipe. The smaller pipe's flow area is:

- A. One half the larger area, matching the ratio of the two pipe diameters directly
- B. One quarter the larger area, since flow area scales with the square of the diameter
- C. Twice the larger area, because reducing the diameter concentrates the available flow area

D. The same area, since the flow rate is conserved through both sections by continuity

68. A steamfitter troubleshoots a boiler producing wet steam with water carryover. A likely cause is:

- A. The steam pressure is far too high, which would tend to produce drier steam instead
- B. The firing rate is too low, which would reduce steaming and improve the steam dryness
- C. The feedwater is too pure, which has no bearing on the carryover of water with the steam
- D. A high water level, rapid load change, or high dissolved solids causing priming and foaming

69. A pipefitter must explain why a vacuum breaker is fitted to a steam-heated tank coil. On shutdown the coil:

- A. Overpressures as residual steam expands, so the breaker vents the excess to atmosphere
- B. Forms a vacuum as steam condenses, and the breaker admits air so condensate can drain
- C. Overheats from trapped steam, so the breaker cools the coil by drawing in ambient air
- D. Loses its prime, so the breaker re-establishes the water seal needed for the trap to work

70. A steamfitter calculates that doubling the diameter of a pipe increases its flow area by a factor of:

- A. Two, since the area increases in direct proportion to the increase in the pipe diameter
- B. Four, because flow area scales with the square of the diameter, so doubling it quadruples area
- C. Eight, because area scales with the cube of the diameter in a cylindrical pipe section
- D. One half, because the larger bore reduces the velocity and therefore the effective flow area

71. A pipefitter must explain why threaded joints are limited to lower pressures and smaller sizes than welded joints. Threading the pipe:

- A. Removes wall material at the threads, weakening the pipe and limiting the pressure it holds
- B. Increases the wall thickness at the threads, which would allow higher rather than lower pressure

- C. Improves the pipe's strength by work-hardening the threads during the cutting process
- D. Has no effect on strength, so the size limit is purely a matter of tooling availability

72. A steamfitter troubleshoots a condensate pump that runs continuously and never shuts off. A likely cause is:

- A. The receiver is empty, which would stop the pump rather than keep it running continuously
- B. The discharge head is too low, which would let the pump cycle off quickly between fills
- C. A failed float switch stuck in the run position, or condensate inflow exceeding pump capacity
- D. The motor is undersized, which would trip the overload rather than run the pump nonstop

73. A pipefitter must explain why insulated cold lines require a vapour barrier on the outside of the insulation. Without the barrier:

- A. The insulation would dry out too quickly and lose its thermal resistance over time in service
- B. Heat would escape from the cold line faster, raising the operating cost of the cooling system
- C. The pipe would overheat because the insulation would trap heat against the cold surface
- D. Moisture would migrate through the insulation, condense on the cold pipe, and ruin the insulation

74. A steamfitter calculates a pump's required power increase when speed rises 20%. By the affinity laws, power varies with the cube of speed, so a 20% speed increase raises power by about:

- A. 73%, found by cubing the 1.2 speed ratio to get roughly 1.73 times the original power
- B. 20%, in direct proportion to the speed increase as a simple linear relationship
- C. 44%, found by squaring the 1.2 speed ratio as though power varied with the square of speed
- D. 8%, found by taking only the fractional part of the cubed ratio as the power increase

75. A pipefitter must select the correct fitting to connect two pipes of different diameters in a vertical line where solids could settle. The best choice is a:

- A. Eccentric reducer installed flat-side down so settling solids are carried through the offset
- B. Bushing threaded into a coupling to reduce the size within a single compact fitting body
- C. Concentric reducer, since a vertical line keeps the bore centred and avoids settling problems
- D. Bell-and-spigot joint that overlaps the two pipe ends to bridge the difference in diameters

76. A steamfitter troubleshoots a steam system where the PRV downstream pressure creeps upward when there is no demand. The most likely cause is:

- A. The PRV seat is worn or fouled, letting it pass steam and raise the downstream pressure
- B. The downstream relief valve is undersized, which would not raise the no-demand pressure
- C. The upstream pressure has dropped, which would lower rather than raise downstream pressure
- D. The condensate trap is oversized, which has no effect on the reduced-pressure setting

77. A pipefitter must explain why a steam trap is installed at every low point and ahead of every riser in a steam main. These locations are where:

- A. The steam velocity is highest and the trap can use that velocity to discharge condensate
- B. The pipe is most accessible, making trap maintenance convenient regardless of condensate flow
- C. Condensate naturally collects, so trapping there removes it before it causes water hammer
- D. The pressure is lowest in the system, allowing the trap to discharge with the least resistance

78. A steamfitter calculates that a relief valve set at 1035 kPa has a 10% blowdown. The valve will reseal at approximately:

- A. 1138 kPa, found by adding 10% to the set pressure rather than subtracting the blowdown
- B. 932 kPa, found by subtracting 10% of the set pressure as the blowdown before reseating
- C. 1035 kPa, equal to the set pressure because blowdown does not affect the reseal point
- D. 104 kPa, found by taking only 10% of the set pressure as the reseal pressure value

79. A pipefitter must explain why a backflow preventer protects the potable supply on a boiler fill line. The device prevents:

- A. The city water pressure from exceeding the boiler design pressure on the fill connection
- B. Treated boiler water from siphoning back into the drinking-water system on a pressure loss
- C. Air from entering the boiler through the fill line when the system pressure drops at night
- D. Sediment in the city water from entering and fouling the boiler feed pump suction strainer

80. A steamfitter troubleshoots a hydronic circulator that runs but moves little water. After ruling out air, the likely cause is:

- A. The expansion tank is waterlogged, which would affect pressure but not the flow directly
- B. The system relief valve is weeping, which would lower pressure rather than stop the flow
- C. A closed isolation valve, a clogged strainer, or a seized impeller blocking the flow path
- D. The boiler is oversized, which would overheat the water but not reduce the circulation rate

81. A pipefitter must explain why steam at higher pressure carries less latent heat per kilogram than steam at lower pressure. As pressure rises:

- A. The total heat content of the steam falls to zero at the critical point of the water
- B. The latent heat increases steadily, opposite to what is observed in steam tables for water
- C. The sensible heat falls while the latent heat rises, keeping the total heat content constant
- D. More of the heat is sensible and less is latent, so the latent portion decreases with pressure

82. A steamfitter calculates the linear expansion of a 25 m copper line heated 60 °C, using a copper coefficient of about 0.0000168 m/m·°C. The expansion is about:

- A. 25 mm, found by multiplying length \times coefficient \times temperature change for the copper line
- B. 2.5 mm, found by dividing the calculated expansion by ten as though the line were shorter
- C. 250 mm, found by multiplying the result by ten, overstating the expansion tenfold for copper

D. 0.25 mm, found by dividing the correct result by one hundred, understating it greatly

83. A pipefitter must explain why a relief valve discharge pipe must not be reduced in size below the valve outlet. A reduced discharge pipe:

- A. Improves the relieving capacity by accelerating the steam through the smaller outlet pipe
- B. Creates backpressure that reduces the valve's relieving capacity and can impair its operation
- C. Has no effect because the valve relieves the same mass flow regardless of the pipe size used
- D. Lowers the set pressure of the valve, causing it to lift earlier than its certified setting

84. A steamfitter troubleshoots a boiler with fluctuating water level and unstable firing. After checking the controls, a likely water-side cause is:

- A. The feedwater being too hot, which would have no effect on the stability of the water level
- B. High dissolved solids causing foaming and priming, which destabilize the level and carryover
- C. The blowdown valve being closed, which would have no bearing on the level fluctuation
- D. The safety valve weeping, which would lower pressure rather than disturb the water level

85. A pipefitter must select the correct support for a vertical pipe riser passing through multiple floors. The standard device is a:

- A. Roller support that lets the riser move freely upward as it expands with rising temperature
- B. Spring hanger sized to carry the full vertical load while allowing unlimited vertical travel
- C. Riser clamp bearing on the floor structure at each level to carry the weight of the riser
- D. Pipe guide that restrains lateral motion only and provides no vertical support for the riser

86. A steamfitter calculates that a 150 mm pipe full of water weighs far more per metre than the empty pipe. For estimating hanger loads, the fitter must always include the:

- A. Weight of the water (and any insulation) in addition to the weight of the empty pipe itself

- B. Weight of the empty pipe only, since water weight is carried by the pump rather than hangers
- C. Weight of the insulation only, because the pipe and water weights cancel out at the supports
- D. Weight of the fittings only, ignoring the straight pipe and its contents between supports

87. A pipefitter must explain why an oversized steam trap wastes energy. An oversized trap:

- A. Cannot pass enough condensate, so it backs up water and reduces the equipment's heat output
- B. Subcools the condensate excessively, recovering extra heat and improving the system efficiency
- C. Cycles too slowly to keep up with the load, flooding the equipment with cold condensate
- D. May pass live steam along with condensate because the valve does not modulate to the load

88. A steamfitter troubleshoots a hydronic system where one radiator stays cold while its zone valve is confirmed open and powered. The likely cause is:

- A. The thermostat is calling for too much heat, which would make the radiator hotter not colder
- B. The boiler is undersized, which would cool all the radiators rather than just the one affected
- C. An air pocket or a closed balancing valve isolating that single radiator from the flow path
- D. The circulating pump is oversized, which would overheat rather than fail to heat the radiator

89. A pipefitter must explain why the root pass of a pipe weld is the most critical pass. The root pass:

- A. Adds the final reinforcement that determines the appearance of the finished weld surface
- B. Removes the slag from the previous passes so the cover pass can be deposited cleanly
- C. Is the easiest pass to complete, requiring the least skill of all the passes in the joint
- D. Establishes full penetration and fusion at the inside of the joint, the foundation of weld integrity

90. A steamfitter calculates that a pump operating at 1750 rpm delivers 200 L/min. By the affinity laws, at 1450 rpm the flow will be about:

- A. 166 L/min, found by scaling the flow directly with the ratio of the two pump speeds
- B. 200 L/min, unchanged because flow does not depend on the speed of a centrifugal pump
- C. 290 L/min, found by scaling the flow with the inverse of the speed ratio instead
- D. 138 L/min, found by scaling the flow with the square of the speed ratio between the two

91. A pipefitter must explain why a steam separator improves heat-exchanger performance. By delivering drier steam, the separator:

- A. Lowers the steam temperature so the heat exchanger operates at a gentler, more even rate
- B. Reduces the steam pressure so the heat exchanger is protected from overpressure damage
- C. Increases the moisture content so more latent heat is available at the heat-transfer surface
- D. Maximizes the latent heat available at the surface, since wet steam transfers heat less effectively

92. A steamfitter troubleshoots a gas burner that ignites then locks out on flame failure. After confirming gas pressure, the likely cause is:

- A. A dirty or mispositioned flame sensor failing to prove the flame, tripping the safety lockout
- B. The combustion air being too high, which would improve rather than impair flame detection
- C. The gas pressure being too high, which was already confirmed as correct in the troubleshooting
- D. The thermostat being satisfied, which would prevent ignition rather than cause a flame-failure trip

93. A pipefitter must explain why a pipe carrying 90 °C water needs expansion provision over a long straight run. The water temperature causes the:

- A. Water inside to expand, bursting the pipe regardless of any provision made on the outside
- B. Steel pipe to expand in length, building stress unless a loop, joint, or offset absorbs the growth
- C. Pipe to contract along its length, pulling the joints apart unless they are anchored firmly
- D. Insulation to swell, crushing the pipe unless expansion space is left around the outside

94. A steamfitter calculates the make-up water for a system losing 2% of its 5000 kg/h circulation to blowdown. The make-up rate is about:

- A. 200 kg/h, found by taking 4% of the circulation rate rather than the stated 2% blowdown
- B. 100 kg/h, found by taking 2% of the 5000 kg/h circulation rate as the make-up needed
- C. 50 kg/h, found by taking 1% of the circulation rate instead of the full 2% blowdown rate
- D. 1000 kg/h, found by taking 20% of the circulation rate, overstating the make-up tenfold

95. A pipefitter must explain why a check valve is installed on each pump in a parallel pumping arrangement. The check valves:

- A. Increase the combined flow by forcing both pumps to share the load equally at all times
- B. Reduce the discharge pressure so the pumps do not overpressure the common header downstream
- C. Prevent flow from a running pump from backing through an idle pump in the parallel set
- D. Allow the idle pump to spin backward freely, which keeps its bearings lubricated during standby

96. A steamfitter troubleshoots a steam coil that knocks loudly on startup. After confirming the trap works, the likely cause is:

- A. The steam pressure is too low, which would reduce knocking rather than cause it on startup
- B. The coil is oversized, which would not produce the knocking sound during the startup period
- C. The trap is oversized, which would subcool the condensate and quiet the coil on startup
- D. Condensate pooling in the coil and being struck by incoming steam, a classic water-hammer knock

97. A pipefitter must select the correct test medium for pneumatic testing where hydrostatic testing is impractical. The added precaution over hydrostatic testing is:

- A. No special precaution, since compressed gas stores the same low energy as water under pressure
- B. Using a higher test pressure than hydrostatic, because gas requires more pressure to find leaks
- C. A larger exclusion zone and staged pressure rise, because compressed gas stores dangerous energy

D. Omitting the relief device on the test rig, since gas tests cannot overpressure the system tested

98. A steamfitter calculates that a boiler's safety valve must pass the full 2000 kg/h output. A valve rated 2200 kg/h at the set pressure is:

- A. Acceptable, since its rated capacity exceeds the boiler's maximum steam output requirement
- B. Unacceptable, because a safety valve must be rated below the boiler output to lift in time
- C. Acceptable only if a second valve is removed so this one carries the entire relieving load alone
- D. Unacceptable, because the rated capacity must exactly equal the output with no margin allowed

99. A pipefitter must explain why a condensate receiver is vented to atmosphere. The vent allows:

- A. Steam to be drawn back into the receiver to keep the condensate hot for reuse in the boiler
- B. Air and flash steam to escape so the pump can fill freely without building backpressure
- C. The receiver to operate under vacuum, which would prevent the pump from filling properly
- D. Cold air to enter and cool the condensate so the pump seals last longer in the service

100. A steamfitter troubleshoots a system where the relief valve chatters rapidly when it lifts. The likely cause is:

- A. The valve is correctly sized and chattering is the normal sound of a relief valve operating
- B. The set pressure is far above the system pressure, so the valve cannot reach its lift point
- C. The discharge pipe is oversized, which would eliminate backpressure and stop the chatter
- D. An oversized valve or excessive inlet pressure drop causing it to cycle open and shut rapidly

101. A pipefitter must explain why a steam main is dripped before a control valve. Condensate ahead of the valve would:

- A. Be carried into the valve and downstream as a slug, causing water hammer and valve erosion

- B. Improve the valve's throttling control by adding mass to dampen the flow fluctuations
- C. Lower the steam pressure at the valve, which would have no adverse effect on operation
- D. Cool the valve body uniformly, extending its service life by reducing thermal cycling

102. A steamfitter calculates the cross-sectional area of a 200 mm bore pipe. Using $\text{area} = \pi r^2$ with a 100 mm radius, the area is about:

- A. 62 800 mm², found by multiplying pi by the 200 mm diameter without squaring the radius
- B. 31 400 mm², found using pi times the 100 mm radius squared for the bore area
- C. 125 600 mm², found by multiplying pi by the diameter squared without dividing by four
- D. 628 mm², found by multiplying pi by the diameter directly as the circumference instead

103. A pipefitter must explain why a steam trap should be installed below the equipment it drains where possible. Draining downward:

- A. Forces the condensate uphill into the trap, which improves the trap's discharge capacity
- B. Prevents condensate from ever reaching the trap, keeping the equipment permanently dry
- C. Raises the steam pressure at the trap, which is required for the trap to open and discharge
- D. Lets gravity assist condensate flow into the trap rather than relying on steam pressure alone

104. A steamfitter troubleshoots a refrigeration sight glass showing a full column of bubbles at steady load. After confirming the system is not low on charge, the likely cause is:

- A. The condenser is subcooling the liquid too much, which would clear the glass rather than fill it
- B. The compressor is short-cycling, which would not produce a steady stream of bubbles at load
- C. A restriction such as a partially plugged filter-drier causing flashing in the liquid line
- D. The receiver being overfilled, which would deliver solid liquid and clear the sight glass fully

105. A pipefitter must explain why a vertical pipe is anchored at the base in a tall riser. The base anchor:

- A. Lets the riser slide downward freely so thermal growth is taken up at the bottom of the run
- B. Establishes a fixed point so expansion is directed upward and controlled along the riser
- C. Carries no load and serves only to mark the reference elevation for the riser installation
- D. Allows the riser to rotate about its axis to relieve the torsional stress from thermal cycling

106. A steamfitter calculates that a pump's NPSH available is 3 m and the pump requires 5 m NPSH. The result will be:

- A. Normal operation, since NPSH available need only be greater than zero for the pump to run
- B. Improved efficiency, because lower NPSH reduces the load on the impeller and the motor
- C. Cavitation, because available NPSH is below the required NPSH and the liquid will flash
- D. Higher flow, since the deficit in NPSH draws additional liquid into the pump suction eye

107. A pipefitter must explain why a steam system uses both an operating control and a separate high-limit control. The high-limit control:

- A. Cycles the burner continuously during normal operation to hold the setpoint pressure
- B. Acts as an independent backup that shuts the burner off if the operating control fails
- C. Replaces the operating control once the system reaches its normal operating temperature
- D. Adjusts the firing rate proportionally to the load during the normal heating cycle period

108. A steamfitter troubleshoots a hot-water boiler that boils and makes noise but the system stays cool. The likely cause is:

- A. The expansion tank is oversized, which would stabilize pressure rather than cause boiling
- B. The relief valve is set too high, which would not prevent the heat from reaching the system
- C. The aquastat is set too low, which would stop the boiler from heating at all rather than boil it
- D. No circulation — a failed pump or closed valve — so the boiler heats but cannot move the heat out

109. A pipefitter must select a method to verify weld quality without cutting the pipe. A suitable non-destructive method is:

- A. Tensile testing a sample cut from the weld to measure its ultimate strength in the lab
- B. Bend testing a coupon removed from the joint to check the ductility of the weld metal
- C. Radiographic or ultrasonic testing, which reveals internal flaws without destroying the weld
- D. Macro-etch sectioning of the weld to expose its internal structure under magnification

110. A steamfitter calculates that a 12 m run of steel pipe heated 100 °C expands about 14 mm (coefficient ≈ 0.0000117). To absorb this, the fitter installs:

- A. A rigid anchor at each end to hold the pipe firmly against any movement along its length
- B. An expansion loop or joint sized to take the 14 mm of movement without overstressing the pipe
- C. Thicker-wall pipe so the run becomes stiff enough to resist the expansion forces entirely
- D. Additional hangers spaced closely to clamp the pipe and prevent it from expanding at all

111. A pipefitter must explain why a gas line is sized for an acceptable pressure drop rather than just velocity. Excessive pressure drop would:

- A. Increase the gas supply pressure at the appliance above the manifold's rated maximum value
- B. Improve combustion by delivering the gas to the burner at a higher velocity than designed
- C. Have no effect, since appliances operate correctly across any supply pressure they receive
- D. Starve the appliance of gas, so it cannot reach its rated input and may burn incompletely

112. A steamfitter troubleshoots a steam trap discharging at a much higher temperature than expected for the pressure. This suggests the trap is:

- A. Passing live steam or flash steam, indicating it has failed open or is undersized for the load
- B. Subcooling the condensate excessively, which would lower the discharge temperature instead
- C. Operating normally, since discharge temperature has no relation to the trap's condition at all

D. Flooded with cold condensate, which would lower rather than raise the discharge temperature

113. A pipefitter must explain why a relief valve is installed on the shell side of a steam-to-water heat exchanger. The relief valve protects against:

- A. Loss of water flow, which would cool the shell and pose no overpressure hazard at all
- B. Low steam pressure, which would reduce heat transfer but never threaten the shell integrity
- C. Excess condensate, which the trap removes and which cannot overpressure the shell side
- D. Overpressure if the steam supply exceeds the shell's rating or a tube ruptures into the shell

114. A steamfitter calculates that a system requires 15 L/s and selects a pump delivering 18 L/s at the operating head. To match the system, the fitter should:

- A. Run the pump at 18 L/s, since delivering more flow than required always benefits the system
- B. Reject the pump because a pump must deliver exactly the required flow and never any more
- C. Add a second pump in parallel to push the combined flow even further above the requirement
- D. Throttle with a balancing valve or trim the impeller to bring the flow down to the 15 L/s design

115. A pipefitter must explain why a steam trap's discharge should be checked during commissioning. Verifying discharge confirms that the trap:

- A. Is removing condensate while holding back steam, the core function it must perform in service
- B. Is colour-coded to match the facility's piping identification standard for steam systems
- C. Has the correct brand name matching the upstream isolation valve in the trap station assembly
- D. Is rated for a pressure far above the system so it will never reach its discharge condition

116. A steamfitter troubleshoots a hydronic system that will not hold pressure overnight when the boiler is off and cool. The likely cause is:

- A. Thermal expansion of the water, which only raises pressure when the system is heated not cooled

- B. A leak in the system or a passing relief valve allowing water to escape from the closed loop
- C. The pump being off, which does not change the static pressure of a filled closed-loop system
- D. The expansion tank doing its job, which maintains rather than loses pressure when cool

117. A pipefitter must select the correct orientation for an eccentric reducer in a horizontal pump suction line. The reducer is installed:

- A. Flat-side down so any settling solids are carried smoothly through the bottom of the reducer
- B. Flat-side up so air cannot be trapped at the top, preventing an air pocket at the pump suction
- C. Either orientation, since a pump suction reducer is unaffected by the position of the flat side
- D. Concentric instead, because eccentric reducers are never used on the suction side of a pump

118. A steamfitter calculates that a relief valve discharges to a vertical stack open to atmosphere. The stack must include a drain at its base to:

- A. Increase the backpressure on the valve so it reseats more firmly after each relieving event
- B. Reduce the relieving capacity of the valve by restricting the discharge through the small drain
- C. Collect flash steam and return it to the boiler for reuse during the relieving discharge event
- D. Remove rainwater and condensate so they do not collect on the valve disc and cause corrosion

119. A pipefitter must explain why a long-radius elbow is specified on the suction side of a pump. The smoother flow path:

- A. Increases turbulence at the impeller eye, which helps the pump prime more quickly on startup
- B. Raises the suction pressure above the discharge pressure, reversing the normal pump operation
- C. Reduces turbulence and pressure loss, improving the NPSH available and reducing cavitation risk
- D. Has no effect on the pump, since elbow radius matters only on the discharge side of the system

120. A steamfitter troubleshoots a boiler where the gauge glass shows a steady but falsely high level. The likely cause is:

- A. The boiler is genuinely overfilled, which the operator should correct by draining excess water
- B. A plugged lower gauge-glass connection, trapping water in the glass and giving a false high reading
- C. The feedwater pump has failed, which would lower rather than falsely raise the level reading
- D. The steam pressure is too high, which compresses the water and would lower the glass reading

121. A pipefitter must explain why a steam main's branch connections are taken from the top of the main. Top connections ensure that:

- A. Dry steam is drawn off while condensate stays in the bottom of the main to drain to traps
- B. Condensate is carried up into the branch along with the steam for removal at the equipment
- C. The branch experiences the highest pressure available anywhere in the steam distribution main
- D. Air is drawn into the branch to vent the equipment of non-condensable gases during operation

122. A steamfitter calculates that a pump's efficiency is 70%, delivering 5 kW of hydraulic power. The motor input power required is about:

- A. 3.5 kW, found by multiplying the hydraulic power by the efficiency rather than dividing by it
- B. 5 kW, equal to the hydraulic power because pump efficiency does not affect the input power
- C. 7.1 kW, found by dividing the 5 kW hydraulic power by the 0.70 efficiency for the input power
- D. 8.5 kW, found by adding the efficiency loss as a fixed amount to the hydraulic power output

123. A pipefitter must explain why a thermostatic trap is well suited to draining a radiator. The thermostatic element:

- A. Opens on live steam to discharge it quickly, then closes when only condensate remains in the unit
- B. Stays open continuously regardless of temperature, venting both steam and condensate freely
- C. Responds only to pressure, ignoring the temperature of the condensate inside the radiator body
- D. Holds condensate until it subcools, then discharges it, releasing the radiator's full heat first

124. A steamfitter troubleshoots a pump motor that trips its overload repeatedly. After confirming the electrical supply, a likely mechanical cause is:

- A. The pump running far out on its curve at excessive flow, overloading the motor with high power draw
- B. The discharge valve being closed, which would deadhead the pump and minimize the power draw
- C. Cavitation reducing the flow, which would lower the motor load rather than trip the overload
- D. The impeller being trimmed smaller, which reduces the power demand below the motor's rating

125. A pipefitter must explain why a flanged joint uses a gasket between the faces. The gasket:

- A. Increases the gap between the flanges so the bolts can be tightened to a higher torque value
- B. Provides electrical isolation between the two flanges to prevent galvanic corrosion at the joint
- C. Acts as a permanent adhesive bonding the two flange faces into a single rigid assembly
- D. Conforms to the flange faces under bolt load, filling surface imperfections to seal the joint

126. A steamfitter calculates that a 2000 kW boiler runs at 80% efficiency. The fuel energy input required is about:

- A. 1600 kW, found by multiplying the output by the efficiency rather than dividing by it
- B. 2500 kW, found by dividing the 2000 kW output by the 0.80 efficiency for the fuel input
- C. 2000 kW, equal to the output because boiler efficiency does not affect the fuel input rate
- D. 1800 kW, found by subtracting the 20% loss from the output as a fixed deduction instead

127. A pipefitter must explain why a steam trap discharging to a flooded return needs a check valve. The check valve prevents:

- A. Live steam from blowing through the trap into the flooded return line during operation
- B. Backflow of condensate from the flooded return into the trap when the trap pressure drops
- C. Air from entering the trap through the discharge line and breaking the trap's water seal

D. The trap from discharging at all until the return line pressure exceeds the supply pressure

128. A steamfitter troubleshoots a system where steam radiators bang loudly when heat is called. The most likely cause is:

A. The radiators are oversized, which would simply reduce the surface temperature without banging

B. The steam pressure is too high, which would heat the radiators faster but not cause the banging

C. The thermostat is set too high, which would call for more heat but not produce the banging sound

D. Condensate trapped by an improper pitch or a failed trap, struck by incoming steam as water hammer

129. A pipefitter must explain why pipe threads are tapered rather than straight. The taper:

A. Allows the fitting to spin on freely without ever wedging tight against the pipe threads

B. Increases the inside diameter of the pipe at the joint to compensate for the flow restriction

C. Wedges the threads together as the joint is made up, creating an interference seal under sealant

D. Has no sealing function and exists only to make the threads easier to start onto the pipe end

130. A steamfitter calculates that a condensate pump must lift condensate 10 m and overcome 3 m of friction plus 2 m residual. The total head required is about:

A. 10 m, counting only the static lift and ignoring the friction and residual pressure components

B. 15 m, found by adding the 10 m lift, the 3 m friction, and the 2 m residual head together

C. 5 m, found by adding only the friction and residual and ignoring the static lift component

D. 30 m, found by multiplying the static lift by three to account for the other two components

Practice Exam 16: Answer Key and Explanations

1. B — A trap hot at the inlet and cold at the outlet with condensate backing up has failed closed; it no longer opens to pass condensate, so water floods the equipment ahead of it. This waterlogging reduces heat transfer and risks water hammer. Failed-closed traps must be repaired promptly to restore drainage.

2. B — Power = $4 \text{ L/s} \times 30 \text{ m} \times 0.00981 = 1.18 \text{ kW}$. The constant converts flow and head to hydraulic power for water. This figure is the water power before adding pump and motor inefficiencies, and it sizes the duty correctly.

3. C — The 6G position is an inclined, fixed (non-rotated) pipe coupon that forces welding in flat, vertical, and overhead orientations at once, so it qualifies the welder for all positions. It is the most comprehensive pipe-welding test. Passing it broadly certifies the welder.

4. C — The top point needs 100 kPa, and a 15 m column adds about 147 kPa of head, so the fill pressure must be at least 247 kPa at the basement. Static head must be overcome to keep the high point above atmospheric. Adequate fill pressure prevents air ingress and ensures circulation to the top.

5. D — Reduced flow, vibration, and a gravel-like noise are the classic signs of cavitation, where vapour bubbles form at the impeller eye and collapse violently. The implosions erode the impeller and degrade performance. Restoring adequate suction head eliminates it.

6. D — High oxygen with low carbon dioxide means excess air is diluting the flue gas, carrying heat up the stack and lowering efficiency. The burner is taking in more air than combustion needs. Tuning the air-fuel ratio toward the optimum restores efficiency.

7. B — Travel = true offset $\times 1.414 = 500 \text{ mm} \times 1.414 = 707 \text{ mm}$. The 45° constant multiplies the true offset to give the diagonal travel. Correct use of the constant ensures the fabricated rolling offset matches the layout.

8. A — An inverted bucket trap is durable and resists water hammer, making it well suited to steam-main drip points on long horizontal mains. Its robust single mechanism tolerates the harsh conditions of main drainage. This matches the trap to the service.

9. B — Insulated chilled-water pipe needs a load-bearing insulation shield or saddle at supports so the hanger load does not crush the insulation. Crushed insulation loses its thermal value and admits moisture. The shield spreads the load across the insulation.

10. B — A Canadian Registration Number confirms the valve's design is registered with the provincial authority for pressure-retaining service. It verifies the design was reviewed and accepted for use. The CRN is required for legal installation in Canada.

11. A — Ticking and creaking as a copper line heats is caused by thermal expansion binding in tight hangers or penetrations as the pipe grows and slips. The noise is the pipe moving against its restraints. Allowing room for expansion eliminates the sound.

12. C — Condensate rate = heat ÷ latent heat = 300 kW ÷ 2000 kJ/kg = 0.15 kg/s, about 540 kg/h. The latent heat released as steam condenses determines the condensate produced per unit of heat transferred. This sizes the trap correctly.

13. B — High superheat with a starved evaporator points to a restriction such as a plugged filter-drier or a TXV stuck nearly closed, limiting refrigerant to the coil. Too little refrigerant reaches the evaporator to fully load it. Clearing the restriction restores capacity.

14. C — Expansion-tank sizing depends on the system water volume and the temperature range over which the water expands and contracts. These determine the acceptance volume the tank must absorb. Correct sizing keeps system pressure within safe limits.

15. B — A joint that leaks hot but seals cold indicates differential thermal expansion relaxing the bolt load, or a gasket not rated for the temperature. As the flange heats, the bolt tension and gasket seal change. Proper gasket selection and bolt load solve it.

16. D — A larger expansion loop reduces bending stress because its longer legs flex more easily to absorb the same pipe growth. More flexibility means lower stress for a given movement. Adequate loop size protects the pipe and anchors.

17. A — A blind (blank) flange or spectacle blind bolted in physically blocks the line, giving the highest assurance against leakage for hot work. A single valve can pass through, but a solid blank cannot. Positive isolation protects against ignition of trapped or leaking product.

18. D — If radiators fill with steam but condensate will not drain, the radiator traps have failed closed, blocking condensate from leaving. Steam enters but the trapped condensate has no exit. Replacing the failed traps restores drainage.

19. B — A hydraulic tensioner improves the accuracy of bolt preload by stretching the bolt directly rather than relying on the friction a torque wrench must overcome. Friction makes torque an indirect, variable measure of load. Direct tensioning gives more consistent, accurate preload.

20. C — Superheated steam holds additional sensible heat above its saturation temperature and carries no liquid water. The extra heat raises its temperature beyond the boiling point for that pressure. Dry superheated steam protects turbines and resists condensation in long mains.

21. C — An overheating zone with a balancing valve present usually has that valve set too far open, passing more than its design flow. The excess flow delivers more heat than the zone needs. Resetting the balancing valve to design flow corrects it.

22. A — On a raised-face flange, the gasket covers the raised face within the bolt circle so compression is confined to the seating area. This concentrates the bolt load on the gasket for an effective seal. Full-face gaskets are used on flat-face flanges instead.

23. A — Centre-to-face = $1.5 \times \text{nominal diameter} = 1.5 \times 100 \text{ mm} = 150 \text{ mm}$. The long-radius factor of 1.5 sets the elbow's take-out dimension. This figure is needed for accurate pipe-cut calculations.

24. C — A low-water fuel cutoff is tested by lowering the water level under controlled conditions and confirming the burner shuts off at the cutoff point. This directly verifies the device performs its protective function. Regular testing is essential to boiler safety.

25. A — On a buried steel gas line, a coating holiday with a corrosion pinhole or a backfill rock that damaged the pipe wall is a likely leak source specific to burial. These defects are hidden until tested. Careful coating and bedding prevent them.

26. D — A steam separator protects a turbine by removing entrained water droplets so dry steam reaches the blades, avoiding erosion. Wet steam at turbine speed erodes the blades rapidly. Dry steam preserves turbine efficiency and life.

27. C — Minimum breaking strength = load \times safety factor = 4 kN \times 5 = 20 kN. The safety factor multiplies the working load to set the required breaking strength. Selecting rod to this value ensures a safe support.

28. A — If the expansion tank is good but the relief valve discharges on every firing, a fill valve or backflow preventer feeding above the relief setting is overpressuring the system. Make-up water is being admitted at too high a pressure. Correcting the fill pressure stops the discharge.

29. B — Pitching a steam line toward drip legs ensures condensate drains to the traps before steam flow can sweep it into a damaging water-hammer slug. Continuous drainage keeps the main clear of accumulated water. Correct pitch and drip legs prevent water hammer.

30. A — Friction head loss varies roughly with the square of the flow rate, so doubling flow nearly quadruples the loss. Small flow increases cause disproportionately large losses. This relationship governs pipe sizing and pump head calculations.

31. C — A ball valve rotates its bore a quarter turn to give fast, tight on/off shutoff, making it ideal for on/off water service. The full-bore opening also gives low pressure drop when open. It is the standard choice for quick isolation.

32. C — A deaerator that fails to remove oxygen usually has insufficient steam or too low an operating temperature, so the water is not heated enough to scrub out dissolved gases. Adequate heat is what drives the gases off. Restoring steam and temperature restores deaeration.

33. D — On detecting a gas leak, the first action is to shut off the gas, remove ignition sources, and repair before restoring supply. Working on or tightening a live, pressurized line risks fire or explosion. De-energizing the hazard comes first.

34. C — Condensate return lines are oversized to accommodate flash steam, which forms when hot condensate drops in pressure and occupies far more volume than the liquid. Undersized returns would be choked by the flash steam. Proper sizing handles both phases.

35. A — Velocity = flow \div area = 0.004 m³/s \div 0.00196 m² \approx 2.0 m/s. Dividing volumetric flow by the bore area gives the fluid velocity. This is the basic check for erosion and noise limits.

36. C — Glycol solutions reduce heat-transfer capacity and increase viscosity compared to water, requiring pump and flow adjustments. The pump must work harder and flow rates change. Accounting for glycol's properties ensures the system performs as intended.

37. A — Before condemning a trap blowing live steam, verify the upstream strainer or trap internals are not held open by debris on the seat. Trapped debris can mimic a failed trap. Clearing it may restore proper operation without replacement.

38. B — Even after isolation, the fitter must assume residual pressure and heat remain, using gloves, face protection, and standing clear when opening the line. Trapped steam and hot condensate can still injure. Cautious opening protects against residual hazards.

39. B — An air-bound circuit shows hot supply and cold return because trapped air blocks circulation through that loop, so water sits without carrying heat onward. The air pocket stops flow. Purging the air at the high point restores circulation.

40. C — Output = flow \times ΔT \times specific heat = $0.5 \times 20 \times 4.18 = 41.8$ kW. The specific heat converts the mass flow and temperature change into a heat rate. This calculation sizes coils and verifies performance.

41. A — Butt welding with a qualified procedure gives a full-strength joint for high-pressure steam in thick-wall carbon steel. Welded joints match the pipe's strength and integrity. They are the standard for high-pressure service.

42. D — Tripping on low water shortly after startup is typically caused by shrinkage of the boiler water level as cold feedwater and rapid steaming disturb the level. The level momentarily drops below the cutoff. Understanding shrink-and-swell prevents nuisance trips.

43. D — A joint that did not sweat properly usually had surfaces that were not cleaned or fluxed properly, so the solder could not wet and flow into the gap by capillary action. Clean, fluxed surfaces are essential for capillary draw. Proper prep ensures a filled joint.

44. C — Static pressure = height \times head factor = $40 \text{ m} \times 9.8 \text{ kPa/m} = 392 \text{ kPa}$. Each metre of water column adds about 9.8 kPa. This calculation gives the pressure at the base of a column.

45. D — A Hartford loop's equalizing connection is made just below the normal water line so a return-line break cannot drain the boiler below that point. This preserves a safe minimum water level. The connection height is what gives the loop its protective function.

46. A — A pump that loses prime each time it stops usually has a leaking foot valve or check valve allowing the suction line to drain back. With the suction drained, the pump is air-bound on restart. Repairing the valve preserves prime.

47. B — Sizing a steam PRV requires the inlet and outlet pressures and the required flow capacity at those conditions. These determine the valve's capacity and trim. Correct sizing delivers stable reduced pressure at the needed flow.

48. B — The pressure differential across a steam trap is what drives condensate out of the trap and through to the lower-pressure return. Without a differential, the condensate cannot flow. Adequate differential is needed for the trap to discharge.

49. C — A valve rated 300 kg/h on a system requiring 500 kg/h cannot relieve the required capacity, so the system can overpressure — an unacceptable installation. The relieving capacity must meet or exceed the demand. Undersizing defeats overpressure protection.

50. A — Nitrogen displaces oxygen so no internal oxide scale forms inside the tubing during brazing. The inert atmosphere keeps the bore clean. Scale would otherwise flake off and foul the refrigeration system.

51. D — A check valve that allows reverse flow usually has debris holding the disc off its seat, or a worn disc or seat that cannot seal. The valve can no longer close fully against backflow. Cleaning or replacing the valve restores its function.

52. A — A reading of 19.0% oxygen is below the safe minimum (about 19.5%), indicating an oxygen-deficient atmosphere, so entry is unsafe without ventilation. Even a small deficiency signals a problem and possible displacement by another gas. Ventilation and retesting are required before entry.

53. A — A globe valve's tortuous S-shaped flow path forces the fluid to change direction, adding resistance and creating more pressure drop than a straight-through gate valve. This same path is what makes it good for throttling. The trade-off is higher pressure loss.

54. D — When a pump produces more head than needed, the fitter uses a balancing valve or trims the impeller to drop the excess head to the design value. This matches the pump to the system curve. It prevents excess flow and wasted energy.

55. D — Even with a closed upstream valve, residual or trapped pressure can spray hot fluid, so a flanged joint is cracked open cautiously. Valves can leak through and trapped fluid remains. Cautious opening protects the worker.

56. A — An inverted bucket trap blowing live steam continuously has usually lost its water prime, so the bucket sank and cannot close the valve against the steam. The water seal is essential to its operation. Restoring prime or fitting a check valve corrects it.

57. D — Total fall = run \div slope denominator = 60 000 mm \div 240 = 250 mm. The 1-in-240 ratio applied to the run gives the drop. Correct pitch ensures the main drains to its drip legs.

58. D — Starting a low-specific-speed centrifugal pump against a closed discharge valve minimizes the starting power demand, because a closed valve corresponds to the lowest power draw on its curve. This eases motor starting. The valve is opened gradually once running.

59. C — Black steel pipe with welded or properly rated threaded joints is suitable for a fuel-oil supply line. It withstands the fuel and the service conditions. PVC, galvanized, and flared soft copper are not appropriate for fuel oil.

60. C — Constant gurgling with adequate fill pressure points to air entrained in the system circulating with the water. The moving air pockets make the noise. Purging at the high points removes the air and quiets the system.

61. D — A safety valve is sealed so its set pressure cannot be tampered with, preserving the certified overpressure protection. Field adjustment could defeat the protection. The seal guarantees the valve lifts at its certified pressure.

62. A — The feedwater rate should be slightly more than 1000 kg/h to replace both the steam produced and the blowdown losses. Blowdown removes water that must also be made up. Accounting for both keeps the boiler level stable.

63. C — Joining copper and steel without isolation forms a galvanic cell in the presence of water, corroding the more anodic metal over time. The dielectric union breaks the electrical path. Isolation prevents the galvanic corrosion.

64. A — Low superheat with a frosted suction line means the TXV is overfeeding refrigerant, allowing liquid to leave the evaporator and reach the compressor. Liquid floodback can destroy the compressor. Adjusting or replacing the TXV protects it.

65. A — A test that seals at low pressure but fails at full pressure indicates a joint or component that leaks once the higher pressure stresses it. The added stress opens the path. The leak must be found and repaired before re-testing.

66. D — Slow warm-up through bypass valves lets condensate drain and the metal heat gradually, avoiding thermal shock and water hammer. Admitting full steam at once would drive condensate slugs and shock the metal. Controlled warm-up protects the main.

67. B — Flow area scales with the square of diameter, so a 50 mm pipe has one quarter the area of a 100 mm pipe. Halving the diameter quarters the bore area. This sharply affects velocity and pressure drop.

68. D — Wet steam with carryover is typically caused by a high water level, rapid load change, or high dissolved solids causing priming and foaming. Water is carried over with the steam. Controlling level and water chemistry restores dry steam.

69. B — On shutdown a steam coil forms a vacuum as the steam condenses, and the vacuum breaker admits air so condensate can drain. Without it the vacuum holds condensate in the coil. The breaker ensures proper drainage.

70. B — Flow area scales with the square of diameter, so doubling the diameter increases the area by a factor of four. Area equals πr^2 , so doubling r quadruples the area. This governs sizing when changing pipe diameters.

71. A — Threading removes wall material at the threads, weakening the pipe and limiting the pressure and size for threaded joints. The reduced section cannot hold high pressure. Welding is used where strength and size exceed threading limits.

72. C — A condensate pump running continuously usually has a failed float switch stuck in the run position, or condensate inflow exceeding pump capacity. Either keeps the pump from shutting off. Diagnosing the float and the load identifies the cause.

73. D — Without a vapour barrier, moisture migrates through the insulation, condenses on the cold pipe, and ruins the insulation. The barrier stops water-vapour intrusion. It is essential on all cold-line insulation.

74. A — By the affinity laws, power varies with the cube of speed: $1.2^3 \approx 1.73$, so a 20% speed increase raises power about 73%. Power rises steeply with speed. This is critical when increasing pump or fan speed.

75. A — In a vertical line where solids could settle, an eccentric reducer installed flat-side down carries settling solids through the offset rather than trapping them. The offset keeps the bottom continuous. This prevents solids accumulation at the size change.

76. A — Downstream pressure creeping up at no demand means the PRV seat is worn or fouled, letting it pass steam and raise the pressure. The valve no longer seals tightly. Repairing or replacing the seat restores control.

77. C — Traps are placed at low points and ahead of risers because condensate naturally collects there, so trapping removes it before it causes water hammer. These are the drainage points of the main. Proper placement protects the system.

78. B — Reseat pressure = set - blowdown = $1035 - (10\% \text{ of } 1035) = 1035 - 103.5 \approx 932 \text{ kPa}$. Blowdown is the drop below set pressure before the valve recloses. Adequate blowdown prevents chattering.

79. B — A backflow preventer stops treated boiler water from siphoning back into the drinking-water system on a pressure loss. This cross-connection control protects public health. It is a code requirement on boiler fill lines.

80. C — A circulator running but moving little water, with air ruled out, usually has a closed isolation valve, a clogged strainer, or a seized impeller blocking the flow path. The flow is physically obstructed. Locating the blockage restores circulation.

81. D — As steam pressure rises, more of its heat is sensible and less is latent, so the latent heat per kilogram decreases. The steam tables show this trend. It means high-pressure steam delivers less latent heat per unit mass at the point of use.

82. A — Expansion = length \times coefficient \times $\Delta T = 25 \times 0.0000168 \times 60 = 0.0252 \text{ m} \approx 25 \text{ mm}$. Copper's higher coefficient produces notable growth. This must be accommodated to avoid stress and noise.

83. B — A relief discharge pipe reduced below the valve outlet creates backpressure that reduces relieving capacity and can impair operation. The restriction chokes the discharge. Discharge piping must be full size or larger.

84. B — Fluctuating level with unstable firing, after checking controls, points to high dissolved solids causing foaming and priming, which destabilize the level and cause carryover. Water chemistry is the culprit. Blowdown and treatment restore stability.

85. C — A riser passing through multiple floors is supported by a riser clamp bearing on the floor structure at each level, carrying the weight of the vertical pipe. Its ears rest on the slab or steel. This prevents the riser from sliding down.

86. A — Hanger loads must always include the weight of the water and any insulation in addition to the empty pipe. A water-filled pipe weighs far more than empty. Ignoring the contents would undersize the supports.

87. D — An oversized steam trap may pass live steam along with condensate because the valve does not modulate well to the light load, wasting energy. The oversized orifice lets steam through. Correct sizing matches capacity to load.

88. C — A single cold radiator with its zone valve open and powered usually has an air pocket or a closed balancing valve isolating it from the flow. The flow cannot reach that radiator. Purging air or opening the valve restores heat.

89. D — The root pass establishes full penetration and fusion at the inside of the joint, the foundation on which the fill and cover passes build. A defective root compromises the entire weld. Its quality is critical to weld integrity.

90. A — By the affinity laws, flow scales directly with speed: $200 \times (1450 \div 1750) \approx 166$ L/min. Flow is proportional to pump speed. This predicts performance when speed changes.

91. D — By delivering drier steam, a separator maximizes the latent heat available at the heat-transfer surface, since wet steam transfers heat less effectively. Water films impede heat flow. Drier steam improves exchanger performance.

92. A — A burner that ignites then locks out on flame failure, with gas pressure confirmed, usually has a dirty or mispositioned flame sensor failing to prove the flame. The control then trips the safety lockout. Cleaning or repositioning the sensor restores proving.

93. B — Heating water to 90 °C makes the steel pipe expand in length, building stress unless a loop, joint, or offset absorbs the growth. The pipe, not just the water, expands. Expansion provision protects the run and its anchors.

94. B — Make-up = 2% of 5000 kg/h = 100 kg/h. The blowdown percentage applied to the circulation rate gives the make-up needed. This sizes the make-up water supply.

95. C — Check valves on parallel pumps prevent flow from a running pump backing through an idle pump. Without them, an idle pump could spin backward and lose prime. The check valves keep flow moving forward through the header.

96. D — A coil knocking on startup, with the trap working, is caused by condensate pooling in the coil and being struck by incoming steam — a classic water-hammer knock. The steam accelerates the trapped water. Proper drainage and slow warm-up prevent it.

97. C — Pneumatic testing requires a larger exclusion zone and a staged pressure rise because compressed gas stores dangerous energy that releases violently on failure. Unlike water, gas is highly compressible. These precautions protect workers during the test.

98. A — A safety valve rated 2200 kg/h on a 2000 kg/h boiler is acceptable because its rated capacity exceeds the boiler's maximum output. The valve can vent all the steam the boiler can produce. Adequate relieving capacity is the safety requirement.

99. B — A condensate receiver is vented so air and flash steam can escape, letting the pump fill freely without building backpressure. A sealed receiver would trap pressure and impair filling. The vent ensures reliable pump operation.

100. D — Rapid chattering when a relief valve lifts is caused by an oversized valve or excessive inlet pressure drop, making it cycle open and shut. The valve cannot hold a stable open position. Correct sizing and inlet piping stop the chatter.

101. A — Condensate ahead of a control valve would be carried into the valve and downstream as a slug, causing water hammer and valve erosion. Dripping the main ahead of the valve removes it. This protects the valve and piping.

102. B — $\text{Area} = \pi r^2 = \pi \times 100^2 \approx 31\,400 \text{ mm}^2$ for a 200 mm bore (100 mm radius). The radius, not the diameter, is squared. Correct area underlies flow and velocity calculations.

103. D — Installing a trap below the equipment lets gravity assist condensate flow into the trap rather than relying on steam pressure alone. Gravity drainage is more reliable. This placement improves condensate removal.

104. C — A full column of bubbles at steady load, with charge confirmed adequate, points to a restriction such as a partially plugged filter-drier causing flashing in the liquid line. The pressure drop flashes the liquid to vapour. Clearing the restriction clears the glass.

105. B — A base anchor on a tall riser establishes a fixed point so expansion is directed upward and controlled along the riser. It gives the thermal growth a defined direction. This prevents uncontrolled movement and stress.

106. C — With NPSH available (3 m) below NPSH required (5 m), the liquid flashes at the impeller eye and the pump cavitates. The suction margin is insufficient. Raising available NPSH is required to prevent damage.

107. B — A high-limit control acts as an independent backup that shuts the burner off if the operating control fails. It stays dormant until a fault occurs. This layered protection guards against overpressure or overtemperature.

108. D — A boiler that boils and makes noise while the system stays cool has no circulation — a failed pump or closed valve — so heat cannot move out. The boiler overheats locally while the building stays cold. Restoring flow solves it.

109. C — Radiographic or ultrasonic testing reveals internal weld flaws without destroying the weld, making it the suitable non-destructive method. Tensile, bend, and macro-etch tests all destroy the sample. NDT verifies quality in place.

110. B — A 14 mm expansion is absorbed by an expansion loop or joint sized to take the movement without overstressing the pipe. Anchoring or stiffening the pipe would cause buckling. Controlled movement is the safe solution.

111. D — Excessive pressure drop in a gas line starves the appliance of gas, so it cannot reach its rated input and may burn incompletely. Adequate supply pressure is needed at the manifold. Proper sizing limits the drop.

112. A — A trap discharging much hotter than expected for the pressure is passing live or flash steam, indicating it has failed open or is undersized. The high discharge temperature signals steam loss. The trap must be repaired or resized.

113. D — A relief valve on the shell side protects against overpressure if the steam supply exceeds the shell's rating or a tube ruptures into the shell. Either event can overpressure the water side. The relief valve guards the shell.

114. D — A pump delivering 18 L/s where 15 L/s is required is matched by throttling with a balancing valve or trimming the impeller to bring flow to design. This sets the system to its intended flow. It prevents excess flow and wasted energy.

115. A — Verifying a trap's discharge during commissioning confirms it is removing condensate while holding back steam — its core function. This proves the trap works as intended. Commissioning checks prevent steam loss and waterlogging.

116. B — A system that loses pressure overnight while cool has a leak or a passing relief valve, since cooling alone would not require make-up. Water is escaping from the closed loop. Finding the loss restores stable pressure.

117. B — On a horizontal pump suction line, an eccentric reducer is installed flat-side up so air cannot be trapped at the top, preventing an air pocket at the suction. A trapped air pocket would cause the pump to lose prime. Flat-side-up keeps the crown continuous.

118. D — A relief discharge stack needs a base drain to remove rainwater and condensate so they do not collect on the valve disc and cause corrosion. Standing water would foul the seat. The drain keeps the valve and stack clear.

119. C — A long-radius elbow on the suction side reduces turbulence and pressure loss, improving NPSH available and reducing cavitation risk. Smoother flow into the pump protects it. This is why long-radius is preferred on suction piping.

120. B — A falsely high steady level is typically caused by a plugged lower gauge-glass connection, trapping water in the glass and giving a false high reading. The glass no longer tracks the true level. Blowing down the connections restores an accurate reading.

121. A — Branch connections taken from the top of a steam main draw off dry steam while condensate stays in the bottom to drain to traps. This keeps water out of the branch. Top connections deliver drier steam to equipment.

122. C — Input power = hydraulic power ÷ efficiency = 5 kW ÷ 0.70 ≈ 7.1 kW. Efficiency losses mean the motor must supply more than the hydraulic output. This sizes the motor correctly.

123. D — A thermostatic trap holds condensate until it subcools, then discharges it, releasing the radiator's full heat first. It closes against live steam and hot condensate, opening only for cooler water. This maximizes the radiator's heat output.

124. A — A motor tripping its overload, with the electrical supply confirmed, is likely from the pump running far out on its curve at excessive flow, drawing high power. Operating beyond the design point overloads the motor. Throttling back toward the BEP corrects it.

125. D — A flange gasket conforms to the flange faces under bolt load, filling surface imperfections to seal the joint. The compressed gasket bridges the microscopic gaps. This is what creates the pressure-tight seal.

126. B — Fuel input = output ÷ efficiency = 2000 kW ÷ 0.80 = 2500 kW. Efficiency losses mean more fuel energy is needed than the output. This calculation sizes the fuel supply and assesses operating cost.

127. B — A trap discharging to a flooded return needs a check valve to prevent backflow of condensate from the return into the trap when the trap pressure drops. Backflow could flood or damage the trap. The check valve keeps flow one-way.

128. D — Steam radiators banging on a call for heat are almost always caused by condensate trapped by an improper pitch or a failed trap, struck by incoming steam as water hammer. The steam accelerates the standing water. Correcting pitch or the trap stops the banging.

129. C — Tapered pipe threads wedge together as the joint is made up, creating an interference seal that, with sealant, becomes pressure-tight. The taper is what produces the seal. Straight threads cannot seal this way.

130. B — Total head = static lift + friction + residual = 10 + 3 + 2 = 15 m. All three components are summed to find the required pump head. Omitting any one would undersize the condensate pump.