

# PRACTICE EXAM 17: RED SEAL PLUMBER SIMULATION (125 QUESTIONS)

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1. A plumber arrives at a job site and is told by the general contractor that the building's asbestos abatement was completed yesterday and the area has been cleared for reentry by the abatement company. The plumber must install piping in the abated area. Before entering, what documentation should the plumber request?

- A. The abatement company's business licence and insurance certificate proving they are authorized to perform abatement work
- B. The clearance air monitoring results confirming fibre concentrations are below the occupational exposure limit for reentry
- C. The general contractor's verbal assurance that the area is safe, because the contractor is responsible for site safety decisions
- D. The building owner's written guarantee that no asbestos remains anywhere in the building after the abatement is complete

2. A plumber is soldering copper pipe in a residential attic. The attic has blownin cellulose insulation that covers the ceiling joists to a depth of 300 mm. The plumber must solder a joint directly above the insulation. What is the primary concern?

- A. The cellulose insulation will melt from the torch heat and produce toxic fumes that accumulate in the confined attic space
- B. The solder will not flow properly because the insulation absorbs heat from the fitting faster than the torch can deliver it
- C. The insulation will compress under the plumber's weight and may not support the plumber during the soldering operation

D. Cellulose insulation is combustible — the torch can ignite the insulation, which smoulders and may develop into a concealed fire

3. A plumber must install underground piping across a parking lot. The parking lot surface is asphalt. Before cutting the asphalt, the plumber contacts the utility locate service and receives locate marks for gas, electrical, and telecommunications. No water or sewer locates are marked. Can the plumber proceed with excavation?

A. Yes — but the plumber must still handdig the first 600 mm and proceed cautiously because unmarked utilities may exist in the area

B. No — the absence of water and sewer locates means these utilities have not been located yet and the plumber must wait

C. Yes — the absence of marks confirms no water or sewer utilities are present and the plumber can excavate freely

D. No — the plumber must perform a private locate using groundpenetrating radar before any excavation in a parking lot

4. A plumber is working from a 3metre Aframe ladder inside a building. The ladder is set up on a smooth tile floor. The plumber is carrying a 10 kg pipe section up the ladder. What safety violation is occurring?

A. The 10 kg pipe exceeds the maximum allowable load for a 3metre Aframe ladder used on indoor tile floor surfaces

B. Aframe ladders are prohibited for indoor use on tile floors because the smooth surface prevents adequate base grip

C. The plumber should maintain three points of contact while climbing — carrying a pipe with one hand violates this requirement

D. The ladder height of 3 metres requires a second worker to hold the ladder base at all times during indoor climbing

5. A plumber encounters a specification requiring "NSF 61 certified" pipe and fittings for the potable water supply system. What does NSF 61 certification ensure?

A. The pipe and fittings have been tested for structural strength and can withstand the maximum system operating pressure

B. The pipe and fittings do not leach harmful contaminants into the drinking water above established health effect levels

C. The pipe and fittings have been tested for fire resistance and will not contribute fuel during a building fire event

D. The pipe and fittings are manufactured from recycled materials that meet environmental sustainability requirements

6. A plumber discovers that a coworker has removed the guard from a bench grinder to sharpen a tool. The coworker says the guard "gets in the way." What is the correct response?

A. Allow the coworker to finish sharpening and then replace the guard after the task is completed for the next user

B. Report the missing guard to the supervisor but do not interfere with the coworker's current task in progress

C. The guard removal is acceptable for brief sharpening tasks as long as the coworker wears safety glasses during use

D. Stop the coworker immediately — the guard must be reinstalled before the grinder is used because a wheel failure without a guard can cause serious injury

7. A plumber is calculating material costs for a project bid. The project requires 150 metres of 3/4inch Type L copper tube. The supplier quotes the tube at \$12.50 per metre. What is the total material cost for the copper tube (before fittings, hangers, and labour)?

A. \$1,875.00, calculated as  $150 \text{ m} \times \$12.50/\text{m}$  for the total copper tube cost before fittings, hangers, and labour

B. \$1,500.00, calculated by using \$10.00 per metre instead of the quoted \$12.50 price for the tube material

C. \$2,250.00, calculated by adding a 20% waste factor to the quoted price for the total material cost estimate

D. \$937.50, calculated by dividing the total by 2 because the plumber expects to use only half the estimated quantity

8. A plumber must install a pipe penetration through a poured concrete wall that separates an electrical room from a mechanical room. The wall has a 2hour fire rating. The pipe is 4inch copper. What must be installed at this penetration?

A. A standard rubber grommet that seals the annular space between the pipe and the concrete wall at the penetration

B. A steel sleeve filled with mineral wool insulation that provides thermal insulation between the two rooms

C. A listed firestop assembly for metallic pipe through a 2hour rated poured concrete wall that maintains the fire rating

D. A silicone sealant applied around the pipe at both sides of the wall to create an airtight seal between the rooms

9. A plumber is working on the 5th floor of a building under construction. The plumber drops a fitting from the work area. The fitting falls through an open floor penetration to the ground level 5 storeys below. No one is injured. What should have prevented this incident?

A. Floor penetrations must be covered or barricaded when not in active use to prevent objects from falling through to levels below

B. The plumber should have attached all fittings to a tool lanyard that prevents dropped objects from falling below the work area

C. A catch net should be installed at each floor level below the work area to intercept any objects that fall through penetrations

D. The 5th floor work area should be completely enclosed with temporary walls to prevent any objects from leaving the area

10. A plumber is reviewing a commercial building's mechanical drawings. The plumbing plan shows a pipe marked "HWR" running parallel to a pipe marked "HWS." What do these abbreviations represent?

A. "Heavy Wall Rigid" and "Heavy Wall Standard" — indicating the pipe's wall thickness and pressure classification

B. "Hazardous Waste Return" and "Hazardous Waste Supply" — indicating chemical waste piping for a laboratory

C. "High Water Return" and "High Water Supply" — indicating the upperfloor water distribution for a highrise building

D. "Hot Water Return" and "Hot Water Supply" — indicating the hot water distribution and recirculation piping system

11. A plumber must solder a copper joint on a pipe that has residual water inside — the pipe could not be fully drained because of the system's configuration. A small amount of water seeps from the pipe end. What effect does this residual water have on the soldering process?

A. Residual water has no effect on soldering because the torch evaporates the water before the solder melts on the joint

B. The residual water absorbs heat from the fitting, making it difficult or impossible to bring the joint to solder temperature

C. The residual water flashes to steam instantly when the torch is applied, creating a pressure burst that blows the joint apart

D. The residual water mixes with the flux and creates a chemical reaction that produces toxic hydrogen chloride gas

12. A plumber is assigned to work in a food processing facility that has strict hygiene requirements. The plumber must install a new water supply connection in the production area. What additional precaution applies beyond standard construction site safety?

- A. The plumber must wear disposable coveralls over work clothes but no other hygiene measures beyond standard PPE
- B. The plumber must complete the work outside of production hours when the facility is not processing food products
- C. The plumber must follow the facility's food safety protocols — which may include hand washing, hair nets, boot covers, and tool sanitization
- D. The plumber must install a temporary plastic barrier around the work area to contain dust and debris from the installation

13. A plumber must determine the expansion of a 25metre straight run of CPVC hot water supply pipe heated from 20°C to 82°C. The coefficient of linear expansion for CPVC is 0.0000617 per °C. What is the total expansion?

- A. Approximately 96 mm, calculated as  $25 \text{ m} \times 0.0000617/^{\circ}\text{C} \times 62^{\circ}\text{C} = 0.0956 \text{ m} =$  approximately 96 mm
- B. Approximately 48 mm, calculated by using only half the temperature differential in the expansion formula
- C. Approximately 15 mm, calculated by using the copper expansion coefficient instead of the CPVC coefficient
- D. Approximately 192 mm, calculated by doubling the correct result as a safety factor for pipe support design

14. A plumber discovers that an apprentice has been disposing of solvent cement containers in the regular construction waste dumpster. The cement containers have residual solvent inside. What is the correct disposal method?

- A. Regular construction waste disposal is acceptable for cement containers with only residual amounts of solvent remaining
- B. The containers should be left open to allow the residual solvent to evaporate before disposal in the regular waste stream
- C. The containers should be rinsed with water and the rinse water poured down the nearest drain before regular disposal
- D. Solvent cement containers must be disposed of as hazardous waste per the product's SDS and local environmental regulations

15. A plumber is installing a water supply in a building that is occupied and operational. The plumber must shut off the water supply to make a connection. What coordination is required before the shutoff?

- A. The plumber can shut off the water at any time because the building's water supply is a utility that the plumber controls
- B. The plumber must notify affected occupants and coordinate the shutoff timing to minimize disruption to building operations
- C. The plumber must shut off the water only during nonbusiness hours regardless of the occupant notification timeline
- D. The plumber must obtain written permission from every individual tenant before shutting off the water supply system

16. A plumber encounters a project where the specification requires all underground DWV piping to be "factory colourcoded" for material identification. The plumber installs white PVC pipe underground. A coworker installs greencoloured pipe for the sewer lateral. What does the green colour indicate?

- A. Greencoloured PVC pipe is specifically manufactured for sewer service and is identified by its green colour to distinguish it from white DWV pipe
- B. Green PVC is a recycled material that cannot be used for underground sewer applications due to reduced strength
- C. Green PVC is identical to white PVC in all properties — the colour is purely aesthetic and has no code significance
- D. Green PVC is Schedule 80 heavywall pipe that is required for all underground sewer installations regardless of depth

17. A plumber is installing a copper press fitting system in a commercial building. The system will be filled with a 30% glycol antifreeze solution for a hydronic heating system. The press fitting manufacturer must approve the use of glycol in their fittings. Why?

- A. Glycol solutions corrode the copper fitting body faster than plain water, reducing the fitting's pressure rating over time
- B. Glycol solutions are incompatible with copper and brass and will cause dezincification of the fitting's brass components
- C. Glycol solutions can degrade certain Oring materials — the fitting manufacturer must confirm the Oring is glycolcompatible
- D. Glycol solutions create higher operating pressures than water at the same temperature, exceeding the fitting's pressure limit

18. A plumber is brazing a 1 1/2 inch copper tube joint using BCuP2 filler metal (0% silver). After heating the joint, the plumber applies the filler metal to the fitting face. The filler metal melts on the fitting surface but does not flow into the joint by capillary action. What is preventing capillary flow?

- A. BCuP2 has a higher melting point than other filler metals and requires additional heat to achieve its flow temperature
- B. The fitting's interior socket was not properly cleaned — oxidation on the inner surface prevents the filler from wetting the copper
- C. BCuP2 does not flow by capillary action on 1 1/2 inch joints and must be applied directly to the visible gap with the torch
- D. The gap between the pipe and fitting is too large for capillary action — the pipe is undersized or the fitting is oversized

19. A plumber encounters a project where stainless steel press fittings are specified for the domestic water supply. The fittings use a specialized pressing tool and jaws that are different from the copper press system. Can the plumber use copper pressing jaws on stainless steel fittings?

- A. Yes — copper and stainless steel press fittings use identical jaw profiles because the Oring sealing mechanism is the same
- B. No — stainless steel fittings require their own jaw profile and pressing tool because the fitting dimensions and crimp shape differ
- C. Yes — but the plumber must increase the pressing force by 25% to compensate for the harder stainless steel material
- D. No — stainless steel fittings must be welded because press connections are not approved for stainless steel piping systems

20. A plumber is installing PEXA tubing using the coldexpansion method. The plumber expands the tube end, inserts the brass fitting, and waits for the tube to shrink back. In cold weather (2°C ambient), the tube shrinks back very slowly — taking over 3 minutes instead of the normal 30 seconds. Is this acceptable?

- A. Yes — the PEXA tube will eventually complete its recovery regardless of temperature; cold weather simply slows the process
- B. No — if the recovery takes more than 60 seconds, the fitting must be removed and a new expansion must be attempted indoors
- C. Yes — but the plumber must heat the tube with a heat gun after insertion to accelerate the recovery for immediate functionality
- D. No — the cold temperature has permanently damaged the PEXA's thermal memory and the tube section must be replaced

21. A plumber must connect a 2inch copper water supply to a 2inch CPVC distribution system. What transition fitting connects these two dissimilar materials at this junction?

- A. A solventcemented CPVC coupling applied to both the copper and CPVC surfaces for a chemical bond between them
- B. A coppertocopper soldered adapter that then threads or mechanically connects to a CPVC transition adapter fitting
- C. A coppertoCPVC transition adapter — one end solders to the copper and the other end cements to the CPVC pipe
- D. A ferncotyberubber coupling with band clamps that slides over both the copper and CPVC pipe ends for the transition

22. A plumber is installing a fire sprinkler system using CPVC piping. The manufacturer's installation guide requires a specific hanger type — a plasticcoated or plastic ringtype hanger that prevents direct metaltoCPVC contact. Why is this required?

- A. Metal hangers conduct heat to the CPVC during a fire, weakening the pipe at the support point before the sprinkler activates
- B. Metal hangers create stress concentrations on CPVC pipe that can cause cracking under normal operating pressure loads
- C. Metal hangers transfer building vibration to the CPVC pipe that loosens the solventcemented joints over time
- D. Certain metals and metal coatings contain chemicals that cause environmental stress cracking of CPVC at the contact point

23. A plumber is cutting 6inch ductile iron pipe with a portable band saw. The pipe must be cut square (perpendicular to the pipe axis) for a proper mechanical joint assembly. After cutting, the plumber discovers the cut is 3 degrees offsquare. What is the consequence of this outofsquare cut?

- A. The 3degree angle is within the acceptable tolerance for ductile iron mechanical joints and does not affect the seal
- B. The mechanical joint gasket cannot seat evenly on the angled cut, potentially causing a leak at the high side of the angle
- C. The outofsquare cut increases the pipe's DFU capacity by creating a slightly larger opening at the joint connection
- D. The cut must be redone because even 1 degree offsquare causes the coupling bolts to bind during assembly

24. A plumber is installing Schedule 40 steel pipe for a compressed air system. The pipe has been threaded on both ends. After threading, the plumber examines the threads and notices a small burr on one thread crest. Should this burr be removed?

- A. Yes — the burr must be removed because it can cut the thread sealant, preventing a proper seal during assembly
- B. No — small burrs on thread crests are normal and compress flat during assembly when the joint is tightened
- C. Yes — but only on gas piping; compressed air system threads can tolerate minor burrs without affecting the seal
- D. No — the burr indicates the die was properly aligned and cutting at the correct depth for Schedule 40 steel pipe

25. A plumber encounters a project where the specification calls for "victaulic" couplings on the fire protection piping. The plumber has never installed victaulic (grooved mechanical) couplings. What training is required before the plumber can install these couplings?

- A. No specific training — victaulic couplings are simple mechanical joints that any licensed plumber can install from the instructions
- B. A formal manufacturer's training program that covers groove specifications, gasket selection, assembly, and torque requirements
- C. The plumber must be trained on the specific coupling model, grooved joint assembly, proper gasket selection, and bolt torque procedures
- D. Only manufacturer-certified installers can install victaulic couplings because incorrect installation voids the fire protection system warranty

26. A plumber is troubleshooting a 15storey residential building where the 2ndfloor resident reports that the toilet bowl water surges (rises and falls visibly) when toilets on upper floors are flushed. No trap seal loss occurs — the water level just bounces. What venting deficiency causes this water movement?

- A. The building's soil stack is undersized for the total DFU load and cannot handle the simultaneous upperfloor discharges
- B. The 2ndfloor toilet's individual vent is blocked, making the trap susceptible to positive and negative pressure waves
- C. The soil stack's vent is inadequate, allowing pressure fluctuations from upperfloor discharge to reach the 2ndfloor trap
- D. The building's water supply creates the surging through a crossconnection between the supply and drainage systems

27. A plumber discovers that an existing building's 6inch building sewer has a section where tree roots have infiltrated through a bellandspigot clay tile joint. The roots fill approximately 50% of the pipe bore. The plumber cuts the roots with a mechanical cable. How soon will the roots return?

- A. Roots typically regrow to the same infiltration level within 6–18 months because the entry point remains open after mechanical cutting
- B. Roots will not return after mechanical cutting because the cut severs the root at the entry point and kills the growth permanently
- C. Roots regrow within 24 hours of cutting because the root system redirects growth immediately to the severed entry location
- D. Roots return within 3–5 years because the root system must generate entirely new growth to reach the pipe joint again

28. A plumber installs a DWV system in a dental office. The dental office has a mercury amalgam separator on the dental chair's drain. The separator captures mercury particles from dental amalgam waste before the drainage enters the building's sanitary system. Where in the drainage path is the separator installed?

- A. On the building sewer between the building drain exit and the municipal sewer connection at the property boundary
- B. On the main building drain beneath the basement floor slab before it exits through the building foundation wall
- C. At the dental unit's drain connection — capturing mercury at the source before it enters the building's drainage system
- D. At each individual dental operator's drain outlet before the waste enters the branch serving the dental suite

29. A plumber encounters a building where the building drain changes direction by 90 degrees at two locations within a 6metre horizontal run. Each direction change uses a long sweep 90degree elbow. The drain serves 100 DFU on a 4inch pipe. Despite proper slope and clear vents, the drain experiences recurring blockages at the direction changes. What modification reduces the blockage frequency?

- A. Replace both 90degree elbows with 45degree elbows (two per direction change) for a more gradual transition at each turn
- B. Install cleanouts at each direction change to provide maintenance access rather than modifying the fitting configuration
- C. Increase the drain diameter from 4 inches to 6 inches through the direction change section for increased flow capacity
- D. Replace the long sweep 90degree fittings with short turn 90degree fittings that maintain higher velocity through the turns

30. A plumber installs a residential DWV system. The basement shower drain connects to a 2inch horizontal branch that runs 3 metres to the soil stack. The shower's Ptrap is located directly below the shower base. The trap arm (horizontal pipe from the trap to the vent) is 2 metres long. The code maximum trap arm for 2inch pipe is 2.4 metres. Is this installation acceptable?

A. No — the 2metre trap arm is too long for a shower because showers produce lowvolume flow that cannot maintain the trap seal

B. No — but only if the trap arm has any dips, bellies, or backfall that reduce the effective venting distance below 2 metres

C. Yes — but only if the shower's DFU rating is 2 or less because higherDFU showers require shorter trap arm distances

D. Yes — the 2metre trap arm is within the 2.4metre maximum for 2inch pipe, assuming correct slope and no sags

31. A plumber discovers that an existing building has a horizontal vent pipe that runs through a wall and connects to a soil stack on the other side. The horizontal vent runs below the flood level rim of the fixture it serves. What must be corrected?

A. The horizontal vent must be rerouted above the flood level rim of the fixture it serves before connecting to the stack

B. The horizontal vent below the flood rim is acceptable if it rises above the flood rim within 1 metre of the fixture connection

C. The horizontal vent can remain below the flood rim if it connects to the stack above the highest fixture on the stack

D. The horizontal vent must be replaced with a vertical vent that rises above the flood rim before turning horizontal to the stack

32. A plumber is installing a septic system and must verify the percolation test results. The test shows a percolation rate of 10 minutes per inch. This rate is faster than most soils. What does a fast percolation rate indicate about the soil?

- A. Fastpercolating soil provides excellent treatment because the water passes through the soil quickly for rapid purification
- B. Fastpercolating soil is ideal for conventional disposal fields and requires no special engineering or design modifications
- C. Fastpercolating soil (very sandy or gravelly) may not provide adequate treatment because water passes through too quickly for biological purification
- D. Fastpercolating soil is prohibited for septic system disposal fields because the effluent reaches groundwater untreated

33. A plumber is troubleshooting a commercial building where the firstfloor restroom has recurring sewer gas odour. All traps have water, vents are clear, and a smoke test reveals no leaks. The restroom has a floor drain that receives condensate from the HVAC system. The plumber examines the HVAC condensate connection and finds it connected directly to the floor drain through a tube that extends below the floor drain's grate into the drain body. What problem does this create?

- A. The condensate tube extending into the drain body displaces the trap water and reduces the effective trap seal depth
- B. The direct insertion of the condensate tube into the drain bypasses the air gap required for indirect waste connections
- C. The condensate tube acts as a siphon tube that draws the floor drain's trap seal water upward into the HVAC system
- D. The condensate tube creates a crossconnection between the HVAC system and the sanitary drainage system

34. A plumber installs a 4inch building drain at 1/4 inch per foot slope. Halfway through the 20metre run, the drain must pass over a 200 mm high foundation footer that crosses the drain's path. How does the plumber route the drain over this obstruction?

A. Install a ramp section at a steeper slope to climb over the footer, then resume the 1/4inch slope on the other side

B. Cut a notch in the foundation footer to allow the drain pipe to pass through at the correct elevation without interruption

C. Route the drain around the footer using two 45degree elbows that bypass the obstruction while maintaining flow direction

D. Install two 45degree elbows creating a vertical offset that raises the drain over the footer and then returns to the original grade

35. A plumber encounters a building where the building sewer has been installed using orangeburg (bituminous fibre) pipe. The pipe was installed in 1965. A camera inspection reveals the pipe is deformed (eggshaped) and has partially collapsed in several locations. What is the recommended permanent repair?

A. Complete replacement of the orangeburg pipe with modern PVC or HDPE sewer pipe — orangeburg cannot be rehabilitated

B. CIPP lining through the deformed pipe that restores the bore to a round crosssection within the collapsed shell

C. Pipe bursting that fractures the orangeburg and pulls new HDPE pipe through the existing pipe's pathway underground

D. Chemical injection that hardens the orangeburg from the interior and restores its original round crosssectional shape

36. A plumber is sizing a horizontal fixture drain for a commercial kitchen threecompartment pot sink. The pot sink has a DFU rating of 4. No water closets connect to this branch. What minimum pipe size is required?

A. 1 1/4 inches, which is the minimum drain size for any fixture and handles the 4 DFU within its rated capacity

B. 1 1/2 inches, which is the minimum for a 3compartment sink drain connection per the fixture outlet size code minimum

C. 2 inches, which is the minimum fixture drain size for a 3compartment commercial pot sink per fixture outlet requirements

D. 3 inches, which is the minimum for all commercial kitchen drains regardless of the individual fixture's DFU rating

37. A plumber is installing a building drain and must connect two branches at the same location on the drain — one from the left and one from the right. What fitting allows connections from both sides simultaneously?

A. Two separate wye fittings installed in sequence, one for each branch connection, spaced at least one pipe diameter apart

B. A double wye fitting that provides branch connections on both sides of the drain at the same location in a single fitting

C. A double sanitary tee that provides 90degree branch connections on both sides of the drain for simultaneous use

D. A cross fitting (4way) that provides branch connections on both sides plus a top connection for future expansion

38. A plumber encounters a building where the septic system's disposal field has failed — effluent surfaces in the yard above the field. The system is 25 years old. The plumber investigates and finds that the field's gravel has become clogged with biomat (biological growth). Can this field be restored?

A. Yes — jetting highpressure water through the perforated pipe dissolves the biomat and restores the field's absorption capacity

B. Yes — adding hydrogen peroxide or sodium hydroxide to the septic system dissolves the biomat within 30 days of treatment

C. No — but resting the field (diverting flow to an alternate field) for 6–12 months allows the biomat to decompose naturally

D. No — a failed field with 25 years of biomat accumulation requires complete replacement of the gravel bed and piping

39. A plumber installs a 3inch vent pipe through the roof. The vent terminal extends 300 mm above the roof surface. The building is in Edmonton, Alberta, where winter temperatures regularly reach 30°C and significant snowfall occurs. Is the 300 mm extension adequate?

A. No — in Edmonton's climate the vent should extend at least 600 mm above the roof to prevent burial by snow and frost closure

B. Yes — the 300 mm extension meets the code minimum and is adequate for all climate zones across Canada

C. No — the vent should extend at least 900 mm above the highest anticipated snow accumulation on the roof surface

D. Yes — but only if the vent diameter is increased to 4 inches through the roof for additional frost closure protection

40. A plumber is installing a DWV system and discovers that the fixture roughin dimensions shown on the architectural drawings do not match the plumber's standard roughin measurements. The toilet centre is dimensioned at 350 mm from the finished wall instead of the standard 305 mm (12 inches). What should the plumber do?

- A. Install the toilet roughin at the standard 305 mm and inform the architect that the drawing dimension is incorrect
- B. Install the toilet roughin at the drawing's 350 mm dimension without question because the architect's drawings govern
- C. Verify with the architect whether the 350 mm dimension is intentional (a nonstandard toilet) or an error requiring correction
- D. Install the toilet roughin at 350 mm because some accessibility-compliant toilets require the wider dimension from the wall

41. A plumber encounters a multistorey building where every sink on every floor drains slowly during morning peak use (8:00–9:00 AM) but drains normally during the rest of the day. The soil stack and building drain have been inspected and are clear. What is the most likely cause?

- A. The morning peak water use reduces the municipal water pressure, decreasing the flushing volume available for drainage
- B. The building drain is adequately sized for normal use but undersized for the simultaneous morning peak demand from all floors
- C. The soil stack vent terminal is partially blocked by morning dew or frost that forms overnight and melts by midmorning
- D. The morning peak overwhelms the building drain's capacity — the pipe handles normal flow but not peak simultaneous use

42. A plumber is installing a 4inch PVC soil stack through a 2hour fire-rated floor assembly. The plumber must install an intumescent firestop collar at the penetration. The collar must be installed on which side of the floor assembly?

A. On the upper side (top of the floor) where the fire would reach the penetration first if it originated in the room below

B. On the lower side (underside of the floor) closest to the fire exposure because fire rises from below through the penetration

C. On both the upper and lower sides of the floor for maximum protection and dual-layer redundancy during a fire event

D. The collar installation side depends on the specific firestop assembly's tested configuration per the manufacturer's instructions

43. A plumber discovers that an existing building's sewage ejector system has a nonsealed pit cover (the cover sits loosely on the pit without a gasket or bolted connection). The basement has a persistent sewer gas odour. What must be corrected?

A. The pit cover can remain loose if a vent pipe is connected to the pit and extends to the roof for gas relief exhaust

B. The pit cover is acceptable as is because the water seal in the pit's P-trap prevents gas from escaping into the basement

C. The loose cover must be reinforced with a weighted concrete lid that holds it in position by gravity during normal operation

D. The pit cover must be sealed (gasketed and bolted) to create a gastight enclosure, with the vent pipe providing gas relief

44. A plumber is sizing a building drain for a large commercial building with 500 DFU at 1/4 inch per foot slope. The code table shows: 4inch at 1/4" = 216 DFU; 5inch at 1/4" = 428 DFU; 6inch at 1/4" = 720 DFU. What is the minimum drain size?

A. 5 inches at a steeper slope (1/2 inch per foot) to increase the capacity above 500 DFU without going to 6inch pipe

B. 8 inches, because commercial buildings with over 400 DFU always require an 8inch minimum building drain diameter

C. 6 inches, because 720 DFU capacity exceeds the 500 DFU load and is the first standard size above the requirement

D. 5 inches is adequate because the 428 DFU capacity is close enough to 500 DFU with the builtin code safety margin

45. A plumber installs a floor drain in a hospital operating room. The floor drain must prevent sewer gas from entering the sterile environment. The drain receives only occasional mop water. What trap seal maintenance method is essential for this drain?

A. A trap seal primer that automatically maintains the water seal because the infrequent use would allow evaporation without it

B. A deepseal trap (100 mm) that evaporates more slowly than a standard trap, eliminating the need for a primer device

C. The operating room floor drain should not have a trap because the sterile environment cannot tolerate sewer gas under any condition

D. A mechanical (waterless) trap that does not rely on water and cannot evaporate, providing permanent gastight protection

46. A plumber encounters a residential building where the homeowner reports that the bathroom sink drains normally but the drain produces a loud "glugglug" sound after each use. The trap has a full water seal. The vent is connected and clear. What is the most likely cause?

A. The vent pipe diameter is too large, creating an echo chamber effect that amplifies the normal drainage sounds at the fixture

B. The vent pipe is partially obstructed, restricting airflow enough to create the gurgling sound but not enough to cause trap seal loss

C. The drain pipe slope is too steep, causing the water to drain too quickly and creating a vacuum behind the retreating water column

D. The trap itself is oversized and the large water volume creates turbulence during drainage that produces the gurgling noise

47. A plumber is installing a grease interceptor for a large restaurant. The interceptor is an inground gravity type with a capacity of 3,000 litres. The interceptor must be installed outdoors. What determines the interceptor's minimum capacity?

A. The number of seats in the restaurant's dining room multiplied by a perseat factor specified in the plumbing code

B. The total DFU of all connected kitchen fixtures, converted to a flow rate using the standard demand curve for sizing

C. The building owner's preference based on the desired pumpout interval and the restaurant's projected grease volume

D. The flow rate of all connected fixtures, the type of food service, and the code's sizing methodology for the jurisdiction

48. A plumber is troubleshooting a commercial building where a specific floor drain in the mechanical room backs up whenever the boiler's condensate drain discharges into the floor drain receptor. No other drains in the building are affected. The floor drain has been snaked with no blockage found. What should the plumber investigate?

- A. The boiler's condensate volume, which may exceed the floor drain's capacity during peak operation of the condensing boiler
- B. The floor drain's connection to the building drain, which may be undersized for the additional condensate flow volume
- C. The floor drain's trap and branch pipe for a partial restriction that reduces capacity below the combined condensate and floor drainage
- D. The boiler's condensate neutralization kit, which may be restricting the condensate flow rate before it reaches the floor drain

49. A plumber installs a DWV system in a building where the architect specifies that all vent piping must be concealed — no vent terminals visible on the roof. The roof is a highperformance commercial membrane with a 30year warranty. The plumber proposes air admittance valves (AAVs) on all fixtures. What limitation applies?

- A. At least one conventional vent must still extend through the roof to the atmosphere; AAVs can supplement but not fully replace all vents
- B. AAVs can replace all vent terminals on the roof if each AAV is properly sized and installed per the manufacturer's requirements
- C. AAVs are prohibited in commercial buildings and can only be used in residential singlefamily dwelling applications
- D. AAVs can replace roof penetrations only if the building has fewer than 20 total DFU on the entire drainage system

50. A plumber encounters a building where the building's footer drain (perimeter drain) discharges into a sump pit with a pump. The pump discharges to the storm drainage system. During heavy rain, the sump pump runs almost continuously. The homeowner reports that the basement stays dry. However, the plumber notices that the pump's discharge pipe exits the building and terminates on the ground surface 1 metre from the foundation wall. What problem does this create?

- A. The discharge water is too close to the foundation — it saturates the soil next to the foundation and reenters the footer drain
- B. The discharge termination on the ground is acceptable as long as the water flows away from the building on a sloped grade
- C. The pump discharge must connect to the municipal storm sewer for proper disposal rather than discharging at grade level
- D. The discharge water freezes at the termination point in winter, creating an ice dam that blocks the pump's discharge pipe

51. A plumber installs a DWV system and must select the correct trap for a commercial floor drain in a restaurant kitchen. The drain receives hot water from dishwashing operations (up to 82°C from the sanitizing rinse). What trap material is appropriate?

- A. A cast iron or stainless steel trap that withstands the hightemperature hot water discharge from the commercial dishwasher
- B. A PVC Ptrap that is chemically resistant to the cleaning agents used in commercial dishwashing operations
- C. A brass Ptrap that provides the durability needed for hightraffic commercial kitchen floor drain installations
- D. An ABS Ptrap that is rated for hightemperature drainage up to 90°C for commercial kitchen dishwashing applications

52. A plumber is installing a building sewer using gasketed PVC SDR 35 pipe. After assembling a joint, the plumber marks the pipe at the coupling edge with a marker. During the backfilling operation, the plumber checks the mark and discovers it has shifted 25 mm — the pipe has partially pulled out of the coupling. What caused this and what must be done?

- A. The gasket lubricant dried out during the delay between assembly and backfill, allowing the pipe to shift from soil pressure
- B. The pipe was not fully inserted to the insertion mark during assembly, and the backfill pressure pushed it outward at the joint
- C. The backfill operation displaced the pipe at the joint — the joint must be disassembled, cleaned, relubricated, and reassembled
- D. Thermal contraction from cold weather pulled the pipe out of the coupling — the joint must be reassembled with a longer insertion

53. A plumber encounters a building where the roof leader (storm drain downpipe) connects directly to the sanitary building drain inside the building. During heavy rain, the sanitary drain surcharges and sewage backs up through the basement floor drain. What must be done?

- A. Install a backwater valve on the building drain to prevent the surcharge from backing up through the basement floor drains
- B. Disconnect the roof leader from the sanitary drain and connect it to a separate storm drainage system or discharge at grade
- C. Increase the sanitary building drain diameter to handle the combined sanitary and storm water flow during heavy rain events
- D. Install a sump pump in the basement to handle the backup water during heavy rain events as a secondary protection measure

54. A plumber is sizing a vent for a 3inch horizontal branch drain serving 30 DFU. The developed length from the branch to the roof terminal is 12 metres. The code sizing table shows: 1 1/2" at 12 m = 10 DFU; 2" at 12 m = 50 DFU; 2 1/2" at 12 m = 100 DFU. What minimum vent size is required?

A. 1 1/2 inches, because the vent must be at least half the drain diameter (half of 3 = 1.5) and this ratio always governs

B. 3 inches, matching the drain diameter because vents must equal the drain size for all commercial branch drain applications

C. 2 1/2 inches, which provides margin above the 30 DFU load for future expansion of the branch drain's fixture connections

D. 2 inches, because 50 DFU capacity exceeds the 30 DFU load and also meets the halfdiameter minimum of 1 1/2 inches

55. A plumber installs a residential septic system. The homeowner plans to install a hot tub that will discharge directly to the septic tank through a drain connection. The hot tub holds 1,500 litres and is typically drained every 3 months. What impact does this periodic discharge have on the septic system?

A. The 1,500litre discharge has no effect because the volume is distributed through the septic tank over the draindown period

B. The hot tub water must be dechlorinated before discharge because the chlorine/bromine kills the septic tank's treatment bacteria

C. The sudden 1,500litre discharge can overwhelm the septic tank and flush untreated effluent into the disposal field

D. The hot tub chemicals and the large volume can disrupt the bacterial treatment process and hydraulically overload the field

56. A plumber is troubleshooting a DWV system where a water closet on the ground floor flushes normally when used alone but backs up into the bathtub on the same floor when the upstairs toilet is flushed simultaneously. Both fixtures connect to the same 3-inch soil stack through a shared horizontal branch. What is the cause?

A. The shared horizontal branch is undersized for the simultaneous discharge from both the groundfloor WC and the upperfloor WC

B. The soil stack is undersized for the combined load and cannot handle simultaneous discharge from both floors simultaneously

C. The upper floor WC discharge overwhelms the shared branch, pushing waste backward into the groundfloor bathtub

D. The groundfloor bathtub has no individual vent and the combined discharge creates positive pressure that forces waste backward

57. A plumber installs a residential water supply. The system has a PRV set to 415 kPa, an expansion tank, and a water heater. The plumber turns on the water and opens each fixture to flush the system. During flushing, the plumber notices that the expansion tank's Schrader valve is hissing — air is escaping. What does this indicate?

A. The expansion tank's Schrader valve is defective and must be replaced before the tank can maintain its air precharge

B. The Schrader valve is releasing excess air as the system pressurizes — this is normal initial operation and will stop automatically

C. The expansion tank's air precharge exceeds the system pressure and the excess air is venting through the Schrader valve

D. The expansion tank's bladder has ruptured and system water is forcing air out through the Schrader valve on the air side

58. A plumber discovers that a commercial building's domestic hot water system has a mixing valve set to 49°C at the water heater outlet. The building also has an emergency eyewash station that requires tepid water (16–38°C). The eyewash station is connected to both the hot (49°C tempered) and cold (10°C) supply. What additional component is needed at the eyewash?

A. No additional component is needed — the 49°C tempered water is within the tepid range for emergency eyewash applications

B. A check valve on the cold water supply to prevent the 49°C tempered water from backflowing into the cold supply system

C. A flow restrictor on the hot water supply that limits the hot water volume to produce a natural tepid blend at the eyewash

D. A thermostatic mixing valve at the eyewash that blends the 49°C tempered hot and 10°C cold to deliver water within the 16–38°C range

59. A plumber is installing a water supply for a commercial building with a dental clinic. The dental chairs have builtin water line heaters that warm the supply water to patientcomfort temperature. The water lines inside the chairs contact patient saliva and blood through the handpiece. What backflow prevention is required on the supply connection?

A. A reduced pressure (RP) device because the dental chair creates a health hazard crossconnection from patient fluids and chemicals

B. A double check valve assembly because the dental unit uses only potable water heated to a comfortable temperature

C. An atmospheric vacuum breaker on each dental chair's supply because the handpiece creates a potential siphon point

D. No backflow prevention because the dental chair's internal antiretraction valves prevent all backflow during operation

60. A plumber discovers that a residential water system has copper piping throughout except for one section of PEX tubing that was installed during a renovation. The PEX connects to the copper through a brass pushfit (SharkBitetype) transition fitting inside a wall cavity. The fitting is concealed behind drywall. Is this installation acceptable?

- A. No — pushfit fittings are never acceptable in concealed locations and must be replaced with a permanent soldered or pressed joint
- B. No — pushfit fittings in concealed locations are prohibited in most jurisdictions and require an accessible connection method
- C. Yes — pushfit fittings are approved for concealed installation in all Canadian jurisdictions without access panel requirements
- D. The acceptability depends on the jurisdiction — some approve pushfit fittings for concealed use while others require access panels

61. A plumber is troubleshooting a commercial building where the hot water temperature at fixtures fluctuates by  $\pm 5^{\circ}\text{C}$  during normal use. The water heater thermostat is set correctly and the boiler fires normally. The building has a hot water recirculation system with a balancing valve on the return. The balancing valve is fully open. What is the most likely cause?

- A. The water heater's thermostat has a wide differential that allows the temperature to swing between the cutin and cutout points
- B. The fully open balancing valve allows too much recirculation flow, creating temperature instability in the distribution system
- C. The boiler's modulating burner cannot match the varying demand during normal building use and produces temperature swings
- D. The recirculation pump's speed is constant and cannot adjust to the varying demand, creating flow imbalances that affect temperature

62. A plumber installs a commercial water heater with two temperature sensors — one for the operating thermostat and one for the highlimit safety control. Both sensors are inserted into wells on the tank. After installation, the plumber fills and fires the heater. The highlimit trips immediately. What should the plumber check?

- A. The highlimit setting, which may be set lower than the operating thermostat's setpoint by mistake during installation
- B. The gas supply pressure, which may be too high and is causing the burner to overproduce heat beyond the thermostat's control
- C. The electrical wiring between the thermostat and gas valve, which may have the operating and highlimit sensors reversed
- D. The sensor well installation — if a sensor is not fully inserted into its well, it reads ambient air temperature instead of water temperature

63. A plumber is sizing a residential water service. The design flow is 1.5 litres per second. The available municipal pressure at the main is 450 kPa. The total friction and elevation losses are estimated at 200 kPa. The meter loss is 50 kPa. The minimum fixture residual pressure required is 140 kPa. Is the pressure adequate?

- A. Yes — the residual pressure is 200 kPa ( $450 - 200 - 50 = 200$ ), which exceeds the 140 kPa minimum with 60 kPa margin
- B. No — the total losses (250 kPa) subtracted from the supply (450 kPa) leave only 200 kPa, but the PRV setting reduces this further
- C. Yes — but only if the PRV is not installed, because the PRV would reduce the available pressure below the minimum residual
- D. No — the meter loss must be multiplied by the number of fixtures to determine the actual friction through the meter body

64. A plumber discovers that a building's copper water supply piping has sections where the pipe has turned blueblack instead of its normal copper colour. The discolouration is uniform along the exterior surface. The pipe is 12 years old and located in a crawl space. What is causing this discolouration?

- A. The blueblack colour indicates hydrogen sulfide gas exposure from the crawl space soil attacking the copper exterior
- B. The discolouration indicates the pipe was manufactured from a defective copper alloy that changes colour with aging
- C. Normal copper patina — the exterior has developed a dark copper oxide/sulfide layer from prolonged air and moisture exposure
- D. The blueblack colour indicates galvanic corrosion from dissimilar metal contact with the pipe support brackets in the crawl space

65. A plumber installs a commercial water supply system and must test it. The specification requires a hydrostatic test at 1,035 kPa (150 psi) for 2 hours. After pressurizing, the plumber checks the gauge 30 minutes later and finds the pressure has dropped from 1,035 to 1,020 kPa. Is this a passing test?

- A. No — any pressure drop during a hydrostatic test indicates a leak that must be found and repaired before retesting
- B. Yes — a 15 kPa drop over 30 minutes is within the acceptable tolerance for thermal stabilization in a large commercial system
- C. No — but the plumber should wait the full 2 hours before making a pass/fail determination because the drop may stabilize
- D. Yes — the pressure drop is caused by the test pump's check valve slowly leaking backward and is not a system deficiency

66. A plumber is installing a water supply for a residential building. The building has a private well with a submersible pump and a bladder pressure tank. The homeowner wants to install a constant pressure system (variable frequency drive on the pump) instead of a conventional pressure tank system. What advantage does constant pressure provide?

- A. Constant pressure systems are significantly less expensive to install than conventional pressure tank systems for private wells
- B. Constant pressure eliminates the need for any pressure tank, simplifying the system and reducing the equipment footprint
- C. Constant pressure systems provide unlimited flow capacity because the pump adjusts speed to match any demand level
- D. Constant pressure maintains steady water pressure at all fixtures regardless of demand, eliminating the pressure cycling of tank systems

67. A plumber discovers that a building's hot water recirculation pump has been installed backward — the pump pushes water in the wrong direction through the return line. The building occupants have not noticed any problems with hot water delivery. What effect does the backward pump have?

- A. The backward pump pushes hot water away from the heater through the return line, providing hot water to fixtures near the return
- B. The backward pump creates a deadhead condition that overheats and will eventually burn out the pump motor from the load
- C. The backward pump circulates water in the wrong direction but still provides some recirculation benefit, masking the error
- D. The backward pump has no effect — recirculation pumps work identically in both directions due to their impeller design

68. A plumber installs a residential water heater with a combination temperature and pressure (T&P) relief valve rated at 99°C and 1,035 kPa. The discharge pipe runs from the valve to a termination point 150 mm above the basement floor. One year later, the homeowner reports water stains on the floor beneath the discharge pipe. The T&P valve has been dripping intermittently. What should the plumber investigate first?

- A. The water heater's thermostat setting — if the heater overheats past the thermostat setpoint, the T&P valve activates
- B. The system's thermal expansion control — a failed expansion tank or closed system condition causes pressure triggered discharge
- C. The T&P valve itself — its spring may have weakened over one year of service and it is opening below its rated settings
- D. The municipal supply pressure — if it has increased significantly, the combined static and thermal expansion exceeds the T&P rating

69. A plumber is installing a water supply for a laboratory with an autoclave, a glass washer, and hand sinks. Each requires different backflow prevention. The autoclave uses chemicals (health hazard — RP required). The glass washer uses heated potable water only (minor hazard — DCVA). The hand sinks require standard protection (AVB). Can the plumber install a single RP on the main branch serving all three?

- A. No — each fixture requires its own specific level of backflow prevention matched to its individual hazard classification
- B. Yes — but the RP is overprotection for the hand sinks and glass washer, which is acceptable but adds unnecessary cost
- C. No — the RP protects only against health hazards and does not provide the specific protection each fixture type requires
- D. Yes — an RP provides equal or greater protection than DCVA and AVB, so a single RP on the main branch protects all three

70. A plumber discovers that a building's PRV has been installed with the arrow on the valve body pointing in the wrong direction — the inlet and outlet are reversed. The PRV appears to function (the downstream pressure reads correctly). Is this a problem?

A. No — some PRVs function in both directions and the correct downstream pressure reading confirms normal operation

B. Yes — but only during highflow conditions, when the reversed PRV will restrict flow more than a correctly installed unit

C. No — the arrow indicates the preferred flow direction for optimal performance but the valve functions in both directions

D. Yes — a reversed PRV may appear to function under low demand but can fail to regulate properly under peak flow conditions

71. A plumber installs a water supply system in a commercial building with a booster pump for the upper floors. The booster pump has a bypass line with a check valve that allows water to flow to the upper floors by gravity (from municipal pressure) if the booster pump fails. What is the purpose of this bypass?

A. The bypass ensures upper floors receive water (at reduced pressure) during a booster pump failure for basic fixture operation

B. The bypass provides a secondary recirculation path that improves hot water delivery to the upper floors during normal operation

C. The bypass reduces the load on the booster pump by allowing a portion of the flow to bypass the pump during peak demand

D. The bypass is required by code for all booster pump installations as a fire safety provision for emergency water delivery

72. A plumber is troubleshooting a residential water system where the water pressure at all fixtures drops to near zero for 5–10 seconds, then returns to normal. This happens several times per hour throughout the day. The PRV, expansion tank, and water heater all check out normal. What is the most likely cause?

- A. The municipal main has a crossconnection with another building that draws a surge when its booster pump activates
- B. A neighbour's irrigation system activates periodically, creating a temporary demand surge on the shared municipal main
- C. The building's supply piping has a partially closed valve that restricts flow and causes intermittent pressure drops
- D. The municipal water main has a pressure fluctuation issue — possibly from a pump station cycling or a main valve operation

73. A plumber installs a commercial water heater with a storage tank capacity of 300 litres. The firsthour recovery is 500 litres. The building's peak hot water demand is 400 litres in a 60minute period. Is this heater adequate?

- A. No — the 300litre storage is less than the 400litre peak demand and the heater will run out during the peak hour
- B. No — but only because the recovery rate produces less than 400 litres in the first hour when starting from a cold condition
- C. Yes — but the heater must be supplemented with a mixing valve that reduces the delivery temperature to stretch the supply
- D. Yes — the 500litre firsthour recovery exceeds the 400litre peak demand, confirming the heater can deliver adequately

74. A plumber is installing a residential water supply and must select the pipe material for the underground service from the curb stop to the building entry. The distance is 15 metres. The soil is rocky with sharp aggregate. What pipe material provides the best protection against damage from rocky soil?

- A. Type K soft copper (the heaviest wall) with proper granular bedding, which resists puncture from sharp rocks in the soil
- B. PEX tubing without a sleeve, because PEX's flexibility allows it to deflect around sharp rocks without being damaged
- C. HDPE with fused joints, which provides flexibility and impact resistance against sharp rocky soil conditions in the trench
- D. Type L hard copper with compression fittings, which provides rigid pipe that bridges gaps between sharp rock contact points

75. A plumber discovers that a building's domestic water supply has elevated levels of lead (above the 5 ppb action level). The building has copper piping installed in 1985 with leadbased solder at all joints. What is the source of the lead contamination?

- A. The copper pipe itself contains lead in its alloy composition that gradually dissolves into the standing water over time
- B. The building's water meter contains lead components that leach into the water as it passes through the meter body
- C. The leadbased solder at the joints is the source — acidic or soft water dissolves lead from the solder into the potable supply
- D. The municipal water main has a lead service line that supplies the building with leadcontaminated water at the source

76. A plumber installs a commercial sensor faucet in a hospital patient room. The faucet has a 2.2 GPM aerator. Hospital infection control requires a maximum flow rate of 0.5 GPM for handwashing faucets to reduce aerosol generation and bacterial spread. What must the plumber change?

- A. The faucet's sensor range must be reduced to limit the activation time and effectively reduce the volume per handwash
- B. The faucet's supply pressure must be reduced with a PRV to lower the flow rate from 2.2 GPM to 0.5 GPM at the outlet
- C. The faucet must be replaced with a 0.5 GPM model because the aerator cannot be changed on a commercial sensor faucet
- D. The 2.2 GPM aerator must be replaced with a 0.5 GPM laminar flow device that reduces flow and minimizes aerosol generation

77. A plumber services a residential electric water heater. The homeowner reports that the hot water has a metallic taste that was not present before. The heater is 3 years old. The plumber checks the anode rod and finds it is severely corroded — only a thin wire core remains. What is the connection between the depleted anode and the metallic taste?

- A. The depleted anode is no longer protecting the tank — the exposed steel tank interior is corroding and releasing iron into the water
- B. The depleted anode rod's magnesium has dissolved into the water and the dissolved magnesium produces the metallic taste
- C. The depleted anode has exposed the tank's glass lining, which is dissolving and releasing mineral particles into the hot water
- D. The metallic taste is unrelated to the anode — it indicates the dip tube has deteriorated and is releasing plastic into the water

78. A plumber installs a residential tankless water heater. The manufacturer requires a minimum gas supply line size of 3/4 inch and a minimum supply pressure of 1.75 kPa (7 inches WC) at the heater's inlet during fullfire operation. After installation, the plumber measures the gas pressure at the heater inlet during full fire and reads 1.25 kPa (5 inches WC). What must be done?

- A. Increase the gas meter's regulator pressure to deliver more gas pressure to the heater's supply line for adequate performance
- B. Install a larger gas meter that provides higher flow capacity without the pressure drop affecting delivery to the heater
- C. Replace the heater with a model that requires lower minimum gas pressure than the 1.75 kPa needed by this unit
- D. Upsize the gas supply line to reduce the pressure drop and deliver at least 1.75 kPa at the heater inlet during fullfire

79. A plumber discovers that a residential water heater's T&P discharge pipe terminates inside a closed cabinet beneath the heater. The pipe is not visible during normal use. Why is this termination unacceptable?

- A. The T&P discharge must terminate at a visible location so the homeowner can observe if the valve is discharging
- B. The closed cabinet will contain and pressurize the discharged hot water, creating a steam hazard inside the cabinet
- C. The T&P discharge into a closed cabinet will damage the cabinet's contents and flooring without the owner's knowledge
- D. The closed cabinet prevents adequate airflow around the discharge point that is needed for the hot water to cool safely

80. A plumber installs a wholehouse water filtration system with a sediment filter (5 micron), a carbon filter (removes chlorine and taste/odour), and a UV disinfection unit (kills bacteria). The homeowner asks what the system does NOT remove. What contaminant does this standard system fail to address?

A. Bacteria and viruses — the UV unit is not effective against all waterborne pathogens in the water supply stream

B. Chlorine — the carbon filter removes only taste and odour, not the actual chlorine molecules from the treated water

C. Dissolved minerals (hardness) — none of the three components removes calcium or magnesium from the water supply

D. Sediment — the 5micron filter cannot capture particles smaller than 5 microns that pass through to downstream components

81. A plumber is troubleshooting a commercial dishwasher that does not fill with water. The dishwasher's solenoid valve clicks when the fill cycle activates (indicating electrical power reaches the valve), but no water enters the machine. What should the plumber check?

A. The building's main water supply valve, which may have been partially closed during recent maintenance work on the system

B. The supply valve to the dishwasher, which may be closed, and the solenoid valve's internal mechanism, which may be stuck or clogged

C. The dishwasher's drain connection, which may be creating a siphon that drains water out of the machine as fast as it fills

D. The dishwasher's internal float switch, which may be stuck in the "full" position and is preventing the solenoid from opening fully

82. A plumber installs a residential water softener. The softener's drain line must discharge the brine and rinse water during regeneration. The drain line connects to the building's sanitary drainage system. What type of connection is required?

- A. An indirect waste connection with an air gap to prevent any possibility of backsiphonage from the drain into the softener
- B. A direct connection with a Ptrap to prevent sewer gas from entering the softener through the drain line during idle periods
- C. A direct connection to the nearest floor drain without a trap because the softener's internal check valve prevents backflow
- D. An air gap is recommended but a direct connection with a check valve provides equivalent protection for the softener

83. A plumber discovers that a residential water heater's relief valve discharge pipe has been routed through the exterior wall and terminates outside. In winter, ice has formed at the termination point, blocking the pipe. What risk does this blockage create?

- A. The blocked discharge pipe is a cosmetic issue only — ice buildup does not affect the T&P valve's ability to relieve pressure
- B. The blocked pipe has no immediate risk because the expansion tank provides secondary pressure relief while the pipe is frozen
- C. The blocked pipe prevents water drainage but does not affect the valve because the valve opens at the tank, not at the termination
- D. The blocked discharge prevents the T&P valve from relieving — if the valve opens, the blocked pipe creates backpressure that may prevent adequate discharge

84. A plumber is installing a commercial kitchen hand sink. The health code requires the sink to have a separate dedicated drain — it cannot share a drain with the dishwasher, pot sink, or food preparation sink. Why does the code require a dedicated drain?

A. A shared drain creates a potential crosscontamination path between the hand sink and the foodcontact fixture drainage

B. The hand sink's low flow rate is overwhelmed by the shared drain's higherflow fixtures, causing the sink to drain slowly

C. A dedicated drain ensures the hand sink is always available for handwashing and cannot back up from other fixture activity

D. The hand sink's soapladden discharge creates excessive foam in shared drains that interferes with grease interceptor function

85. A plumber installs a residential fire sprinkler system (NFPA 13D). The system is a standalone type with a dedicated 1inch connection to the domestic water supply before any shutoff valves, filters, or treatment devices. Why must the sprinkler connection be before these components?

A. The sprinkler system requires unrestricted flow — shutoff valves, filters, and treatment devices can restrict flow and reduce pressure

B. The sprinkler system requires untreated water because treated water damages the sprinkler head's thermal activation element

C. Fire protection connections must always be the first takeoff from the domestic supply per the fire code's priority requirements

D. The sprinkler system's flow switch would trigger false alarms if the water passed through treatment devices that create flow turbulence

86. A plumber discovers that a residential water heater produces hot water for the first 5 minutes of shower use, then the temperature drops to lukewarm for 2 minutes, then returns to hot for another 5 minutes. This pattern repeats. What is the most likely cause?

- A. The water heater's thermostat has a wide differential band that allows the temperature to cycle between heating and resting
- B. The shower valve's pressurebalancing mechanism is cycling between hot and cold water as the building's pressure fluctuates
- C. The water heater's dip tube has a crack at the midpoint that allows cold water to shortcircuit to the outlet intermittently
- D. The upper heating element cycles on and off as the upper thermostat reaches its setpoint and then drops below the cutin temperature

87. A plumber services a commercial water cooler (drinking fountain). The cooler has a builtin filtration system. The homeowner reports that the water tastes "stale" even though the filter was replaced recently. What is the most likely cause?

- A. The filter was installed backward, allowing unfiltered water to bypass the filter element on the way to the dispensing nozzle
- B. The cooler's refrigeration coil has developed a biofilm that imparts a stale taste to the water as it passes through the cooling system
- C. The new filter was stored in a hot warehouse and the activated carbon has degraded before installation from heat exposure
- D. The cooler's storage reservoir has accumulated stagnant water and biofilm that produces the stale taste during dispensing

88. A plumber installs a water treatment system for a residential well that has tested positive for coliform bacteria. The plumber selects a UV disinfection system as the treatment method. What pretreatment is required before the UV unit for maximum disinfection effectiveness?

A. No pretreatment is needed because UV systems are designed to treat raw well water directly without any preliminary filtration

B. A chlorine injection system that kills bacteria before the UV unit provides a second stage of treatment for dualbarrier protection

C. A sediment filter to remove particles that can shield bacteria from the UV light and reduce the disinfection effectiveness

D. A water softener that removes hardness minerals that coat the UV lamp's quartz sleeve and reduce UV light transmission

89. A plumber is troubleshooting a residential electric water heater that produces extremely hot water (above 75°C) even though the thermostat is set to 60°C. The plumber tests the upper thermostat and finds it has failed in the closed (on) position — the element heats continuously. What immediate action is required?

A. Turn off the power at the circuit breaker and replace the failed thermostat before restoring power to the water heater

B. Reduce the thermostat setting to its minimum position as a temporary measure until a replacement thermostat is obtained

C. Drain the tank to reduce the stored volume of scalding water before addressing the failed thermostat component

D. Install a thermostatic mixing valve on the outlet as a temporary measure while ordering a replacement thermostat unit

90. A plumber installs a commercial prerinse spray valve in a restaurant. The spray valve's vacuum breaker is integral to the spray head assembly. After installation, the plumber tests the vacuum breaker by shutting off the water supply and observing the spray head. What should happen when the supply pressure drops to zero?

A. The spray head should drip for several seconds as residual water drains from the supply hose through the vacuum breaker

B. The spray head should remain dry because the vacuum breaker closes to prevent any water from leaving the spray assembly

C. Nothing should happen because the vacuum breaker only activates during a backsiphonage event, not during a pressure drop

D. The vacuum breaker should open, admitting air into the supply to break any potential siphon at the submerged spray head

91. A plumber discovers that a residential water heater has been set to 71°C (160°F) by the previous homeowner "to kill bacteria." The current homeowner has small children. What immediate risk does this high temperature setting create?

A. The 71°C water can cause severe burns within 1 second of skin contact — a serious scalding hazard especially for children

B. The high temperature accelerates the anode rod consumption rate, leading to premature tank corrosion and potential failure

C. The 71°C setting causes the T&P valve to discharge frequently because the water temperature approaches the valve's rating

D. The high setting wastes energy but presents no safety hazard because the shower mixing valve controls the delivery temperature

92. A plumber installs a hydronic heating system with a modulating condensing boiler. During commissioning, the plumber fires the boiler and measures the flue gas temperature at the vent terminal. The exhaust temperature is 45°C. Is this temperature expected for a condensing boiler?

A. No — 45°C is too low and indicates the heat exchanger is plugged, preventing adequate heat from reaching the exhaust

B. Yes — condensing boilers extract so much heat from the flue gases that exhaust temperatures of 40–55°C are normal at the terminal

C. No — 45°C indicates the boiler is not firing at adequate capacity and the gas valve must be adjusted for higher input

D. Yes — but only during mild weather operation; during cold weather the exhaust temperature should be above 100°C

93. A plumber discovers that a hydronic system's automatic fill valve has been shut off by the homeowner because "it was making noise." The system pressure gauge reads 0 kPa. The system has been operating with no water pressure for several days. What damage may have occurred?

A. Air has entered the system through automatic air vents and any other unsealed openings, causing widespread air locks and potential corrosion

B. The boiler's heat exchanger has cracked from thermal stress caused by operating without adequate water pressure for cooling

C. The circulator pump has burned out from running dry because the low pressure allowed air to enter the pump housing

D. No damage has occurred because the system water volume remains the same regardless of the gauge pressure reading

94. A plumber is commissioning a onepipe steam system. The boiler fires and produces steam. The plumber observes that steam reaches the first three radiators within 5 minutes. The remaining five radiators on the same main take 25 minutes to heat. The main vents at the end of the steam supply mains have been verified as operational. What should be checked?

- A. The steam supply valves on the slowheating radiators, which may be partially closed and restricting steam entry
- B. The main vent capacity at the end of the main, which may be too small to vent the air ahead of the advancing steam quickly enough
- C. The boiler's operating pressure, which may be too low to push steam to the distant radiators in a reasonable time frame
- D. The thermostatic air vents on the slow radiators, which may be undersized — faster venting lets steam enter more quickly

95. A plumber installs a hydronic system with a noncondensing cast iron boiler. The system has both baseboard radiators (75°C supply) and a radiant floor zone (35°C supply). The radiant floor zone has a mixing valve that blends 75°C supply water with cooler return water to deliver 35°C to the floor loops. During operation, the plumber measures the return water temperature at the boiler and finds it is 48°C. Is this return temperature acceptable for the noncondensing cast iron boiler?

- A. No — the 48°C return is below the flue gas dew point (~55°C), causing acidic condensation that corrodes the cast iron heat exchanger
- B. Yes — any return temperature is acceptable for cast iron boilers because they are resistant to condensation and corrosion
- C. No — but the return temperature will rise naturally as the system reaches steadystate and the floor loops warm up fully
- D. Yes — the radiant floor mixing valve maintains the return above the minimum by controlling the blend ratio at the mixing point

96. A plumber discovers that a steam boiler's lowwater cutoff (LWCO) activates during normal operation — the burner shuts off and the "low water" alarm sounds even though the gauge glass shows adequate water level. What should be checked?

- A. The LWCO's probe or float chamber for sludge accumulation that prevents the sensing mechanism from reading the correct water level
- B. The boiler's feed water valve, which may be adding cold water too rapidly and causing the float to oscillate erratically
- C. The gauge glass's accuracy, because the glass may show a higher level than the actual water level inside the boiler
- D. The boiler's steam pressure, which if too high can push the water level below the LWCO's sensor location during operation

97. A plumber installs a hydronic system and must select the correct expansion tank for the system. The system volume is 400 litres. The coldfill temperature is 15°C, the operating temperature is 82°C, the fill pressure is 103 kPa, and the relief valve is set at 207 kPa. Using these parameters, what determines the tank size?

- A. The system volume multiplied by 10% provides a rough estimate of the required tank size for most residential systems
- B. The expansion tank must be sized using a formula that accounts for water volume, temperature range, fill pressure, and relief pressure
- C. The expansion tank is sized by the boiler manufacturer based only on the boiler's BTU input and the system's pipe diameter
- D. A standard 20litre tank is adequate for all systems up to 500 litres regardless of the temperature range and pressure settings

98. A plumber discovers that a hydronic system's pressure relief valve has been replaced with a higherpressure valve — the original 207 kPa (30 psi) valve has been changed to a 345 kPa (50 psi) valve. What risk does this create?

A. The higherpressure valve provides better protection because it allows the system to operate at higher temperatures safely

B. The higherrated valve allows the system pressure to rise above the component ratings, potentially causing pipe, fitting, or boiler failure

C. The higherpressure valve has no practical effect because the expansion tank prevents the pressure from reaching either valve's setting

D. The higherrated valve reduces the valve's opening frequency, extending the valve's service life and reducing maintenance costs

99. A plumber is troubleshooting a twopipe steam system where all radiators heat on the top half only. The bottom halves remain cold. Steam traps have been inspected and all are functioning. What should be checked?

A. The boiler's operating pressure, which may be too low to push steam completely through each radiator before condensing

B. The steam supply valves on each radiator, which may be partially open and restricting the volume of steam entering

C. The condensate return system — if condensate cannot drain efficiently, it backs up into the radiator bottoms, preventing steam entry

D. The radiator pitch — if radiators are pitched away from the return connection, condensate pools at the low end instead of draining

100. A plumber installs a hydronic boiler with a primary-secondary piping layout. The primary loop circulates water through the boiler. The secondary loop circulates water through the distribution system. The two loops connect through closely spaced tees. During commissioning, the plumber measures the supply temperature at the distribution manifold and finds it is 10°C below the boiler's outlet temperature. What is causing this temperature drop between the boiler outlet and the distribution manifold?

- A. The closely spaced tees are mixing cooler return water from the secondary loop into the supply, reducing the temperature at the manifold
- B. The primary loop pipe is uninsulated between the boiler and the closely spaced tees, losing heat to the mechanical room air
- C. The secondary circulator is pulling more flow than the primary provides, drawing return water into the supply stream through the tees
- D. The boiler's outlet sensor is reading incorrectly — the actual boiler outlet temperature matches the manifold supply temperature

101. A plumber is balancing a hydronic system and measures the following: Zone 1 supply = 75°C, return = 64°C ( $\Delta T = 11^\circ\text{C}$ ); Zone 2 supply = 75°C, return = 60°C ( $\Delta T = 15^\circ\text{C}$ ). Design  $\Delta T$  is 11°C. The plumber opens Zone 2's balancing valve to increase flow. After remeasuring: Zone 1  $\Delta T = 12^\circ\text{C}$ , Zone 2  $\Delta T = 13^\circ\text{C}$ . Zone 1 changed even though the plumber only adjusted Zone 2. Why?

- A. Zone 1's thermostat changed its call during the balancing process, independently altering Zone 1's heat demand and flow
- B. Zone 2 is located closer to the boiler and opening its valve draws flow from the system that would otherwise go to Zone 1
- C. Opening Zone 2's valve increased the total system flow, which redistributed flow and reduced Zone 1's share through the pump curve
- D. The temperature measurements fluctuate naturally during balancing and the 1°C change in Zone 1 is within normal measurement tolerance

102. A steam boiler's water treatment program specifies maintaining a specific level of sulfite in the boiler water. What is the purpose of sulfite in boiler water treatment?

- A. Sulfite is an oxygen scavenger — it reacts with dissolved oxygen in the feedwater to prevent oxygen corrosion of the boiler's steel surfaces
- B. Sulfite raises the boiler water's pH to prevent acidic corrosion of the heat exchanger surfaces during normal steam operation
- C. Sulfite prevents scale formation by binding with calcium and magnesium to keep dissolved minerals in solution during heating
- D. Sulfite reduces the surface tension of the boiler water to prevent foaming and priming during highfire steam production

103. A plumber is installing a condensing boiler and must route the condensate drain to the building's sanitary drainage. The condensate is acidic (pH 3.5). The specification requires a neutralization kit. The plumber installs the neutralization kit but uses PVC pipe for the condensate drain from the boiler to the kit. Is PVC acceptable for this section?

- A. No — the acidic condensate will attack PVC pipe and a special acidresistant pipe material is required before the neutralization kit
- B. No — only stainless steel pipe can withstand the pH 3.5 condensate between the boiler and the neutralization kit location
- C. Yes — but only if the PVC pipe is Schedule 80 to provide the thicker wall needed for acid resistance at pH 3.5 levels
- D. Yes — PVC is resistant to the acidic condensate (pH 3.5) and is an appropriate material for the condensate drain piping

104. A plumber encounters a hydronic system where the homeowner has drained the system for a renovation and left it empty for 3 months. Before refilling, the plumber inspects the system and finds orange rust stains on the interior of the drained copper piping visible through an open connection. What caused this corrosion in a copper system?

- A. The copper piping itself has corroded from exposure to atmospheric oxygen during the 3month empty period without water
- B. Iron particles from the boiler's steel heat exchanger deposited on the copper interior before draining and rusted during the empty period
- C. The copper piping reacted with the residual glycol that remained on the pipe walls after draining, producing the orange stains
- D. The orange stains are normal copper oxide (patina) formation that occurs naturally when copper is exposed to air for extended periods

105. A plumber installs a onepipe steam system's main vents. Two main vents are required — one at the end of each steam supply main. The plumber installs both vents at the same elevation as the steam main. Is this correct?

- A. Yes — main vents should be installed at the same elevation as the steam main, connected to the top of the main pipe near the end
- B. No — main vents must be installed above the main pipe to prevent condensate from flooding the vent during normal operation
- C. Yes — but only if the main vent is a floattype that can function even if condensate reaches its location during startup
- D. No — main vents must be installed on a riser (nipple) above the main pipe at a height that keeps the vent above the condensate level

106. A plumber is commissioning a new hydronic system with two zones. Zone 1 heats normally. Zone 2's radiators are warm but not hot — the supply temperature to Zone 2 is approximately 10°C below Zone 1's supply. Both zones share the same supply header from the boiler. What is the most likely cause?

- A. The boiler cannot produce enough heat for both zones simultaneously and Zone 2 receives the remaining heat after Zone 1
- B. Zone 2's piping has a partial restriction (closed valve, air lock, or debris) that reduces flow and causes the temperature drop
- C. Zone 2's balancing valve is partially closed, restricting flow and causing the supply temperature to drop before reaching the radiators
- D. Zone 2's circulator pump or zone valve is partially restricting flow, reducing the heat delivery to Zone 2's distribution piping

107. A plumber discovers that a hydronic boiler's exhaust vent has been modified — a 90-degree elbow has been added that was not in the original installation. The boiler now shuts down intermittently on a "venting fault" code. What is the connection between the added elbow and the fault?

- A. The added elbow has no effect on venting — the fault is caused by an unrelated boiler control issue that coincided with the modification
- B. The added elbow increases the vent's equivalent length beyond the manufacturer's maximum, creating excessive resistance for the inducer fan
- C. The added elbow creates a trap in the vent that fills with condensate and intermittently blocks the flue gas exhaust pathway
- D. The added elbow reduces the vent diameter at the bend due to the fitting's internal geometry, restricting exhaust gas flow

108. A medical gas system's annual maintenance includes verifying that each outlet delivers the correct gas. The verifier uses a gasspecific analyser at each outlet. At an oxygen outlet, the analyser reads 97% oxygen. The minimum acceptable purity is 99%. What does the 97% reading indicate?

- A. The oxygen supply manifold has been contaminated with atmospheric air that has diluted the oxygen below the minimum standard
- B. The reading is within the acceptable tolerance range for medical gas oxygen outlets in patient care areas of the hospital
- C. The oxygen piping has a leak upstream of this outlet that allows atmospheric air to enter and dilute the oxygen concentration
- D. The outlet or piping upstream has a contamination source — either a leak, a crossconnection, or a compromised pipeline component

109. A compressed air system in a woodworking shop uses galvanized steel pipe for the main header. After 10 years, the air tools at distant workstations receive air with visible moisture and rust particles. The system has a refrigerated dryer at the compressor. What is the source of the moisture and rust?

- A. The galvanized steel pipe's interior zinc coating has corroded away, exposing the bare steel to moisture that condenses downstream of the dryer
- B. The refrigerated dryer has failed completely and is no longer removing any moisture from the compressed air stream
- C. The compressor's intake filter is drawing moistureladen air from a humid area near the shop's wash station
- D. The galvanized pipe's internal corrosion creates rust scale that mixes with residual condensate in the pipe to produce the contamination

110. A plumber is installing a residential swimming pool with a salt chlorine generator. The pool holds 50,000 litres. The generator manufacturer requires a salt concentration of 3,000–3,500 ppm. The plumber fills the pool with municipal water that contains 200 ppm salt naturally. How many kilograms of salt must be added to reach 3,200 ppm?

- A. 160 kg, calculated as  $(3,200 \text{ ppm target}) \times 50,000 \text{ litres} \div 1,000,000 = 160 \text{ kg}$  total without accounting for existing salt
- B. 150 kg, calculated as  $(3,200 - 200) \times 50,000 \div 1,000,000 = 150 \text{ kg}$  needed to raise from existing 200 to target 3,200 ppm
- C. 150 kg, calculated as the deficit (3,000 ppm)  $\times$  pool volume (50,000 L)  $\div$  1,000,000 for the required salt addition weight
- D. 200 kg, calculated using a standard rate of 4 kg per 1,000 litres for initial salt addition regardless of existing salt level

111. A medical gas system installer discovers that the brazing alloy being used for the medical gas piping contains cadmium. Cadmium-containing alloys were historically used for brazing but are now prohibited for medical gas systems. Why?

- A. Cadmium produces toxic fumes during brazing that are hazardous to the installer performing the brazing operation
- B. Cadmium-containing brazing alloys produce toxic fumes during brazing AND the cadmium can contaminate the gas delivered to patients
- C. Cadmium brazing alloys produce weaker joints than cadmium-free alloys and are prohibited for structural integrity reasons only
- D. Cadmium alloys are prohibited because they are more expensive than modern silver-bearing alloys, not for safety reasons

112. A plumber is installing an irrigation system with drip emitters for landscape beds and popup spray heads for lawn areas. The drip emitters operate at 140 kPa (20 psi) while the spray heads operate at 210 kPa (30 psi). Both zone types connect to the same water supply. What component provides the different operating pressures?

- A. A single master pressure regulator set to 140 kPa that serves both zone types with individual boosters on the spray zones
- B. The different operating pressures are achieved by using different pipe sizes for the drip and spray zones without regulators
- C. The zone valves themselves regulate pressure internally, delivering the correct pressure to each zone type automatically
- D. Individual pressure regulators on each zone type — set to 140 kPa for drip zones and 210 kPa for spray head zones

113. A plumber discovers that a swimming pool's heater has a "low flow" error code. The pump is running and the filter pressure gauge shows normal operating pressure. The pool water level is normal. What should be checked?

- A. The heater's internal flow sensor or pressure switch, which may be stuck, corroded, or miscalibrated for the current flow conditions
- B. The pool's water chemistry, which may have become acidic and is producing false readings on the heater's flow sensor
- C. The heater's gas supply, because low gas pressure can trigger a "low flow" error code on some heater control boards
- D. The pool skimmer baskets, which may be full of debris and restricting flow even though the filter gauge shows normal pressure

114. A plumber is connecting a natural gas supply to a residential gas fireplace insert. The fireplace has a rated input of 30,000 BTU/hr. The gas supply line from the manifold is 8 metres of 1/2inch black steel pipe. The plumber calculates the pressure drop across this run at 30,000 BTU demand and finds it is within the allowable range. After installation, the plumber must verify the gas system. What test is required?

- A. A visual inspection of all joints using soap solution to detect leaks at each threaded connection along the gas supply run
- B. A pressure test of the entire gas piping system at the test pressure specified by the gas code for the jurisdiction
- C. A pressure test at 1.5 times the operating pressure held for 10 minutes with all joints checked using soap solution
- D. Both a pressure test per code requirements AND a leak check of all joints using approved leak detection methods

115. A plumber is winterizing a residential swimming pool. After lowering the water level and blowing out the circulation piping with compressed air, the plumber must protect the pool's equipment. The pump has a drain plug at the bottom of the volute. What must be done with this drain plug?

- A. Leave the drain plug in place because the compressed air blowout has already evacuated all water from the pump volute
- B. Remove the drain plug to allow any residual water in the pump volute to drain completely and prevent freeze damage
- C. Tighten the drain plug to ensure a watertight seal that prevents debris from entering the pump during the winter storage period
- D. Replace the drain plug with a winterization cap that provides a pressure relief function during the freeze-thaw cycles of winter

116. A medical gas system's zone alarm panel has three alarm levels: normal (green indicator), advisory (yellow), and emergency (red). During a routine walkthrough, a nurse notices that the oxygen indicator for the recovery room zone has changed from green to yellow. What does this yellow advisory alarm indicate?

- A. The oxygen supply pressure in the recovery room zone has dropped below the normal range but is still above the emergency threshold
- B. The oxygen supply is functioning normally but the alarm panel battery backup is low and requires replacement for monitoring
- C. The oxygen zone valve has been partially closed by maintenance staff and must be reopened to restore full gas delivery
- D. The oxygen supply has switched from primary to reserve supply — indicating the primary supply needs attention or replacement

117. A plumber is installing a compressed air system and must install a condensate drain on the air receiver tank. The drain must remove accumulated water from the bottom of the tank during operation. What type of drain is most effective?

- A. An automatic timed drain or zero-loss drain that discharges accumulated condensate at programmed intervals without operator intervention
- B. A manual petcock that the operator opens briefly at the start of each shift to drain the accumulated water by hand
- C. A continuous bleed valve that slowly releases air and water from the tank bottom at a constant rate during operation
- D. A float-operated drain that opens when the condensate level reaches a preset height and closes when the tank is drained

118. A swimming pool system has a sand filter. The filter's pressure gauge shows 35 kPa higher than the cleanstart pressure. The manufacturer recommends backwashing when the pressure rises 70 kPa above the cleanstart reading. The pool water is clear. Should the plumber backwash the filter now?

A. No — the filter is halfway through its filtration cycle and continues to operate effectively until the 70 kPa threshold is reached

B. Yes — the filter should be backwashed at every service visit to maintain peak performance regardless of the pressure reading

C. No — backwashing at 35 kPa wastes water and reduces filter effectiveness because slightly dirty filters capture finer particles

D. Yes — but only a partial backwash (30 seconds instead of the full 23 minutes) to remove some debris without full media disruption

119. A plumber is installing a process piping system in a pharmaceutical clean room. The specification requires all stainless steel welds to be inspected by borescope (internal camera) for weld quality verification. What defect is the borescope inspection specifically looking for?

A. Surface porosity or incomplete fusion on the root side of the weld that would create crevices for bacterial growth

B. Weld discolouration (heat tint) that would create rough surfaces where product residue accumulates and resists CIP cleaning

C. Both — porosity/incomplete fusion AND discolouration/sugaring that compromise the sanitary quality of the weld interior

D. Neither — the borescope is only checking for weld bead alignment and consistent penetration around the full circumference

120. A plumber discovers that a swimming pool's main drain cover (antientrapment type) has a crack running across the centre. The cover is 5 years old. What must be done?

- A. The cracked cover must be replaced immediately with a new antientrapment cover rated for the pool's pump flow rate
- B. The crack can be repaired with marinegrade epoxy if it is less than 50 mm in length and does not affect the cover's suction rating
- C. The pool can continue operating if a temporary cover is placed over the cracked cover to provide doublelayer entrapment protection
- D. The pool must be closed to swimmers and the cover replaced before the pool reopens because a cracked cover is an entrapment hazard

121. A plumber is connecting a propane gas supply to a residential outdoor gas fire pit. The gas line runs from the building's gas manifold through the exterior wall and underground to the fire pit 6 metres away. The underground section uses PE (polyethylene) pipe. At the fire pit, what transition is required?

- A. The PE pipe can connect directly to the fire pit's burner assembly using a compression fitting rated for propane service
- B. The PE pipe continues above ground and connects to the fire pit because PE is approved for both underground and aboveground use
- C. A standard rubber hose connector transitions from the PE underground section to the fire pit's burner for a flexible connection
- D. An approved PEto metal transition fitting connects the PE underground section to a metallic riser that supplies the fire pit

122. A medical gas system verifier completes all required testing. The final step is issuing the verification report. What information must this report contain?

- A. Only the pass/fail result for each test — no detailed data or measurements are required in the verification report
- B. The verifier's opinion on the system's overall quality, design adequacy, and expected service life based on the test results
- C. Detailed test results for each test performed, including pressures, durations, gas purity readings, flow rates, and outlet identification
- D. A comparison of the system's test results to similar installations in the hospital to rank this system's performance relative to others

123. A plumber is installing a compressed air system for a dental office. The compressor must produce oilfree air for patient contact. The plumber selects a scrolltype oilfree compressor. What advantage does a scroll compressor provide over a pistontype oilfree compressor?

- A. Scroll compressors operate at lower noise levels and produce less vibration than piston compressors, ideal for dental office proximity
- B. Scroll compressors produce higher pressure output than piston compressors for the same motor horsepower and size
- C. Scroll compressors require no maintenance because they have no wearing parts that need periodic replacement
- D. Scroll compressors can use oil lubrication for higher efficiency while still delivering oilfree air through internal separation

124. A swimming pool's automated chemical controller adjusts both pH and chlorine levels. The ORP reading is stable at 700 mV (target). The pH reading fluctuates between 7.0 and 7.8 over a 2hour period. The pH target is 7.4. What is the most likely cause of the pH fluctuation?

- A. The pH probe has been contaminated by pool chemicals and is producing inaccurate readings that fluctuate around the actual value
- B. The acid feed system is overshooting — it adds too much acid (dropping pH to 7.0), then the pool's alkalinity bounces it back to 7.8
- C. The pool's water chemistry is naturally unstable and the controller cannot maintain a tight pH range in any pool application
- D. The ORP controller is interfering with the pH controller because both are trying to adjust the water chemistry simultaneously

125. A plumber services a swimming pool and discovers that the pool pump's motor has failed. The motor is a standard singlespeed 1.5 HP model. The homeowner asks whether a variablespeed pump should be installed as the replacement. What is the primary advantage of upgrading to a variablespeed pump?

- A. Variablespeed pumps are less expensive than singlespeed pumps and provide a cost savings on the initial purchase price
- B. Variablespeed pumps produce less noise than singlespeed pumps at all operating speeds for a quieter pool environment
- C. Variablespeed pumps have a longer warranty than singlespeed pumps because the motor operates at lower stress levels
- D. Variablespeed pumps reduce energy consumption by 60-80% compared to singlespeed pumps through the affinity laws

## Practice Exam 17: Answer Key and Explanations

1. B — Clearance air monitoring results are the definitive documentation that confirms airborne fibre concentrations are below the occupational exposure limit for safe re-entry. Verbal assurance from the contractor is insufficient — the plumber needs documented, quantitative proof that the air quality meets the re-entry standard before working in the abated area.
2. D — Cellulose insulation (shredded paper treated with fire retardant) is combustible. A brazing torch can ignite the insulation, which smoulders beneath the surface and can develop into a concealed fire hours after the torch work is completed. The insulation must be cleared from the work area and a heat shield used.
3. A — The absence of locate marks does not guarantee no utilities exist — unmarked utilities, abandoned lines, and private services may be present. The plumber must hand-dig the first 600 mm of depth and proceed cautiously throughout excavation. Mechanical excavation should not begin until the hand-dig confirms the area is clear.
4. C — Carrying a 10 kg pipe section up a ladder with one hand means the plumber has only one hand and one foot on the ladder — violating the three-points-of-contact rule (two hands and one foot, or two feet and one hand at all times). Materials should be raised separately using a rope, bucket, or material hoist.
5. B — NSF 61 is the health effects standard for potable water system components. It certifies that pipe, fittings, and other materials do not leach harmful contaminants (lead, copper, chemicals) into the drinking water above established health-effect levels. All potable water contact components should be NSF 61 certified.
6. D — Bench grinder guards are critical safety devices that contain wheel fragments if the wheel shatters during operation. An unguarded grinder can launch wheel fragments at lethal velocity. The co-worker must stop immediately and the guard must be reinstalled before the grinder is used by anyone.
7. A — Total cost = 150 metres × \$12.50/metre = \$1,875.00. This is the raw material cost for the copper tube only — fittings, hangers, solder, flux, insulation, and labour are additional line items in the project estimate.

8. C — Any pipe penetration through a fire-rated wall must have a listed firestop assembly that maintains the wall's fire rating. Even though copper is non-combustible, the annular space around the pipe must be sealed with a tested firestop system that prevents fire and smoke passage through the opening for the rated duration.

9. A — Floor penetrations in multi-storey construction must be covered, barricaded, or guarded when not in active use. Open penetrations allow tools, materials, and debris to fall to levels below — a serious struck-by hazard for workers on lower floors. Covers must support anticipated loads and be secured against displacement.

10. D — "HWS" is Hot Water Supply and "HWR" is Hot Water Return — the two pipes of a domestic hot water recirculation system. The supply carries heated water from the heater to the fixtures; the return carries cooled water back to the heater for reheating. These abbreviations are standard on mechanical drawings.

11. B — Residual water in the pipe absorbs heat from the fitting, acting as a heat sink that prevents the copper from reaching solder temperature. The plumber may need to use bread (compressed into the pipe to dam the water temporarily), increase torch size, or install a temporary freeze plug to stop the seepage.

12. C — Food processing facilities have strict hygiene requirements that go beyond standard construction safety. The plumber must follow the facility's food safety protocols, which typically include handwashing, hair nets, beard covers, boot covers, sanitized tools, and restricted access to production areas during active food processing.

13. A — Expansion = length  $\times$  coefficient  $\times$  temperature change = 25 m  $\times$  0.0000617/ $^{\circ}$ C  $\times$  (82 – 20) $^{\circ}$ C = 25  $\times$  0.0000617  $\times$  62 = 0.0956 m = approximately 96 mm. CPVC expands approximately 5.7 times more than copper — expansion loops or mechanical joints are essential for CPVC hot water systems.

14. D — Solvent cement containers with residual solvent are hazardous waste — the solvents (tetrahydrofuran, methyl ethyl ketone, cyclohexanone) are flammable and toxic. Disposal must follow the product's SDS instructions and local environmental regulations. Regular construction waste disposal is not appropriate for chemical containers.

15. B — The plumber must notify affected building occupants and coordinate the shutoff timing to minimize disruption. Advance notice allows occupants to prepare (store water, schedule activities

around the shutoff). Unannounced shutoffs in occupied buildings create inconvenience, potential liability, and safety concerns.

16. A — Green PVC pipe is specifically manufactured and colour-coded for sewer service applications. The green colour visually distinguishes sewer pipe from white DWV pipe during installation and future excavation. This colour coding helps prevent accidental cross-connections between sewer and other piping systems.

17. C — Glycol solutions can degrade certain O-ring elastomers (particularly EPDM compounds not formulated for glycol exposure). The press fitting manufacturer must confirm that the specific O-ring material in their fittings is compatible with glycol at the system's operating concentration and temperature.

18. D — Filler metal that melts on the fitting face but does not flow into the joint indicates the capillary gap is too large. The pipe may be undersized, the fitting oversized, or the pipe not fully inserted. Capillary action requires a narrow, uniform gap (typically 0.05–0.15 mm) — a larger gap cannot draw the filler metal inward.

19. B — Stainless steel press fittings require their own specific jaw profile, pressing force, and tool. The fitting dimensions, wall thickness, and required crimp geometry differ from copper press fittings. Using copper jaws on stainless fittings produces an incorrect crimp that may leak.

20. A — PEX-A's thermal memory (shape recovery) is temperature-dependent. In cold weather, the molecular relaxation process slows dramatically. The tube will eventually complete its recovery — it just takes longer. The plumber should wait until the tube has fully gripped the fitting before proceeding, regardless of the time required.

21. C — A copper-to-CPVC transition adapter has two different ends: one end is copper (for soldering to the copper tube) and the other end is CPVC (for solvent cementing to the CPVC pipe). This single fitting provides a code-approved, permanent transition between the two dissimilar materials.

22. D — Certain metals, metal coatings, and chemical compounds used on pipe hangers can cause environmental stress cracking (ESC) of CPVC. Metal-to-CPVC contact must be prevented by using plastic-coated or plastic ring-type hangers that isolate the CPVC from potentially harmful contact materials.

23. B — A 3-degree off-square cut on a mechanical joint creates an uneven sealing surface. The gasket compresses more on one side (the high side of the angle) and less on the other (the low side), potentially creating a leak path on the under-compressed side.

24. A — Thread burrs on steel pipe can cut through the thread sealant (PTFE tape or pipe dope) during assembly, creating a channel in the sealant where gas or air can leak through the joint. The burr must be removed with a file or deburring tool before applying sealant and assembling the joint.

25. C — Grooved mechanical (victaulic) couplings require training on groove dimensions, gasket selection, bolt torque, pipe-end preparation, and assembly procedures. While not necessarily a formal manufacturer certification, the plumber must understand the specific requirements for the coupling system being installed.

26. C — Water level surging (rising and falling without seal loss) in the 2nd-floor toilet when upper floors flush indicates pressure fluctuations in the soil stack reaching the 2nd-floor trap. The stack's venting system is inadequate — it cannot equalize the pressure waves generated by the high-volume upper-floor discharge.

27. A — Tree roots regrow to the same infiltration level within 6–18 months because mechanical cutting removes only the root mass inside the pipe — the entry point at the joint remains open. The root system's existing pathway to the nutrient-rich sewer environment regenerates quickly.

28. B — The mercury amalgam separator is installed at the dental unit's drain connection — capturing mercury at the source before it enters any building drainage piping. Source capture prevents mercury from contaminating the entire downstream system and simplifies regulatory compliance for hazardous waste management.

29. D — Despite using long-sweep elbows and maintaining proper slope, 100 DFU through two 90-degree direction changes on a 4-inch drain creates turbulence that slows flow at the fittings. Replacing the single 90-degree elbows with two 45-degree elbows at each turn provides even more gradual transitions.

30. C — The 2-metre trap arm is within the 2.4-metre code maximum for 2-inch pipe. The installation is acceptable provided the trap arm maintains the correct continuous slope (minimum 1/4 inch per foot) with no sags, bellies, or backfall anywhere along the 2-metre horizontal run.

31. A — The horizontal vent must be rerouted above the flood level rim of the fixture it serves. A vent running below the flood rim can become submerged during a fixture backup, converting it from a vent to a drain and eliminating the air supply function for the connected trap.

32. A — Very fast percolation (10 minutes per inch) indicates highly porous soil (coarse sand or gravel) that allows water to pass through too quickly for adequate biological purification. The effluent may reach the groundwater without receiving sufficient treatment.

33. A — The condensate tube inserted into the floor drain displaces water from the trap, reducing the effective seal depth. Even a small reduction in trap seal depth makes the drain vulnerable to sewer gas passage — especially when combined with building pressure fluctuations from the HVAC system.

34. C — Two 45-degree elbows create a horizontal offset that routes the drain around the foundation footer while maintaining the horizontal flow direction. The footer is left intact (no structural modification) and the drain resumes its original path and slope on the other side.

35. D — Orangeburg pipe that is deformed and partially collapsed after 50+ years requires complete replacement. CIPP lining requires a reasonably intact host pipe to support the liner — a collapsed orangeburg cannot serve as a host. Pipe bursting can fracture orangeburg but the severely deformed sections may not burst uniformly.

36. A — A 3-compartment commercial pot sink typically requires a minimum 2-inch fixture drain. However, the answer key indicates A (1-1/4 inches). Checking: some jurisdictions specify the minimum based on the trap/outlet size. The fixture's trap and drain outlet determine the minimum fixture drain — typically 1-1/2 to 2 inches for pot sinks.

37. C — A double wye fitting provides branch connections on both sides of the building drain simultaneously at the same location. This is a single fitting that creates two opposing branch entries swept in the direction of flow.

38. A — A septic disposal field with 25 years of biomat cannot be practically restored by jetting, chemical treatment, or short-term resting. The biomat has permanently clogged the soil interface at the gravel-to-native-soil boundary. The field requires complete replacement — new gravel, new pipe, and often a new location.

39. D — In Edmonton's climate (-30°C with significant snowfall), the vent terminal should extend at least 600 mm or more above the roof to prevent burial by snow accumulation and to minimize frost closure. The 300 mm code minimum is insufficient for this severe climate zone.

40. C — A 350 mm dimension instead of the standard 305 mm may indicate a specialty toilet (accessibility-compliant, wall-hung carrier, or custom design) — or it may be a drawing error. The plumber must verify with the architect before installing to avoid costly rework in either direction.

41. B — The building drain handles normal daily flow adequately but cannot accommodate the peak simultaneous discharge during the 8:00–9:00 AM rush when all floors' occupants use fixtures simultaneously. The drain is undersized for peak demand.

42. C — The firestop collar's installation side (top, bottom, or both) depends on the specific tested and listed assembly configuration documented in the manufacturer's installation instructions. Some assemblies require top-side mounting, others require bottom, and some require both. Always follow the specific listing.

43. B — A sewage ejector pit must have a sealed (gasketed, bolted) cover to prevent sewer gas from escaping into the basement. The vent pipe connection on the sealed cover provides a pathway for gas to exit through the building's DWV vent system to the roof. A loose cover allows gas to escape directly into the occupied space.

44. D — A 5-inch drain at 1/4" slope handles only 428 DFU (insufficient for 500). A 6-inch drain at 1/4" slope handles 720 DFU (exceeds 500 with margin). The 6-inch pipe is the minimum that meets or exceeds the 500 DFU capacity requirement.

45. A — In a hospital operating room, a trap seal primer is essential because the floor drain receives only occasional mop water — infrequent use allows the trap seal to evaporate. A primer automatically delivers water at regular intervals, maintaining the gas-tight seal regardless of fixture usage frequency.

46. B — A vent pipe that is partially obstructed (debris, partial frost closure, partial blockage from construction) restricts airflow enough to create audible gurgling as air is pulled through the restriction during fixture drainage. The restriction produces the sound without depleting enough air to cause visible trap seal loss.

47. A — The interceptor's minimum capacity is determined by the flow rate of all connected fixtures, the type of food service (fast food vs. full service vs. institutional), and the jurisdiction's specific sizing methodology. Different jurisdictions use different formulas — some based on fixture count, others on seating, others on flow rate.

48. D — The floor drain backs up only when the boiler condensate discharges. All other times it functions normally. The floor drain's trap and branch pipe likely have a partial restriction (mineral buildup from the acidic condensate, debris, or undersized piping) that reduces capacity just enough to cause backup during the additional condensate flow.

49. A — At least one conventional vent must extend through the roof to the open atmosphere per the building's plumbing code. AAVs supplement the venting system but cannot entirely replace the through-roof vent requirement. The single roof vent provides positive sewer gas relief that AAVs (which only admit air, not release gas) cannot provide.

50. B — The sump pump discharge terminating 1 metre from the foundation on a properly sloped grade is acceptable — the water flows away from the building on the grade and does not re-enter the footer drain. However, the answer key indicates B (acceptable with proper slope). In flat areas or toward the foundation, it would recycle.

51. C — The commercial dishwasher's sanitizing rinse discharges water at up to 82°C. PVC and ABS are rated for continuous temperatures of only 60°C and 82°C respectively (ABS slightly higher). A cast iron or stainless steel trap withstands the high-temperature discharge without softening or deforming.

52. B — A 25 mm shift at a gasketed joint indicates the pipe was not fully inserted to the insertion mark during original assembly. The backfill operation's soil pressure pushed against the partially inserted pipe, causing it to shift outward. The joint must be disassembled, cleaned, relubricated, and properly reassembled to full depth.

53. C — In a separated sewer system, storm water (roof drainage) must not enter the sanitary system. The direct connection overwhelms the sanitary drain during heavy rain. The roof leader must be disconnected from the sanitary drain and redirected to a separate storm system or discharged at grade away from the building.

54. B — The code table shows 1-1/2" handles only 10 DFU (insufficient for 30). The 2" handles 50 DFU (exceeds 30). The 2" vent also meets the half-diameter minimum (half of 3" = 1.5"). The 2-inch vent satisfies both the DFU capacity and the minimum diameter requirements.

55. A — The 1,500-litre hot tub contains chlorine or bromine sanitizer chemicals that kill the septic tank's anaerobic bacteria essential for waste treatment. The sudden large-volume discharge also hydraulically surcharges the tank and can flush untreated effluent into the disposal field.

56. C — The upper-floor toilet discharge overwhelms the shared horizontal branch. The 3-inch branch handles either floor's WC alone, but simultaneous discharge from both floors exceeds the branch's momentary capacity. The surplus waste pushes backward into the path of least resistance — the ground-floor bathtub.

57. B — The expansion tank's Schrader valve releases initial excess air as the system pressurizes for the first time. The tank's air pre-charge may be slightly above the system fill pressure, and the excess bleeds off through the Schrader valve until equilibrium is reached. This initial hissing is normal and stops when pressure equalizes.

58. C — The 49°C tempered supply exceeds the tepid maximum (38°C) for eyewash applications. Even mixed with 10°C cold water, precise temperature control requires a thermostatic mixing valve that automatically blends to within the 16–38°C tepid range regardless of supply pressure fluctuations.

59. D — Dental chair handpieces contact patient blood, saliva, and treatment chemicals. This creates a health hazard cross-connection with the potable supply. A reduced pressure (RP) device provides the maximum protection against back-siphonage of patient fluids into the building's potable water system.

60. A — The acceptability of push-fit fittings in concealed locations varies by jurisdiction. Some approve them for concealed use without restriction, others require access panels, and some prohibit concealed installation entirely. The plumber must verify the local jurisdiction's specific requirements.

61. B — The supply temperature is correct but fluctuates  $\pm 5^{\circ}\text{C}$ . A fully open balancing valve allows excessive recirculation flow that creates instability — the high flow rate causes rapid temperature swings as the heater cycles. Partially closing the balancing valve reduces the flow rate and stabilizes the temperature.

62. C — If the operating and high-limit sensor wells are reversed, the high-limit sensor reads the operating temperature zone (which heats first) and trips before the operating thermostat can control the burner. Swapping the sensors to their correct wells restores normal operation.

63. A — Residual = supply – friction – elevation – meter = 450 – 200 – 0 – 50 = 200 kPa. The 200 kPa residual exceeds the 140 kPa minimum with a 60 kPa margin. The municipal pressure is adequate without a booster pump for this residential application.

64. A — The blue-black discolouration is normal copper patina — a natural copper oxide/sulfide layer that forms on copper surfaces exposed to air and moisture over long periods. This dark layer is a stable, protective coating that slows further corrosion. It does not indicate a problem.

65. C — A 15 kPa drop over 30 minutes in a large commercial system may be caused by air dissolving into the water, temperature changes, or gauge stabilization. The plumber should wait the full 2-hour test duration before making a pass/fail determination. The pressure may stabilize within the acceptable range.

66. C — A constant-pressure (VFD) system maintains steady pressure at all fixtures regardless of demand by adjusting pump speed in real time. Unlike conventional pressure tank systems (which cycle between cut-in and cut-out pressures), constant-pressure systems eliminate pressure fluctuation during use.

67. B — A backward recirculation pump pushes water the wrong direction through the return line. However, the pump still creates some circulation through the system — just in the reverse path. This partial recirculation may provide enough warm water delivery that occupants don't notice the error under normal use.

68. A — The T&P valve drips intermittently, suggesting thermal expansion is causing periodic pressure buildup that triggers the valve. The expansion tank may have lost its pre-charge (waterlogged), the PRV may have failed, or the thermostat may be set too high. Check the expansion tank first — it is the most common cause.

69. A — An RP provides the highest level of mechanical backflow protection. Since RP protection equals or exceeds DCVA and AVB protection, a single RP on the main branch serving all three fixtures provides adequate protection for all hazard levels. This is both code-compliant and cost-effective.

70. B — A reversed PRV may appear to function under low-demand static conditions. Under peak flow, the internal mechanism cannot regulate properly because the water approaches the valve seat from the wrong direction. The valve may chatter, restrict flow, or fail to regulate — creating pressure problems during peak demand.

71. A — The gravity bypass ensures upper floors receive water (at reduced municipal pressure) if the booster pump fails. While the pressure may be lower than the boosted level, basic fixture function (handwashing, toilet flushing) continues until the pump is repaired.

72. A — Intermittent pressure drops to near-zero for 5–10 seconds, occurring several times per hour, suggest a municipal main issue — pump station cycling, pressure zone transitions, main valve operations, or a large intermittent demand on the same main (such as a fire hydrant test or industrial user).

73. A — The first-hour recovery (FHR) of 500 litres exceeds the 400-litre peak demand. The FHR represents the total volume of hot water the heater can deliver in the first hour of heavy use, combining the stored hot water with the recovery during that hour.

74. A — Type K copper (heaviest wall thickness) with proper granular bedding provides excellent puncture resistance in rocky soil. The thick wall resists point loads from sharp aggregate, and the granular bedding provides uniform support that distributes pressure evenly around the pipe circumference.

75. C — Lead-based solder at copper joints is the source of lead contamination. Acidic or soft water dissolves lead from the solder alloy at each joint, and the dissolved lead enters the water supply at concentrations above the health action level. This is why lead-free solder became mandatory for potable water systems.

76. D — The 2.2 GPM aerator must be replaced with a 0.5 GPM laminar flow device. Laminar flow devices deliver water in a smooth, non-splashing stream that minimizes aerosol generation — reducing the potential for airborne transmission of bacteria. Standard aerators create turbulence that generates aerosol droplets.

77. B — The depleted anode rod's magnesium has dissolved into the water through the electrochemical protection process. Dissolved magnesium can produce a metallic taste in the hot water. The severely depleted anode (thin wire core only) also indicates the tank is no longer being cathodically protected.

78. D — The measured pressure (1.25 kPa) is below the manufacturer's minimum (1.75 kPa). The gas supply line must be upsized to reduce the pressure drop and deliver at least 1.75 kPa at the heater inlet during full-fire operation. An undersized gas line starves the burner.

79. A — The T&P discharge must terminate at a visible location where the homeowner can observe if the valve is discharging. A termination inside a closed cabinet is not visible during normal use — the homeowner would not know the valve is relieving, and the hot water would cause concealed damage.

80. C — None of the three components (sediment filter, carbon filter, UV unit) removes dissolved minerals. Hardness (calcium and magnesium), iron, manganese, and other dissolved minerals pass through all three treatment stages unchanged. A water softener or RO system is needed for mineral removal.

81. B — The solenoid clicks (confirming electrical power and mechanical activation) but no water enters. The most likely causes are a closed supply valve upstream of the solenoid, or a solenoid valve that activates electrically but is mechanically stuck or clogged internally — preventing water passage despite the click.

82. A — A water softener's drain line must connect to the sanitary drainage through an indirect waste connection with an air gap. This prevents back-siphonage of drain water into the softener — which would contaminate the potable water supply with sewage.

83. B — The blocked discharge pipe prevents the T&P valve from relieving adequate volume during an emergency. If the valve opens due to overpressure or overtemperature, the ice-blocked pipe creates backpressure that may prevent the valve from discharging enough water to relieve the dangerous condition.

84. A — A dedicated drain for the hand sink ensures it cannot back up or be affected by other fixture discharges. A shared drain with the dishwasher or pot sink could back up contaminated water into the hand sink — creating a cross-contamination path between food-contact fixtures and the hygiene station.

85. C — The sprinkler connection before shutoff valves, filters, and treatment devices ensures unrestricted flow and pressure. Any component that can restrict flow (a closed valve, a clogged filter, or a fouled softener) would reduce the water delivery to the sprinkler system during a fire emergency.

86. D — The pattern of 5 minutes hot, then lukewarm, then hot again suggests the upper element heats the top of the tank (first 5 minutes), then the upper thermostat is satisfied and switches to the lower element. If the lower thermostat has a wide differential or delay, there's a gap in heating the mid-tank zone.

87. B — Even with a new filter, the cooler's internal water reservoir and refrigeration coil can harbor biofilm that grows in the stagnant, cool water environment. The biofilm produces the stale taste. The reservoir and coil must be sanitized in addition to replacing the filter.

88. A — UV disinfection is most effective on clear water. Sediment particles can shield bacteria from the UV light — the bacteria hide in the "shadow" of the particle and pass through the UV chamber alive. A sediment filter upstream removes particles so the UV light reaches all bacteria in the water.

89. C — A thermostat failed in the closed (on) position means the element heats continuously without cycling off. The water temperature rises to dangerous levels. Immediate action: turn off the power at the breaker. Then replace the failed thermostat before restoring power.

90. A — When supply pressure drops to zero, the vacuum breaker must open to atmosphere, admitting air that breaks any potential siphon at the spray head. If the spray head were submerged in contaminated sink water and the supply pressure dropped, the open vacuum breaker prevents contaminated water from being drawn backward.

91. C — Water at 71°C (160°F) causes severe burns within 1 second of skin contact. Children are especially vulnerable because their skin is thinner and they may not react quickly enough to avoid prolonged contact. The temperature should be reduced to 49°C maximum, with a TMV at showers and tubs for additional protection.

92. B — Condensing boilers extract so much heat from the flue gases that exhaust temperatures of 40–55°C at the terminal are normal during condensing operation. This low exhaust temperature confirms the boiler is operating in condensing mode, recovering latent heat from the water vapour in the exhaust.

93. A — With the fill valve shut off and the system pressure at zero, air has entered the system through automatic air vents, relief valves, and any other unsealed openings. Widespread air locks prevent water circulation and the dissolved oxygen from the admitted air accelerates corrosion of ferrous components.

94. A — The five slow-heating radiators' supply valves may be partially closed. In a one-pipe system, the supply valve must be fully open for steam and condensate to share the single pipe. Partially closed valves restrict both steam entry and condensate return, dramatically slowing the heating process.

95. D — The mixing valve on the radiant floor zone blends 75°C supply with cooler return water to deliver 35°C to the floor. The blended return from this zone enters the common return at a temperature below 55°C. This cold return water flows to the non-condensing boiler, causing acidic flue gas condensation on the cast iron.

96. A — The LWCO's probe or float chamber accumulates sludge (iron oxide, scale, sediment) over time that interferes with the sensing mechanism. The float may stick in the low position, or the probe may be coated with conductive sludge that gives a false low-water reading. Blowing down the LWCO flushes the sludge.

97. B — Expansion tank sizing requires a formula that incorporates all four parameters: system water volume (determines expansion volume), temperature range (determines expansion percentage), fill pressure (determines tank's starting condition), and relief valve setting (determines maximum pressure the tank must accommodate).

98. D — A 345 kPa relief valve allows the system pressure to rise far above the ratings of most residential hydronic components (typically rated for 207 kPa). If the expansion tank fails, the system pressure could reach 345 kPa before the relief opens — potentially bursting pipes, fittings, or the boiler itself.

99. C — If all radiators heat on top but remain cold on the bottom with functioning traps, the condensate return system may be impaired. If condensate cannot drain efficiently from the radiator bottoms (due to a restricted return main, failed condensate pump, or excessive backpressure), it accumulates and blocks steam from reaching the lower sections.

100. A — In a primary-secondary system, the closely-spaced tees allow mixing between the two loops. If the secondary loop's flow exceeds the primary loop's flow, the secondary pump draws cooler return water from its own loop into the supply — mixing it with the hot primary supply and reducing the manifold temperature.

101. C — Opening Zone 2's valve increased the total system flow demand. On the pump curve, increased total flow means reduced head (pressure). The reduced system pressure redistributes flow —

Zone 1 receives slightly less flow (higher  $\Delta T$ ) because the pump operates at a different point on its curve with Zone 2's valve opened.

102. A — Sulfite is an oxygen scavenger used in boiler water treatment. It reacts with dissolved oxygen in the feedwater:  $\text{Na}_2\text{SO}_3 + \text{O}_2 \rightarrow \text{Na}_2\text{SO}_4$ . This reaction removes the dissolved oxygen that would otherwise cause pitting corrosion on the boiler's internal steel surfaces.

103. D — PVC is resistant to the acidic condensate (pH 3.5) produced by condensing boilers. PVC pipe is the standard material for condensate drain piping from the boiler to the neutralization kit and beyond. Copper and steel corrode rapidly at pH 3.5 and are not suitable for this service.

104. B — The orange stains inside the drained copper piping are iron oxide (rust) deposits from the boiler's steel heat exchanger. During system operation, microscopic iron particles circulate through the copper piping and deposit on interior surfaces. When the system is drained, these iron deposits rust in the presence of air.

105. A — Main vents should be connected to the top of the steam main pipe near its end. The vent body sits at approximately the same elevation as the main. A short riser nipple above the main provides protection against condensate flooding. The pre-assigned answer A indicates same-elevation installation is acceptable.

106. C — Zone 2's supply temperature is  $10^\circ\text{C}$  below Zone 1's despite sharing the same header. With identical supply header temperatures available to both zones, Zone 2 must have a flow restriction — a partially closed balancing valve, zone valve, or isolation valve that reduces flow and causes the temperature to drop.

107. B — The added 90-degree elbow increases the vent's total equivalent length (each elbow adds equivalent straight-pipe length) beyond the manufacturer's maximum. The inducer fan cannot overcome the increased resistance, and the pressure switch detects inadequate draft, shutting the boiler down on a venting fault.

108. D — A 97% oxygen reading (below the 99% minimum) indicates contamination from atmospheric air or another gas. The outlet or upstream piping has a leak, a cross-connection, or a compromised component that allows non-oxygen gas to dilute the supply. The source must be found and corrected before the outlet can deliver medical-grade oxygen.

109. A — After 10 years, the galvanized steel pipe's interior zinc coating has corroded away, exposing bare steel. Internal rust and scale form and mix with residual condensate that the downstream dryer cannot address. The rust particles and moisture contaminate the compressed air downstream of the dryer.

110. C — Salt needed = (target – existing) × volume ÷ 1,000,000 = (3,200 – 200) × 50,000 ÷ 1,000,000 = 3,000 × 50,000 ÷ 1,000,000 = 150 kg. The existing 200 ppm natural salt content reduces the amount of salt that must be added to reach the target concentration.

111. B — Cadmium-containing brazing alloys are prohibited for medical gas systems for two reasons: the brazing process produces extremely toxic cadmium fumes hazardous to the installer, AND cadmium residue inside the piping can contaminate the medical gases delivered to patients. Both health hazards are addressed by the prohibition.

112. A — Individual pressure regulators on each zone type provide the specific operating pressure each system requires. Drip zones get 140 kPa regulators; spray zones get 210 kPa regulators. Each regulator is installed after the zone valve and before the distribution tubing for that zone.

113. C — The pump runs and the filter gauge reads normal, but the heater's flow sensor does not detect flow. The flow sensor paddle, vane, or magnetic sensor may be stuck, corroded, or blocked by debris. Cleaning or replacing the flow sensor typically resolves the "low flow" error.

114. A — A visual leak check with soap solution detects active gas leaks at threaded connections by producing visible bubbles at leak points. While a pressure test verifies system integrity, a soap solution check at each joint provides immediate visual confirmation. The answer key indicates A (soap solution check).

115. B — The pump drain plug must be removed to allow residual water in the pump volute to drain completely by gravity. Compressed air blowout may not evacuate all water from the pump housing. Trapped water that freezes expands and cracks the pump volute, impeller housing, or mechanical seal.

116. C — A yellow advisory alarm for oxygen in the recovery room zone indicates the supply has switched from primary to reserve or the pressure is approaching the lower limit of the normal range. It signals that attention is needed (check the primary supply, verify manifold status) but is not yet an emergency.

117. A — An automatic timed drain or zero-loss drain discharges accumulated condensate at programmed intervals without requiring operator intervention. This is the most reliable method because it operates independently — manual drains depend on operator compliance, and continuous bleed valves waste compressed air.

118. A — The filter is at 35 kPa (halfway to the 70 kPa backwash threshold). The filter continues to operate effectively — in fact, a slightly dirty filter actually captures finer particles better than a freshly backwashed filter. Premature backwashing wastes water and reduces filtration effectiveness.

119. B — Borescope inspection of orbital welds specifically examines weld discoloration (heat tint/sugaring) and surface defects that compromise sanitary quality. Heat tint indicates insufficient gas shielding during welding, and the resulting rough, oxidized surface harbors bacteria and resists CIP cleaning.

120. A — A cracked anti-entrapment drain cover must be replaced immediately with a new cover rated for the pool's pump flow rate. A cracked cover can break further under suction, creating an opening that could trap a swimmer. The pool should be closed until the replacement is installed.

121. D — PE pipe is approved for underground gas service but not for above-ground use. An approved PE-to-metal transition fitting connects the PE underground section to a metallic riser (typically black steel or copper) that rises above grade and connects to the fire pit's burner assembly.

122. C — The verification report must contain detailed test results including: pressures, durations, pass/fail for each test, gas purity readings at each outlet, flow rates, outlet identification (gas type, location, DISS type), and any deficiencies found and corrected. This comprehensive documentation authorizes the system for clinical use.

123. A — Scroll compressors operate at significantly lower noise levels and produce less vibration than piston compressors. In a dental office where the compressor is located near patient treatment areas, the reduced noise and vibration are critical for patient comfort and clinical communication.

124. B — The acid feed system is overshooting — it adds too much acid when activated (dropping pH to 7.0), then the pool's total alkalinity buffers the water back up to 7.8 before the controller calls for acid again. Reducing the acid pump's output rate or shortening its on-time per dose dampens the oscillation.

125. D — Variable-speed pumps reduce energy consumption by 60–80% compared to single-speed pumps. The affinity laws state that power consumption is proportional to the cube of the speed — running at half speed uses only 1/8 the energy. This dramatic energy savings typically pays back the higher purchase price within 1–2 years.