

# PRACTICE EXAM 16: RED SEAL PLUMBER SIMULATION (125 QUESTIONS)

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1. A plumber is brazing a copper joint in an underground parking garage of a commercial building. The garage has concrete walls, a concrete ceiling, and adequate ventilation from vehicle exhaust fans. The plumber's hot work permit has been approved. During brazing, the plumber notices that the ventilation fans have been shut off by the building engineer for an unrelated maintenance issue. What should the plumber do?

- A. Continue brazing because the concrete construction is noncombustible and the garage has sufficient volume for safe torch work
- B. Increase the torch flame to finish the joint faster before the air quality deteriorates from the brazing fumes accumulating
- C. Stop brazing and do not resume until the ventilation is restored — brazing produces toxic fumes that require adequate ventilation
- D. Move to a different location in the garage that has natural ventilation from the vehicle entrance ramp openings

2. A plumber is assigned to install a new water service in a trench that crosses a residential driveway. The trench is 1.2 metres deep and 600 mm wide. The soil is firm clay. Does this trench require shoring, sloping, or other protective measures?

- A. Yes — trenches over 1.2 metres deep require protective measures in most Canadian jurisdictions regardless of soil type
- B. No — firm clay soil is selfsupporting and does not require protection at any depth for trenches under 1.5 metres
- C. Yes — but only if the trench will be occupied for more than 4 hours because shortduration work is exempt from protection

D. No — the 600 mm width is too narrow for a worker to enter, so protective measures are not required for this trench

3. A plumber encounters a job site where a coworker has connected a portable generator to power a submersible pump for dewatering a trench. The generator is running on the ground surface next to the trench. Fuel is stored in a jerry can 2 metres from the generator's exhaust. What is the primary hazard with this fuel storage location?

A. The fuel vapours from the jerry can will be drawn into the generator's air intake and contaminate the engine's fuel system

B. The generator's vibration will tip the jerry can, spilling fuel on the ground that soaks into the trench's soil backfill

C. The jerry can will overheat from the generator's radiant heat and the fuel may vaporize and accumulate near the hot exhaust

D. The fuel stored near the generator's hot exhaust creates a fire hazard — fuel must be stored at least 3 metres from heat sources

4. A plumber must install a large diameter pipe (6 inch cast iron) vertically through a floor penetration from the first floor to the basement below. The pipe weighs approximately 50 kg per 3 metre section. What is the safest method to lower the pipe through the floor penetration?

A. Two workers hold the pipe at the floor opening while a third worker in the basement guides the pipe down by hand

B. Use a chain hoist or comealong attached to the floor structure above the opening to lower the pipe in a controlled manner

C. Slide the pipe down through the opening and let it rest on the basement floor — the pipe can withstand the impact

D. The pipe must be cut into 1metre sections and lowered individually to reduce the weight per section for manual handling

5. A plumber is reviewing a project specification that requires all pipe hangers to have a "maximum deflection of 3 mm under full load." What does this specification control?

A. The maximum amount the hanger can bend or sag under the combined weight of the pipe, water, and any insulation loading

B. The maximum distance the pipe can move laterally from its centreline when subjected to thermal expansion forces

C. The maximum distance the pipe can move vertically during a seismic event before the hanger restraint engages

D. The maximum amount the concrete anchor can pull out of the ceiling under the hanger's full design load condition

6. A plumber is working on a construction site where welding is being performed by the steel erection crew on the floor above. Sparks and slag are falling through open floor penetrations to the plumber's work area below. What protection should the plumber request?

A. A hard hat with a face shield that protects the plumber from falling sparks while continuing to work below the welding

B. Temporary removal from the area until the welding is complete because there is no practical protection from falling slag

C. Fire blankets or spark curtains installed at the floor penetrations above to prevent sparks from falling to the level below

D. A fire extinguisher positioned at the plumber's work station to immediately suppress any fires started by falling sparks

7. A plumber must calculate the diagonal of a right triangle to determine the length of a pipe offset. The horizontal run is 1,200 mm and the vertical rise is 900 mm. Using the Pythagorean theorem ( $a^2 + b^2 = c^2$ ), what is the diagonal?

A. 2,100 mm, calculated by adding the horizontal and vertical measurements together for the total diagonal length

B. 1,050 mm, calculated by averaging the horizontal and vertical measurements for the approximate diagonal distance

C. 2,250,000 mm<sup>2</sup>, which is the sum of the squares (this is the intermediate step, not the final diagonal answer)

D. 1,500 mm, calculated as  $\sqrt{(1,200^2 + 900^2)} = \sqrt{(1,440,000 + 810,000)} = \sqrt{2,250,000} = 1,500$  mm diagonal

8. A plumber discovers that the electrical panel in the mechanical room has been left open (the panel cover is removed and live bus bars are exposed). The plumber must work in the mechanical room to install pipe. What is the correct action?

A. Work carefully around the open panel because only the electrician is responsible for the panel's condition and safety

B. Do not work in the room until the panel cover is replaced or the panel is deenergized — exposed bus bars are a lethal hazard

C. Cover the open panel with a piece of plywood as a temporary barrier and continue with the plumbing installation work

D. Notify the site supervisor about the open panel but continue working because the plumber will not touch the panel

9. A plumber is using a laser level to establish a reference line for a horizontal pipe run. The laser projects a red dot on the far wall. The plumber must mark pipe hanger locations along the wall at exact intervals. What precaution must all workers observe regarding the laser?

A. Never look directly into the laser beam — laser light can cause permanent eye damage even from brief direct exposure

B. Wear laserrated safety glasses at all times when the laser is operating to filter the harmful wavelength from the beam

C. The laser is safe for direct viewing because constructiongrade lasers are classified as "eyesafe" at all distances

D. Only the plumber operating the laser needs eye protection — other workers are not at risk from the reflected beam

10. A plumber is preparing to install underground pipe and must verify the location of all buried utilities before excavation. The plumber calls the One Call utility locate service and receives locate marks on the surface. The locate marks show approximate positions. What is the acceptable tolerance for locate marks?

- A. Locate marks are exact — the buried utility is directly beneath the paint mark with no tolerance or margin of error
- B. Locate marks are approximate within 5 metres on either side of the mark, requiring careful hand digging throughout
- C. Locate marks guarantee that no utility exists within the marked area — if no marks are present, no utilities are buried
- D. Locate marks are approximate — typically within 1 metre on either side, requiring hand digging within that zone

11. A plumber is cutting stainless steel pipe with an abrasive cutoff disc. The sparks from the cut are landing on nearby carbon steel piping. What concern does this create?

- A. The sparks will ignite the carbon steel pipe because carbon steel has a lower ignition temperature than stainless steel
- B. The carbon steel pipe is unaffected by stainless steel sparks because sparks cool to ambient temperature before landing
- C. Stainless steel particles embedded in the carbon steel surface cause localized corrosion (rust staining) at each contact point
- D. The sparks will weld themselves to the carbon steel surface, creating permanent bumps that interfere with pipe insulation

12. A plumber is installing domestic water piping in a hospital and must cross a corridor that serves as a fire exit route. The pipe runs at ceiling level across the corridor and is supported by hangers from the structure above. What code requirement applies to this pipe crossing?

- A. No piping is permitted to cross a fire exit corridor at any elevation because it obstructs the egress path during emergencies
- B. The pipe must be installed above the minimum clearance height and must not obstruct the corridor's required egress width or height
- C. The pipe must be installed inside a fire-rated chase that maintains the corridor's fire separation rating throughout the crossing
- D. Only metallic pipe (copper or steel) may cross fire exit corridors — plastic pipe is prohibited in all egress route locations

13. A plumber is reviewing the project's quality assurance (QA) requirements. The specification states: "All soldered joints shall be visually inspected for 100% coverage of solder fillet around the circumference." The plumber completes a joint and examines it. The solder fillet is visible around approximately 340 degrees of the circumference, with a 20-degree gap. Does this joint pass the QA inspection?

- A. No — the specification requires 100% (360°) solder coverage; the 20-degree gap constitutes a defect that must be repaired
- B. Yes — 340 degrees of coverage (94%) exceeds the industry standard minimum of 90% for acceptable solder joints
- C. No — but the gap can be filled by reheating the joint and adding solder to the uncovered section without disassembly
- D. Yes — the 20-degree gap is within the acceptable tolerance for field-soldered joints on all pipe diameters and applications

14. A plumber encounters a situation where a pipe must penetrate a concrete masonry block (CMU) wall that is a fire-rated partition between two tenant spaces. The pipe is 3-inch ABS DWV. What determines the firestop system that must be installed at this penetration?

- A. The pipe material only — all ABS penetrations use the same firestop regardless of wall type, rating, or annular space
- B. The wall thickness only — thicker walls require larger firestop collars regardless of the pipe material or fire rating
- C. The building inspector's preference — the inspector selects the firestop system at the time of inspection based on availability
- D. The specific tested and listed firestop assembly for the combination of pipe material, wall construction type, and fire rating

15. A plumber is working on a highrise construction project. The building has 20 floors. The plumber must install a vertical riser from the basement to the 20th floor. The riser pipe weighs approximately 15 kg per metre. The total riser height is 60 metres. What is the total weight of the riser pipe that the support system must carry?

- A. 300 kg, calculated by multiplying 15 kg/m by 20 floors instead of by the actual pipe length in metres
- B. 600 kg, calculated by doubling the weight to account for the additional load of water filling the riser during testing
- C. 900 kg, calculated as  $15 \text{ kg/m} \times 60 \text{ m} = 900 \text{ kg}$  of pipe weight supported by the riser clamp system
- D. 1,500 kg, calculated by multiplying the pipe weight by a 2.5× safety factor for the dynamic loading during operation

16. A plumber must verify that a 4inch copper pipe is round (not ovalized) before installing a press fitting. The fitting manufacturer requires the pipe to be within 2% of its nominal outside diameter for a proper press seal. The nominal OD of 4inch copper is 4.125 inches (104.8 mm). What is the maximum allowable ovality?

A. 4.125 mm, calculated by dividing the OD by the tolerance percentage for the maximum permitted diameter variation

B. Approximately 2.1 mm, calculated as 2% of 104.8 mm = 2.096 mm maximum deviation from round for proper fit

C. 10.48 mm, calculated as 10% of the OD because all press fittings accept up to 10% ovality without seal compromise

D. Zero — press fittings require perfectly round pipe and any measurable ovality prevents a proper seal from forming

17. A plumber is installing a copper water supply system and encounters a fitting that has been stored outdoors for several months. The fitting's interior socket has turned dark browngreen with oxidation. Can this fitting be used?

A. Yes — the fitting can be used as is because the soldering process burns off any surface oxidation during heating

B. Yes — but only if the fitting is cleaned with a wire brush or abrasive pad until bright copper is exposed inside the socket

C. No — outdoorstored fittings with heavy oxidation must be discarded because the oxide layer cannot be fully removed

D. No — but the fitting can be restored by soaking it in a mild acid bath (vinegar) for 30 minutes before installation

18. A plumber is installing HDPE (highdensity polyethylene) water service pipe using butt fusion joining. The pipe ends are prepared by facing them with a planing tool that shaves a thin layer from each end. Why is this facing step critical?

A. The facing step creates fresh, clean, unoxidized surfaces on both pipe ends that are essential for achieving a proper molecular fusion bond

B. The facing step reduces the pipe wall thickness at the joint to match the fusion machine's heating plate capacity limit

C. The facing step creates a groove in each pipe end that fills with melted HDPE during fusion to form a mechanical key

D. The facing step is cosmetic — it produces a smooth appearance at the joint but does not affect the fusion bond quality

19. A plumber is soldering a copper joint and notices that the solder flows freely on one side of the joint but stops at approximately the halfway point and does not continue around to the other side. What is the most likely cause?

A. The pipe was not inserted to the full depth of the fitting socket, creating a gap on one side where solder cannot bridge

B. The torch flame is too small and cannot heat the entire circumference of the fitting to the solder's flow temperature

C. The solder has been applied unevenly — the plumber must feed solder from multiple points around the circumference

D. Insufficient flux or contamination on the unsoldered side prevents the solder from wetting and flowing on that surface

20. A plumber is installing PEX tubing through a series of floor joists. The joists are  $38 \times 235$  mm ( $2 \times 10$  nominal). The plumber drills 25 mm (1 inch) holes through each joist at the centre of the joist's depth. The code limits the hole diameter relative to the joist depth. Is a 25 mm hole in a 235 mm joist acceptable?

A. No — the 25 mm hole exceeds the maximum permitted hole size for residential floor joists regardless of the joist depth

B. Yes — 25 mm (1 inch) is well within the typical maximum hole diameter of  $1/3$  the joist depth (about 78 mm) for  $2 \times 10$  joists

C. No — holes in floor joists must be drilled in the top third only, not at the centre, to maintain the joist's structural capacity

D. Yes — but only if the holes are spaced at least 600 mm apart and are not within 50 mm of the joist's bearing points

21. A plumber must join two sections of 6 inch ductile iron pipe using a mechanical joint (MJ) coupling. The MJ coupling has a gland, a gasket, and bolts. During assembly, the plumber must verify that the pipe spigot is inserted to the correct depth. How is this depth verified?

A. The pipe is inserted until it contacts the bottom of the coupling's socket — the positive stop confirms full insertion depth

B. The pipe is inserted until it is flush with the outer edge of the coupling body — no projection or recession is visible

C. A factory line marked on the pipe spigot must align with the coupling's edge — indicating the pipe is at the correct depth

D. The insertion depth is marked on the pipe spigot by measuring from the manufacturer's specification before assembly begins

22. A plumber is installing copper tube using ProPress fittings in a system that will be tested at 1,380 kPa (200 psi). The standard ProPress fitting is rated for 200 psi at 120°F. Can this system be tested at 1,380 kPa?

A. Yes — the 200 psi test matches the fitting's maximum rated pressure, so the test is within the fitting's design capacity

B. No — the test pressure must not exceed 150% of the system's operating pressure and 200 psi exceeds this for all systems

C. Yes — but the test duration must be limited to 15 minutes because sustained pressure at the maximum rating stresses the Oring

D. No — test pressures exceeding the fitting's working pressure rating risk damaging the Oring seal and voiding the warranty

23. A plumber is brazing a copper joint using an oxyacetylene torch with BCuP5 (15% silver) filler metal. The plumber adjusts the flame to a neutral setting. How does the plumber identify a neutral flame?

A. A neutral flame has a long, blue outer cone with a yellow tip that indicates perfect combustion of the fuel gas

B. A neutral flame produces no visible inner cone — only a soft, uniform blue glow from the torch tip to the outer edge

C. A neutral flame has a sharp, welldefined inner cone with no feathery acetylene fringe and no hissing oxidizing sound

D. A neutral flame has a short inner cone surrounded by a greentinted outer envelope that indicates complete combustion

24. A plumber encounters a situation where a 3inch copper DWV pipe must be joined in a tight ceiling space where a torch cannot be used safely. What alternative joining method can be used for copper DWV pipe?

A. Solvent cement designed for copper tube that creates a chemical bond identical to PVC solventcemented joints

B. Mechanical couplings (nohub style with neoprene gasket and stainless steel band clamps) that do not require heat

C. Cold solder compound that cures at room temperature and creates a bond equivalent to heatsoldered copper joints

D. Compression fittings with brass ferrules that provide a leaktight mechanical connection without any torch or heat

25. A plumber is installing Schedule 80 PVC pipe for a chemical waste system in a laboratory. The specification requires all joints to be doublecemented — cement applied to both the pipe exterior and the fitting interior for maximum bond strength. After applying cement to the pipe, the plumber notices the cement on the pipe has already dried (turned from wet to matte) before the fitting is assembled. What should the plumber do?

A. Assemble the joint immediately because the matte appearance is normal for twostep cement applications on Schedule 80

B. Add more cement on top of the dried layer and assemble immediately before the second application also dries

C. Reheat the dried cement with a heat gun to reactivate the solvents and restore the cement's bonding capability

D. Wipe off the dried cement, clean the surface, and start over — dried cement cannot create a proper chemical fusion bond

26. A plumber is troubleshooting a 10storey commercial building where the 2ndfloor restroom experiences trap seal loss on multiple fixtures when the building's HVAC system switches from heating to cooling mode. The traps refill after each use but lose their seal within hours. No other floors are affected. What is the most likely cause?

A. The HVAC mode change alters the building's air pressure balance, and the 2nd floor experiences negative pressure that draws trap seals down

B. The 2nd floor's vent piping is connected to the HVAC return duct, and the cooling mode creates suction through the vent system

C. The temperature change from heating to cooling causes rapid condensation in the 2ndfloor vent piping that blocks airflow

D. The 2ndfloor restroom's trap seals evaporate faster in cooling mode because the air conditioning reduces humidity levels

27. A plumber discovers that an existing building has a circuit vent serving 8 water closets on a horizontal branch. The circuit vent connects to the branch at the downstream end, between the last two fixtures. During heavy simultaneous use of all 8 toilets, the first 2 toilets on the branch (farthest from the vent) gurgle. What does this indicate?

A. The circuit vent diameter is adequate but the vent connection should be between the first and second fixtures, not the last two

B. The circuit vent is inadequate for 8 water closets — it should be replaced with individual vents for each water closet

C. The circuit vent is functioning as designed — the farthest fixtures from the vent experience the greatest pressure fluctuation

D. The branch drain is undersized for 8 water closets and the gurgling is a drainage issue, not a venting deficiency

28. A plumber is installing a DWV system and must select fittings for a horizontal-to-horizontal drain connection. The plumber has four fitting types available: sanitary tee, combination wye and eighth bend, standard wye, and long sweep 90. Which is the correct fitting for connecting a 2-inch horizontal branch to a 4-inch horizontal building drain?

A. A sanitary tee, which provides the correct 90-degree branch angle for all horizontal drain connection applications

B. A combination wye and eighth bend (or a standard wye), which provides a swept entry in the direction of flow

C. A long sweep 90, which redirects the branch at 90 degrees with a gentle curve that prevents blockage accumulation

D. Any of the four fittings is acceptable for horizontal-to-horizontal connections per the current plumbing code provisions

29. A plumber is sizing a building sewer for a commercial building with 200 DFU at 1/8 inch per foot slope. The code table shows: 4-inch at 1/8" = 180 DFU; 5-inch at 1/8" = 390 DFU; 6-inch at 1/8" = 700 DFU. What is the minimum sewer size?

A. 4 inches at a steeper slope (1/4 inch per foot) to increase the 4-inch capacity above 200 DFU without upsizing

B. 6 inches, because building sewers should be oversized by at least two pipe sizes above the minimum calculation

C. 4 inches, because 180 DFU capacity is close enough to 200 DFU with the built-in safety margin in the code table

D. 5 inches, because 390 DFU capacity exceeds the 200 DFU load and is the first size that provides adequate capacity

30. A plumber encounters a residential building where the kitchen sink drain has a strong odour even though the trap has water. The plumber examines the drain connection and discovers that the dishwasher's drain hose connects directly to the garbage disposal without a high loop or air gap. What problem does this create?

- A. The dishwasher drain water backflows into the disposal and creates a stagnant pool of food waste that produces odour
- B. The disposal's grinding chamber vents sewer gas through the dishwasher drain hose into the dishwasher and kitchen cabinet
- C. The dishwasher and disposal connections are correct — the odour must originate from a different source in the system
- D. The direct connection without a high loop allows gravity drainage from the disposal to backflow into the dishwasher

31. A plumber installs a 4inch building drain beneath a basement slab. The drain must accommodate a future bathroom addition. The plumber installs a capped 3inch branch connection (wye with a cap) at the planned bathroom location. What must be done when the future bathroom is built?

- A. Remove the cap, connect the new bathroom fixtures to the existing 3inch branch, and extend the drainage and venting
- B. Remove the entire wye fitting and install a new, larger fitting because the 3inch branch is undersized for a full bathroom
- C. Leave the capped branch in place and install a completely new drain run from the bathroom to the building drain instead
- D. The capped branch cannot be used for a future bathroom because it has been exposed to sewer gas that contaminates the pipe

32. A plumber discovers that an existing building's 3-inch soil stack has a standard (pressure-type) tee at the base where it turns from vertical to horizontal. The branch of this tee connects a cleanout. The plumber observes recurring blockages at this location. What should be done?

A. Replace the standard tee with a sanitary tee that has a swept branch for smoother waste flow at the stack base transition

B. Replace the standard tee with a longsweep combination fitting (quarter bend with cleanout) for improved flow at the base

C. Add a second cleanout downstream of the existing fitting to provide access from both directions for clearing blockages

D. Install a grinder pump at the stack base to macerate the waste before it enters the horizontal building drain downstream

33. A plumber installs a septic tank and must verify the tank's structural integrity before backfilling. The tank is precast concrete with a sealed lid. How is the tank's integrity verified?

A. Fill the tank with water to the outlet invert and check for leakage over 24 hours — any visible drop indicates a leak

B. Apply a soap solution to all exterior joints and seams and pressurize the tank with air to detect bubbles at leak points

C. Visual inspection of the interior and exterior for cracks, honeycombing, or joint defects is adequate for precast concrete tanks

D. Fill the tank with water to the inlet invert and hold for a minimum period (typically 24 hours) to verify no leakage occurs

34. A plumber encounters a building where the grease interceptor serving a restaurant kitchen has an alarm panel that shows "high level." The interceptor was pumped 6 weeks ago. The typical pump interval is 3 months. What should the plumber investigate?

A. The alarm panel sensor is faulty — replace the sensor because the interceptor cannot have reached the highlevel threshold in 6 weeks

B. The restaurant's grease output is normal — 6 weeks is too early for a highlevel alarm and the alarm must be malfunctioning

C. The restaurant's menu, volume, or cleaning practices have changed, increasing grease output beyond the original design assumptions

D. The interceptor's outlet is restricted or blocked, preventing treated effluent from exiting and causing the level to rise prematurely

35. A plumber installs a 3inch vent that passes through a roof. The vent terminal must be flashed to prevent water leakage at the roof penetration. The roof is covered with asphalt shingles. What type of flashing is standard for this application?

A. A lead, aluminum, or rubber vent boot (coneshaped flashing) that slides over the pipe and integrates with the shingle courses

B. A flat piece of sheet metal bent around the pipe and sealed to the shingles with roofing tar applied at the base

C. A preformed plastic collar that snaps around the pipe and is glued to the shingle surface with waterproof construction adhesive

D. A stainless steel band clamp tightened around the pipe at the roof surface with silicone sealant applied to the joint

36. A plumber is troubleshooting a residential DWV system where the basement shower drains normally but the toilet on the same branch drains very slowly. The plumber snakes both the toilet branch and the main branch — no blockage is found. The vent is clear. What should the plumber investigate?

- A. The toilet itself — the siphon jet, rim holes, or internal trap passage may be partially blocked with mineral deposits
- B. The wax ring seal beneath the toilet — a damaged wax ring can restrict the flow from the toilet outlet to the drain pipe
- C. The branch drain slope between the toilet and the shower connection — an incorrect slope can restrict toilet drainage
- D. The toilet's flush valve assembly — a worn flapper or flush valve may be releasing water too slowly for effective flushing

37. A plumber installs a building sewer connecting to a municipal combined sewer system. During a heavy rainstorm, the combined sewer surcharges. A backwater valve has been installed on the building drain. The homeowner reports that during the surcharge, the basement toilet cannot be flushed and the kitchen sink drains slowly. Why?

- A. The backwater valve has failed in the open position and is allowing surcharged sewer water to enter the building drain
- B. The backwater valve is functioning correctly — when closed to prevent backup, it also blocks the building's drainage from exiting
- C. The building drain is too small for the combined domestic and storm drainage volume during the surcharge event
- D. The sump pump in the basement is overwhelmed by the surcharge and is backing up through the toilet and sink drains

38. A plumber is installing a DWV system in a building where the soil stack must offset horizontally for 3 metres between the 4th and 5th floors. The offset uses two 45degree fittings with a 3metre horizontal section. What additional requirement applies to this horizontal offset in the soil stack?

- A. The horizontal section must be installed at a level grade (zero slope) to prevent the offset from acting as a branch drain
- B. The offset section must be vented at the upper end to prevent pressure fluctuations from affecting fixtures above and below
- C. The horizontal offset must be treated as a branch drain — properly sloped, supported, vented, and with a cleanout for maintenance
- D. The offset requires no additional treatment because the 45degree fittings maintain the stack's continuous airflow through the offset

39. A plumber encounters a building where the 4inch building drain exits the foundation wall and connects to a 4inch clay tile building sewer. The connection is made with a fernco coupling. Over time, the fernco coupling has shifted and the joint now leaks groundwater into the sewer (infiltration). What is the consequence of this infiltration?

- A. Groundwater entering the sewer increases the hydraulic load on the downstream municipal treatment plant and the building's drain capacity
- B. The infiltration has no consequence because groundwater is clean and does not affect the sewer system's operation
- C. The infiltrated groundwater dilutes the sewage, improving its quality before reaching the municipal treatment plant
- D. The groundwater erodes the clay tile sewer pipe's interior, gradually weakening the pipe from the inside surface outward

40. A plumber installs a floor drain in a restaurant kitchen. The drain is connected to the building's grease interceptor. The floor drain has a removable strainer basket. After installation, the plumber notices that kitchen staff have removed the strainer basket because it "gets dirty too fast." What will happen without the strainer?

- A. The grease interceptor will function more efficiently because the strainer was restricting the flow rate to the interceptor
- B. Food solids enter the drain and accumulate in the branch pipe, the interceptor, and the downstream sewer — causing blockages
- C. The floor drain's Ptrap will clog with food debris that the strainer was designed to capture before it entered the drainage
- D. Nothing — the grease interceptor is designed to handle both grease and food solids without a prestraining device

41. A plumber is sizing a horizontal fixture branch for a commercial washroom with 2 water closets (3 DFU each), 2 urinals (2 DFU each), 2 lavatories (1 DFU each), and 1 mop sink (3 DFU). The total is 15 DFU. Water closets are connected. What minimum pipe size is required?

- A. 3 inches, which accommodates the DFU total and meets the soil pipe minimum because water closets are connected
- B. 4 inches, because the total DFU exceeds the typical 3inch branch maximum when water closets are connected
- C. 2 1/2 inches, which accommodates 15 DFU per the sizing table regardless of fixture types on the branch connection
- D. The minimum depends on whether a circuit vent or individual vents are used — the vent type determines the branch size

42. A plumber encounters a building where the building sewer has been installed at a slope that is too steep (2 inches per foot). The sewer carries typical residential wastewater. What problem does the excessive slope create on a long sewer run?

A. The steep slope accelerates water velocity but has no negative effect on the sewer's ability to carry waste material

B. The water outruns the solids on the steep slope — the liquid drains away too quickly and the solids strand on the pipe floor

C. The steep slope causes the waste to splash and overflow at each fitting because of the high velocity at the direction changes

D. The steep slope creates excessive erosion on the pipe floor that gradually thins the pipe wall from the highvelocity abrasion

43. A plumber installs a DWV cleanout in a finished basement wall. The cleanout must be accessible for drain maintenance. The plumber installs a cleanout with a flushmount cover behind a removable access panel in the finished drywall. What size must the access panel be?

A. Large enough to remove the cleanout plug and insert a drain cleaning cable — typically at least 300 × 300 mm (12" × 12")

B. The exact size of the cleanout plug diameter because only the plug needs to be removed through the panel opening

C. A minimum of 600 × 600 mm (24" × 24") to provide adequate room for a drain cleaning machine to operate inside the wall

D. No specific size is required — any panel that provides visual access to the cleanout location satisfies the code requirement

44. A plumber is installing a septic system disposal field. The disposal field trenches are 600 mm wide and 750 mm deep. The bottom 300 mm is filled with washed gravel, the perforated pipe sits on the gravel, more gravel covers the pipe to 50 mm above the crown, and landscape fabric covers the gravel before backfilling with native soil. What is the purpose of the landscape fabric?

A. It provides an additional layer of filtration for the effluent before it enters the surrounding soil for final treatment

B. It prevents the native soil backfill from migrating downward into the gravel bed and clogging the drainage stone voids

C. It insulates the disposal field from frost penetration during winter to maintain biological treatment effectiveness

D. It prevents plant roots from growing into the gravel bed and clogging the perforated pipe distribution network below

45. A plumber encounters a situation where a 1 1/2 inch kitchen sink trap arm runs 1.5 metres before connecting to its vent. The code maximum trap arm length for 1 1/2 inch pipe is 1.07 metres (42 inches). The trap arm exceeds the maximum by 430 mm. What must be done?

A. Reduce the trap arm diameter to 1 1/4 inches, which has a longer maximum trap arm length than 1 1/2 inch pipe

B. Install an air admittance valve at the midpoint of the trap arm to provide intermediate venting within the maximum distance

C. Extend the vent connection closer to the trap — the vent must be relocated to within 1.07 metres of the trap's weir

D. Increase the trap arm diameter to 2 inches, which has a longer maximum trap arm length that would accommodate 1.5 metres

46. A plumber is installing an underground storm drainage system for a commercial parking lot. The catch basins collect surface water from the parking lot. The piping runs from the catch basins to a storm water management pond. What pipe material is commonly used for this underground storm drainage application?

A. Copper Type K, which provides maximum corrosion resistance for underground storm drainage in commercial applications

B. PVC DWV Schedule 40, which provides the smooth interior and structural strength needed for underground storm piping

C. PVC SDR 35, corrugated HDPE, or reinforced concrete pipe — standard materials for underground storm drainage service

D. Cast iron nohub, which provides the acoustic performance and structural strength needed for parking lot storm drainage

47. A plumber discovers that an existing building's DWV system has a vent pipe that runs through an exterior wall and up the outside of the building to above the roofline. The vent pipe is exposed to weather on the building's exterior. Is this installation acceptable?

A. Yes — exterior vent piping is permitted by code as long as it extends above the roof and meets all terminal clearance requirements

B. No — all vent piping must run inside the building's thermal envelope to prevent frost closure in Canadian climates

C. Yes — but only if the vent pipe is insulated and heat-traced on the exterior to prevent frost closure in cold weather

D. No — exterior vent piping is prohibited in all Canadian jurisdictions because the exposed pipe freezes and blocks

48. A plumber installs a commercial building's DWV system. The building has a food court with 6 restaurant tenants. Each restaurant has its own grease interceptor. All 6 interceptors' outlets connect to a common building drain that runs to the municipal sewer. The building owner asks whether a single large interceptor could replace the 6 individual units. What is the advantage of individual interceptors per tenant?

- A. Individual interceptors are always less expensive than a single large unit for the same total combined flow capacity
- B. Individual interceptors allow each tenant to be responsible for their own grease management and maintenance costs
- C. Individual interceptors provide better grease separation because smaller units have shorter retention times for the waste
- D. Individual interceptors allow each tenant to maintain their own unit and be responsible for their own compliance and pumping

49. A plumber is troubleshooting a building where the sewage ejector pump cycles on and off very rapidly (every 15 seconds). The pump runs for 5 seconds, shuts off, then restarts 10 seconds later. This continues indefinitely. The ejector pit appears to have adequate water to pump. What is the most likely cause?

- A. The ejector pump's float switch has failed and is cycling erratically regardless of the actual water level in the pit
- B. The check valve on the force main has failed — pumped water flows back into the pit immediately, retriggering the float switch
- C. The ejector pump's impeller is clogged with debris, reducing its pumping capacity to a fraction of its design output
- D. The basement fixtures are using more water than the pump can handle, continuously refilling the pit faster than it can empty

50. A plumber installs a 4-inch PVC building drain beneath a concrete slab. The drain has been tested and approved. Before the concrete pour, the plumber must protect the open pipe ends and stubouts from concrete intrusion. What protection method is used?

- A. Cap or plug all open pipe ends with temporary test plugs, duct tape covers, or expandable foam to prevent concrete from entering
- B. Leave the pipe ends open because the concrete contractor is responsible for preventing intrusion during the pour operation
- C. Fill each open pipe end with a wad of newspaper that can be easily removed after the concrete sets and hardens
- D. Install permanent caps on all open ends — the caps will be cut off with a saw when the fixtures are connected later

51. A plumber encounters a building where the building drain has two separate exit points through the foundation wall — one for the sanitary sewer and one for the storm sewer. Both pipes are the same material (PVC) and the same diameter (4 inches). How does the plumber distinguish between the two at the foundation wall?

- A. The sanitary pipe has a trap visible near the foundation wall while the storm pipe exits without a trap at the wall
- B. The sanitary and storm pipes are identical — only the building's interior piping layout identifies which is which
- C. The sanitary pipe is always on the left side of the building and the storm pipe is always on the right when facing the street
- D. The pipes should be labeled or colourcoded — without identification, the plumber must trace each pipe to its source

52. A plumber is installing a DWV system and must connect a 3inch vent pipe to a 4inch vent stack. What fitting is appropriate for this venttovent connection?

A. A sanitary tee with the 3inch branch connected to the 4inch stack using a reducing bushing in the tee branch outlet

B. A standard reducing tee (4×4×3) — because this is a vent connection (no drainage), any tee type is acceptable

C. A reducing wye (4×4×3) with the 3inch branch sweeping in the direction of airflow through the vertical stack

D. A combination wye and eighth bend that provides a swept connection identical to drainage fitting requirements

53. A plumber discovers during a renovation that a building has a 2inch wet vent serving a bathroom group (water closet, lavatory, and bathtub). The wet vent carries the lavatory's drainage while providing ventilation for the water closet and bathtub. The lavatory is the uppermost fixture on the wet vent. What would happen if the lavatory were relocated to the lowest position on the wet vent?

A. Moving the lavatory to the lowest position would flood the wet vent with drainage from above, blocking the air supply to the WC and tub traps

B. The relocation has no effect because the wet vent functions identically regardless of the fixture connection order

C. Moving the lavatory down would improve drainage because water flows downhill and the lowest connection empties fastest

D. The wet vent would require an increase to 3 inches to handle the changed flow pattern from the relocated lavatory

54. A plumber installs a 4inch building drain at 1/4 inch per foot slope. After 10 metres, the drain must drop an additional 300 mm to reach a lower elevation before continuing at 1/4 inch per foot. What fitting creates this vertical drop in the horizontal drain?

A. A standard 90degree longsweep elbow installed vertically in the horizontal run to make the 300 mm elevation change

B. A vertical section with two 45degree elbows (one at the top, one at the bottom) creating a gradual "step" in the horizontal drain

C. A ramp section of pipe at a steeper slope (1 inch per foot) for a short distance to transition between the two elevations

D. A combination wye and eighth bend installed at the upper elevation with a short vertical drop and a second combination at the lower level

55. A plumber is troubleshooting a commercial building where a floor drain in a mechanical room consistently emits sewer gas. The drain has a properly filled trap, the vent is clear, and a smoke test shows no leaks. The mechanical room has a large air handling unit (AHU) with a powerful supply fan. What is the most likely cause?

A. The AHU's supply fan creates negative pressure in the mechanical room that draws gas through the partially depleted trap seal

B. The floor drain's trap seal is being depleted by the AHU's positive pressure pushing air down through the drain and out the trap

C. The sewer gas is entering through the AHU's fresh air intake from the vent terminal on the roof, not through the floor drain

D. The AHU's positive pressure in the mechanical room pushes room air into the drain, preventing gas from escaping upward

56. A plumber installs a sewage ejector system for a commercial basement restroom. The force main diameter is 2 inches. The vertical lift is 4 metres. The horizontal run is 8 metres. The force main has 3 elbows. The plumber must calculate the total dynamic head (TDH) to size the pump. What components contribute to the TDH calculation?

- A. Only the 4metre vertical lift — friction losses in force mains are negligible and elbows have no measurable effect
- B. The vertical lift (4 m) plus the friction loss in the 8 m horizontal run plus the friction equivalent of the 3 elbows combined
- C. The vertical lift (4 m) multiplied by 1.5 to account for all friction losses as a simplified field calculation method
- D. The vertical lift (4 m) plus the friction loss through 8 m of 2inch pipe plus the equivalent length of 3 elbows for total friction

57. A plumber installs a residential water supply system. After completing the installation, the plumber pressurizes the system and opens each fixture to flush debris. During flushing, the plumber notices small copper shavings and flux residue exiting the faucet aerators. What is the significance of this debris?

- A. The debris indicates defective pipe that is deteriorating internally and will require replacement within 12 years
- B. The debris is residual from the installation process and will flush out completely during the initial use period
- C. The debris indicates excessive flux was used during soldering, which will cause accelerated internal corrosion if not flushed
- D. The debris indicates the system was not properly reamed — burrs inside the pipe are breaking loose under flow pressure

58. A plumber discovers that a commercial building's domestic hot water system has a mixing valve at the water heater outlet set to 49°C. The building also has a commercial dishwasher that requires 60°C minimum inlet temperature for the wash cycle. How should the hot water distribution accommodate both requirements?

A. A dedicated hot water line from the heater (before the mixing valve) supplies the dishwasher at the full 60°C storage temperature

B. The mixing valve must be adjusted to 60°C to serve the dishwasher, with thermostatic mixing valves at each fixture for scald protection

C. The dishwasher's booster heater raises the 49°C supply to the required temperature, eliminating the need for separate piping

D. Both A and C are valid approaches — a dedicated line bypassing the mixing valve or reliance on the dishwasher's booster heater

59. A plumber is installing a water supply for a commercial building with a laboratory autoclave. The autoclave sterilizes instruments at 134°C under pressure. The autoclave uses chemical sterilants in addition to heat. What backflow prevention is required on the supply?

A. A double check valve assembly (DCVA) because the autoclave uses only potable water heated above standard temperatures

B. An atmospheric vacuum breaker installed 150 mm above the autoclave's highest fill connection on the supply pipe inlet

C. No backflow prevention because the autoclave's sealed chamber prevents any water from flowing backward to the supply

D. A reduced pressure (RP) assembly because the combination of heat, pressure, and chemicals creates a health hazard

60. A plumber is troubleshooting a residential water system where the cold water pressure at all fixtures is 415 kPa (60 psi) — matching the PRV setting — but the hot water pressure at all fixtures is only 275 kPa (40 psi). The water heater is a gasfired storage type. What is the most likely cause of the hot water pressure reduction?

- A. The water heater's dip tube has failed, creating internal turbulence that manifests as reduced pressure at the fixture outlets
- B. A partially closed valve, restricted nipple, or debrislogged connection on the hot water outlet of the water heater
- C. The water heater's thermostat is set too high, causing the water to expand and reduce the effective pressure at the outlet
- D. The hot water piping is a smaller diameter than the cold water piping, creating greater friction loss on the hot water side

61. A plumber installs a residential water heater with an expansion tank. The expansion tank is properly sized, precharged to match the PRV setting, and connected to the cold water supply. Six months later, the homeowner reports the T&P valve discharges a small amount of water every morning. The plumber checks the expansion tank — the precharge is correct and the bladder is intact. What else should be checked?

- A. The water heater thermostat — if set too high, excessive thermal expansion overwhelms the correctly sized expansion tank
- B. The T&P valve itself — its spring may have weakened or the seat may have debris that causes it to open below its rating
- C. The PRV — if the municipal pressure has increased significantly, the higher supply pressure raises the system's baseline pressure
- D. All three — the thermostat setting, T&P valve condition, and current municipal pressure should all be verified systematically

62. A plumber discovers that a building's copper water supply piping has areas of erosion corrosion — thinned pipe walls at elbows, tees, and direction changes on the hot water recirculation loop. The system is 8 years old. What is the primary cause of erosion corrosion?

A. The water chemistry is too acidic (low pH) and the acid attacks the copper surface preferentially at turbulent flow areas

B. Stray electrical current from the building's grounding system flows through the water and erodes the pipe at fittings

C. Excessive water velocity through the piping creates turbulence at fittings that strips the protective oxide layer from the copper

D. The recirculation pump's cavitation produces microbubbles that implode at fittings, eroding the pipe wall at each impact

63. A plumber is installing a water supply for a commercial building with a dental office. The dental unit chairs have self-contained water bottles that the hygienist fills manually with distilled water. No connection to the potable supply exists. The dentist asks the plumber to install a direct potable supply connection to the dental chairs to eliminate the manual filling. What concern applies?

A. The building's water supply pressure may exceed the dental chair's maximum rated working pressure for the supply connection

B. The potable supply must have adequate residual chlorine to meet the dental unit's minimum water quality standard

C. The connection to the potable supply creates a potential crossconnection hazard from the dental chair's chemicals and suction

D. A direct connection creates a crossconnection because the dental chair's internal water contacts chemicals and patient fluids

64. A plumber is troubleshooting a residential water system where the kitchen faucet's hot water has air bubbles (sputtering) when first opened. The cold water flows normally without sputtering. After running the hot water for 10 seconds, the sputtering stops and clear hot water flows. What is causing the sputtering?

- A. The water heater's dip tube has cracked, allowing air to enter the tank through the break in the dip tube wall
- B. Dissolved air in the cold water supply comes out of solution when heated in the water heater and accumulates at the top
- C. The hot water recirculation pump is drawing air into the system through a leak in the suction side of the pump connection
- D. The water heater's anode rod is producing hydrogen gas through the electrochemical reaction with the tank's water chemistry

65. A plumber installs a water supply for a commercial building. The specification requires all water supply piping to be pressure tested at 1.5 times the working pressure for 2 hours. The system's working pressure is 415 kPa (60 psi). What is the required test pressure?

- A. 415 kPa (60 psi), which is the normal working pressure and provides the baseline for system integrity verification
- B. 830 kPa (120 psi), calculated by doubling the working pressure for the maximum safety margin during testing
- C. 622 kPa (90 psi), calculated as  $1.5 \times 415 \text{ kPa} = 622 \text{ kPa}$  for the specified 1.5× test pressure requirement
- D. 1,035 kPa (150 psi), calculated by applying the standard 2.5× safety factor used for all commercial pressure tests

66. A plumber discovers that a residential water heater has a 3/4inch ball valve on the cold water inlet but no valve on the hot water outlet. The homeowner wants to service the heater. How does the plumber isolate the heater for service?

A. Close the cold inlet valve and open a hot fixture to relieve pressure — this effectively isolates the heater for draining and service

B. Close the building's main shutoff valve to isolate the entire supply system including the heater from the municipal main

C. The heater cannot be properly isolated without a valve on both the inlet and outlet — a hotside valve must be added

D. Open the T&P valve to depressurize the heater — this isolates it from the supply through the reduced pressure

67. A plumber is installing a dedicated water supply branch for a commercial coffee maker. The manufacturer requires a maximum flow rate of 3.8 litres per minute to the machine. The building's supply pressure is 550 kPa (80 psi). What component limits the flow rate to the machine's requirement?

A. A check valve on the supply branch that opens only when the coffee maker's solenoid activates for fill cycles

B. A pressure-reducing valve set to a lower pressure that naturally limits the flow rate through the reduced pressure

C. An adjustable flow restrictor or metered valve on the supply branch that limits the maximum flow to 3.8 LPM

D. A flow restrictor or PRV on the supply branch that limits the flow to the manufacturer's specified maximum rate

68. A plumber tests a backflow preventer (RP device) and discovers that the first check valve holds but the second check valve leaks slightly. The relief valve functions correctly. Does the RP pass the annual test?

A. Yes — the first check provides primary protection and the relief valve provides secondary protection even with the second check leaking

B. Yes — a slight leak on the second check valve is within the acceptable tolerance for annual RP device testing results

C. No — both check valves must hold for the RP to pass the annual test; the second check must be repaired or the RP replaced

D. No — any check valve failure requires immediate replacement of the entire RP device regardless of the failure severity

69. A plumber is installing a water supply system and must select the correct type of copper tube for a section that will be embedded in a concrete wall. The tube will carry potable cold water at normal building pressure. What type of copper is appropriate?

A. Type K copper, which has the thickest wall and provides the maximum corrosion allowance for concrete-embedded service

B. Type L copper, which is the standard for aboveground supply piping and is acceptable for concrete embedment

C. Type M copper, which has the thinnest wall and must be sleeved when embedded in concrete for corrosion protection

D. Type DWV copper, which is designed specifically for wall-embedded installations at zero-pressure drainage service

70. A plumber discovers that a building's domestic hot water recirculation system has a balancing valve on the return line. The valve is fully open. The plumber measures the return water temperature and finds it is 55°C — only 5°C below the 60°C supply temperature. The  $\Delta T$  design is 10°C. What does the low  $\Delta T$  indicate?

- A. The system is perfectly balanced — a low  $\Delta T$  means the recirculation flow rate matches the design for optimal performance
- B. The recirculation flow rate is too high — water is moving through the loop too fast, not losing enough heat per pass
- C. The supply water temperature is too low and must be increased from 60°C to 65°C to achieve the design 10°C  $\Delta T$
- D. The balancing valve is malfunctioning and must be replaced with a new valve to restore the design flow characteristics

71. A plumber installs a frostfree hose bibb on a residential exterior wall. The wall insulation is spray foam. After installation, the plumber verifies the bibb operates correctly — water flows when the handle is opened and stops when closed. However, the plumber does not verify one critical function. What must be checked?

- A. The bibb's builtin vacuum breaker must be tested by lifting the plunger to verify it opens and reseats properly
- B. The bibb's backflow preventer must be tested by disconnecting the hose and verifying no water drains from the spout
- C. The bibb's shutoff must be verified for zero drip — any water remaining after closing must drain from the exposed stem
- D. The bibb must be verified to drain properly when closed — with no hose attached, residual water must drain from the outdoor end

72. A plumber installs a water heater with a powered anode rod. The powered anode requires a 120V outlet. The nearest outlet is a GFCI-protected receptacle in the utility room. Can the powered anode be plugged into this GFCI outlet?

A. Yes — a GFCI outlet is appropriate and provides additional electrical safety for the powered anode near the water heater

B. No — the powered anode requires a dedicated non-GFCI circuit because the anode's low-voltage output trips the GFCI

C. Yes — but only if the GFCI receptacle is tested monthly to verify it has not tripped and interrupted power to the anode

D. No — the powered anode must be hardwired to a dedicated circuit because plug-in connections are not code-approved

73. A plumber is sizing the hot water supply for a small commercial building. The total hot water WSFU is 20. Using the demand curve, the plumber converts 20 WSFU to approximately 1.3 litres per second (20 GPM). This is the peak hot water demand. The water heater must deliver this flow rate at the design temperature. What additional capacity factor should the plumber consider?

A. A 25% safety margin above the calculated peak demand to account for future fixture additions and load growth

B. The standby losses from the storage tank and distribution piping that reduce the heater's effective delivery capacity

C. The peak demand already accounts for all factors — no additional capacity adjustments are needed beyond the curve value

D. A diversity factor that reduces the peak demand by 30% because not all hot water fixtures operate simultaneously

74. A plumber discovers that a building's PRV has been installed with no strainer on the inlet side. After 5 years of service, the PRV chatters intermittently. What is the likely connection between the missing strainer and the chattering?

- A. The missing strainer has no connection to the chattering — PRV chattering is always caused by oversizing, not debris
- B. Debris from the supply has accumulated on the PRV's seat, preventing it from regulating smoothly and causing intermittent chatter
- C. The missing strainer allowed large particles to pass through that physically damaged the PRV's internal spring mechanism
- D. The strainer's absence caused the PRV to overheat from unfiltered water that carries more thermal energy to the valve

75. A plumber installs a water supply system in a commercial building. The building has a fire sprinkler system supplied from the same municipal main as the domestic supply. During a fire sprinkler flow test, the domestic supply pressure drops significantly. What causes this pressure drop?

- A. The fire sprinkler test valve is crossconnected to the domestic supply, drawing directly from the domestic piping
- B. The fire department connection is backfeeding water from the sprinkler system into the domestic supply, reducing pressure
- C. The building's main shutoff valve is partially closed, restricting flow to both the domestic and sprinkler systems simultaneously
- D. The fire sprinkler flow test draws a large volume from the same municipal main, reducing the available pressure for the domestic supply

76. A plumber installs a commercial wallhung water closet on a concealed carrier. After installation, the plumber performs a flush test. The toilet flushes normally but the bowl does not refill completely — the water level is approximately 25 mm below the normal fill line. What is the most likely cause?

- A. The flush valve's refill tube is not properly connected to the overflow tube, so bowl refill water is not directed to the bowl
- B. The supply stop valve is partially closed, restricting the flow rate to the flush valve during the refill portion of the cycle
- C. The concealed carrier's supply connection has a builtin flow restrictor that limits the refill rate below the bowl's requirement
- D. The water supply pressure is too low to fully activate the flush valve's refill mechanism during the postflush bowl refill cycle

77. A plumber services a residential water softener. The homeowner reports that the softener uses significantly more salt than when it was first installed 3 years ago. The water hardness has not changed. The plumber checks the system. What is the most likely cause of increased salt consumption?

- A. The resin bed has partially fouled with iron, reducing its effective capacity and requiring more frequent regeneration cycles
- B. The softener's control valve timer has drifted, triggering regeneration more frequently than the programmed schedule
- C. The household water consumption has increased (new family member, new fixtures) without reprogramming the softener
- D. The resin bed has degraded — regeneration is less effective per cycle, requiring more brine to achieve the same softening result

78. A plumber installs a commercial sensor faucet. The specification requires a "metering" function — the faucet delivers a fixed volume of water per activation regardless of how long the user's hands are in front of the sensor. What is the purpose of metering on a commercial sensor faucet?

- A. Metering prevents excessive water use by limiting each activation to a predetermined volume, conserving water in hightraffic washrooms
- B. Metering provides consistent water pressure to each user by limiting the flow duration regardless of system pressure
- C. Metering prevents the faucet from running indefinitely if the sensor malfunctions in the "on" position during a failure
- D. Metering allows the building's water meter to accurately record water consumption from each individual faucet separately

79. A plumber discovers that a residential water heater produces adequate hot water for the first 10 minutes of a shower but the water turns cold suddenly (not gradually). The heater is an electric 190litre model with upper and lower elements. What does the sudden (not gradual) temperature change suggest?

- A. The dip tube has failed, causing cold water to shortcircuit to the outlet once the upper portion of the tank is depleted
- B. The lower element has failed — the upper element heats only the top 1/3 of the tank, which depletes in about 10 minutes
- C. The lower element has failed — only the upper portion of the tank is heated, and when it is depleted the temperature drops suddenly
- D. The thermostat has drifted and is shutting off the elements prematurely before the full tank volume reaches the set temperature

80. A plumber is installing a residential fire sprinkler system using CPVC piping. The CPVC manufacturer prohibits the use of certain thread sealants, pipe dopes, and lubricants on or near the CPVC pipe. Why?

- A. These products contain chlorinated solvents that attack the CPVC material at the molecular level, weakening the pipe wall
- B. Certain chemicals in these products cause environmental stress cracking (ESC) of CPVC, leading to sudden brittle pipe failure
- C. The products create a chemical reaction with the CPVC cement that weakens the solventcemented joints on the piping
- D. The lubricants reduce the friction coefficient of the pipe surface, causing hangers and supports to slip during operation

81. A plumber services a commercial water treatment system with a reverse osmosis (RO) membrane. The RO system produces purified water for a pharmaceutical application. The system includes a conductivity meter that monitors the product water quality. The conductivity reading has increased from 5  $\mu\text{S}/\text{cm}$  to 25  $\mu\text{S}/\text{cm}$  over the past month. What does the increased conductivity indicate?

- A. The RO membrane's rejection rate has decreased — more dissolved solids are passing through the membrane into the product water
- B. The RO system's pressure pump has increased output, forcing more water through the membrane at a higher flow rate
- C. The prefilter has become clogged, increasing the pressure on the membrane and forcing concentrated water through
- D. The RO membrane has improved its performance — higher conductivity indicates purer water with more dissolved oxygen

82. A plumber installs a water heater with a standard magnesium anode rod. The building's water supply is from a private well. The well water has elevated manganese (0.5 ppm). After installation, the hot water has a brownishblack discoloration that the cold water does not have. What is causing this?

- A. The magnesium anode rod reacts with the dissolved manganese in the hot water, producing manganese dioxide that discolours the water
- B. The water heater's dip tube is deteriorating and releasing dark plastic particles into the hot water distribution system
- C. The water heater's internal glass lining has cracked, exposing the bare steel tank to the water and producing iron oxide rust
- D. The hot water temperature causes dissolved manganese to oxidize and precipitate as dark manganese dioxide particles

83. A plumber is troubleshooting a residential water closet that "phantom flushes" — the fill valve activates briefly every 30 minutes without anyone flushing the toilet. The plumber adds food colouring to the tank water and waits 30 minutes. The coloured water appears in the bowl. What does this confirm?

- A. The fill valve is defective and is overfilling the tank, causing water to run over the overflow tube into the bowl
- B. The toilet has an internal crack between the tank and bowl that allows water to seep from the tank to the bowl
- C. The flapper (flush valve seal) is leaking — tank water slowly passes the flapper into the bowl, dropping the tank level
- D. The tankto bowl gasket has deteriorated, allowing tank water to leak externally and drip into the bowl from outside

84. A plumber installs a pointofuse tankless electric water heater to serve a single commercial hand sink. The heater is rated at 3.5 kW (120V, 29A). The hand sink requires tempered water at 38°C. The incoming cold water temperature is 10°C. What is the maximum flow rate this heater can produce at 38°C with a 28°C temperature rise?

A. Approximately 0.5 litres per minute, calculated using the heater's kW output and the required temperature rise for the application

B. Approximately 1.8 litres per minute, calculated as  $3.5 \text{ kW} \div (4.186 \text{ kJ/L/}^\circ\text{C} \times 28^\circ\text{C} \div 60 \text{ s})$  for the flow conversion

C. Approximately 3.8 litres per minute, matching the hand sink faucet's maximum flow rate regardless of the heater's output capacity

D. Approximately 7.6 litres per minute, calculated by using the 120V supply voltage as the primary factor in the flow determination

85. A plumber discovers that a residential bathtub's overflow drain is not connected — the overflow pipe from the tub terminates inside the wall cavity without connecting to the drain piping. If the tub overfills, the overflow water enters the wall cavity. What must be corrected?

A. The overflow pipe must be painted with a waterproof sealant inside the wall to create a sealed channel to the floor below

B. The overflow is decorative only and is not required to connect to the drainage system in residential bathtub installations

C. The overflow pipe must be capped because an unconnected overflow is less dangerous than one that leaks inside the wall

D. The overflow pipe must be connected to the tub's wasteandoverflow assembly, which drains through the tub's Ptrap

86. A plumber installs a wholehouse UV disinfection system on a residential well supply. The UV system is installed after the sediment filter and carbon filter. The plumber commissions the system and verifies the UV lamp is operating. What ongoing maintenance is required?

A. Annual UV lamp replacement and periodic cleaning of the quartz sleeve that separates the lamp from the water flow

B. Monthly cleaning of the UV lamp by removing it from the chamber and wiping it with an alcoholsoaked cloth

C. Quarterly replacement of the UV lamp because well water conditions degrade the lamp faster than municipal supplies

D. No maintenance — UV lamps and quartz sleeves are maintenancefree for the life of the disinfection system unit

87. A plumber is troubleshooting a residential electric water heater that produces hot water but the temperature fluctuates — sometimes it's very hot (above 60°C) and other times it's lukewarm (below 45°C). Both thermostats are set to 60°C. What is the most likely cause?

A. One thermostat has failed in the "on" position, causing its element to heat continuously regardless of the temperature

B. The upper thermostat's temperature sensor has drifted, causing inconsistent cycling that produces variable water temperatures

C. A thermostat has failed or drifted — one element runs too hot while the other underheats, producing inconsistent tank temperatures

D. The electrical supply voltage fluctuates, causing the elements to produce variable heat output depending on the available voltage

88. A plumber installs a commercial dishwasher with a booster heater. The dishwasher's sanitizing rinse cycle requires 82°C water for a minimum of 10 seconds of contact time. After installation, the health inspector tests the rinse temperature and reads only 75°C at the dishes. What should the plumber investigate?

- A. The building's hot water supply temperature at the dishwasher inlet — if the supply is below 60°C, the booster cannot achieve 82°C
- B. The booster heater element, which may have failed or be undersized for the dishwasher's rinse volume and cycle timing
- C. The dishwasher's internal temperature probe, which may be reading higher than actual and not calling for additional boost heating
- D. The supply water pressure, which may be too high and is pushing water through the booster too quickly for adequate heating

89. A plumber is installing a water softener on a residential well supply. The well water test shows hardness of 25 gpg and iron of 4 ppm. The softener manufacturer rates the unit for a maximum of 2 ppm iron removal capacity. What must be installed before the softener?

- A. A dedicated iron removal filter upstream of the softener to reduce the iron from 4 ppm to below 2 ppm before it reaches the resin
- B. A larger softener with higher iron removal capacity that can handle both the 25 gpg hardness and 4 ppm iron simultaneously
- C. A sediment filter that captures the particulate iron before it reaches the softener's resin bed for dissolved iron treatment
- D. A chlorine injection system that oxidizes the dissolved iron to particulate form for capture by the softener during regeneration

90. A plumber discovers that a residential water heater's T&P relief valve has been piped to discharge into a bucket on the floor next to the heater. The homeowner empties the bucket weekly because the valve "drips occasionally." What does the weekly dripping indicate?

- A. The system has a thermal expansion issue — the T&P valve is relieving pressure buildup that should be absorbed by an expansion tank
- B. The T&P valve is defective and should be replaced with a new valve that does not leak under normal operating conditions
- C. The weekly dripping is normal wear on the T&P valve spring and the homeowner should continue emptying the bucket
- D. The water heater's thermostat is malfunctioning and overheating the water above the T&P valve's temperature rating

91. A plumber installs a residential water heater and must verify the T&P discharge pipe routing. The discharge pipe runs from the valve downward and terminates 150 mm above the basement floor. The pipe has no valves, no traps, and is not reduced below the valve's 3/4inch outlet. Is there any remaining code requirement the plumber must verify?

- A. The discharge pipe material must be listed for the T&P valve's maximum discharge temperature (typically 99°C / 210°F)
- B. The discharge pipe must have a union fitting within 300 mm of the valve for easy removal during annual T&P valve testing
- C. The discharge pipe must be insulated to prevent burns if someone contacts the pipe during a T&P discharge event
- D. The discharge pipe termination must be visible so the homeowner can observe whether the valve is discharging water

92. A plumber installs a hydronic heating system with a condensing boiler. The boiler's venting specification requires Category IV venting — a positive pressure, condensing vent system. The plumber selects PVC pipe for the vent. What characteristic of Category IV venting makes PVC necessary?

A. The flue gases are above 260°C and only PVC can withstand these temperatures without degrading or failing structurally

B. The flue gases are under positive pressure and contain acidic condensate that corrodes metal vent pipe but not PVC

C. The flue gases are under negative pressure (natural draft) and PVC provides the smooth interior needed for adequate draft

D. PVC is required only for aesthetic reasons — metal vent pipe is equally suitable for Category IV condensing boiler installations

93. A plumber discovers that a hydronic system's expansion tank is mounted on the return pipe, 3 metres from the boiler. The circulator pump is on the supply pipe near the boiler outlet. The system has recurring air problems — air accumulates at high points and the automatic air vents discharge frequently. What is the relationship between the component locations and the air problem?

A. The expansion tank location on the return has no effect on air problems — the issue is caused by insufficient air separation

B. The expansion tank is too far from the pump — it must be within 300 mm of the pump inlet for proper air elimination

C. The pump should be relocated to the return pipe near the expansion tank connection for proper pressure zone management

D. The pump on the supply creates a low pressure zone at its suction (near the expansion tank) that can draw air into the system

94. A steam boiler has a Hartford Loop connecting the condensate return to the equalizer pipe. The plumber examines the connection and finds it is 100 mm (4 inches) below the boiler's normal water line. The standard is approximately 50 mm (2 inches). What problem does this excessive distance create?

- A. The Hartford Loop at 100 mm below normal water line may not provide adequate protection — the boiler could lose more water through a return leak before the loop stops the drainage
- B. The 100 mm distance is within the acceptable range and provides additional safety margin compared to the standard 50 mm
- C. The excessive distance causes the condensate return to flood with boiler water that overflows back through the return piping
- D. The Hartford Loop distance has no effect on boiler safety — it serves only to prevent steam from entering the return piping

95. A plumber is commissioning a hydronic system with 3 zones. During startup, all 3 zones call for heat simultaneously. The boiler fires but the supply water temperature rises very slowly and never reaches the setpoint. The pump is running. What should the plumber check?

- A. The gas supply pressure to the boiler, which may be insufficient to produce the BTU output needed for the connected load
- B. The boiler's heat exchanger for scale that insulates the water from the combustion gases and reduces heat transfer efficiency
- C. The boiler may be undersized for the total connected load — when all 3 zones call simultaneously, the demand exceeds the boiler's capacity
- D. The system water volume, which may be too large for the boiler to heat in a reasonable time during the initial coldstart period

96. A plumber discovers that a onepipe steam system's radiator in a bedroom heats to full temperature even when the thermostat is not calling for heat. The radiator has a thermostatic air vent. What has failed?

A. The thermostat is functioning correctly but the radiator's supply valve is stuck in the open position regardless of the call

B. The thermostatic air vent has failed in the open position — air vents continuously, allowing steam to enter the radiator regardless of room temperature

C. The boiler's pressuretrol has failed in the "on" position and is producing steam continuously regardless of the thermostat

D. The radiator's steam trap has failed in the open position, allowing steam to flow through the radiator continuously

97. A plumber installs a hydronic system and must select between a standard cast iron circulator pump and a stainless steel circulator pump. The system uses 50% propylene glycol antifreeze. Which pump material is appropriate?

A. Stainless steel — glycol solutions can be corrosive to cast iron pump components, and stainless steel resists glycolrelated corrosion

B. Cast iron — the glycol inhibitor package protects cast iron from corrosion and stainless steel is an unnecessary expense

C. Either material is acceptable because propylene glycol is noncorrosive to both cast iron and stainless steel at any concentration

D. Neither — a bronze pump is the only material approved for hydronic systems with glycol antifreeze concentrations above 30%

98. A plumber is troubleshooting a hydronic system where the boiler fires and the circulator runs, but the supply water temperature at the boiler outlet is 80°C while the supply temperature at the distribution manifold (5 metres away) is only 50°C. What is causing the 30°C temperature drop over 5 metres?

A. The 5metre pipe run is uninsulated and loses 30°C through radiation and convection to the surrounding mechanical room air

B. A mixing valve or injection pump between the boiler and the manifold is reducing the supply temperature for radiant floor zones

C. The pipe between the boiler and manifold has a partial blockage that restricts flow and causes heat loss in the stagnant water

D. A mixing valve, injection pump, or 3way valve between the boiler and manifold is blending return water to reduce the temperature

99. A plumber installs a condensing boiler with a stainless steel heat exchanger. The manufacturer specifies that the system pH must be maintained between 7.0 and 8.5. The plumber fills the system with municipal water that has a pH of 8.0. After adding a corrosion inhibitor, the pH rises to 9.2. What concern does this create?

A. A pH of 9.2 is within the normal range for inhibited hydronic systems and does not affect the stainless steel heat exchanger

B. A pH of 9.2 is slightly above the manufacturer's maximum — monitor and adjust but no immediate action is required

C. A pH of 9.2 exceeds the manufacturer's maximum of 8.5 — the alkaline water can corrode the stainless steel heat exchanger

D. The inhibitor has raised the pH above the safe range — the system water must be partially drained and diluted with fresh water

100. A plumber discovers that a hydronic system's zone valve has an "end switch" — a small switch inside the valve that closes when the valve reaches the fully open position. What does this end switch signal?

- A. The end switch signals the zone's thermostat to stop calling for heat because the valve has reached its open position
- B. The end switch signals the boiler and circulator to start — they do not fire until the zone valve is confirmed fully open
- C. The end switch illuminates an indicator light on the zone valve box that confirms the valve is in the open position
- D. The end switch signals the building's fire alarm panel that the heating system zone valve has opened for monitoring

101. A twopipe steam system has condensate return piping that runs through an unheated crawl space. During winter, the condensate in the return piping occasionally freezes, blocking the condensate from returning to the boiler. What must be done to prevent this?

- A. Insulate the condensate return piping in the crawl space and consider adding heat trace cable to prevent freezing
- B. Install a condensate pump that returns condensate faster so it does not have time to freeze in the crawl space piping
- C. Increase the boiler's operating pressure to push condensate through the return piping faster before it can freeze
- D. Reroute the condensate return through heated interior spaces to eliminate the exposure to freezing crawl space temperatures

102. A plumber installs a hydronic boiler and the manufacturer specifies a minimum water flow rate through the heat exchanger at all times during firing. What is the consequence of firing the boiler without adequate water flow?

- A. The boiler operates at reduced efficiency because the heat cannot transfer to the water without adequate flow velocity
- B. The boiler's modulating burner automatically reduces its firing rate to match the reduced flow for safe operation
- C. The heat exchanger overheats locally, potentially cracking from thermal stress or triggering the highlimit safety control
- D. The system pressure increases rapidly because the limited water volume absorbs the heat and expands beyond normal

103. A plumber is balancing a 4zone hydronic system. After initial balancing, the plumber records: Zone 1  $\Delta T = 11^{\circ}\text{C}$ , Zone 2  $\Delta T = 14^{\circ}\text{C}$ , Zone 3  $\Delta T = 9^{\circ}\text{C}$ , Zone 4  $\Delta T = 11^{\circ}\text{C}$ . Design  $\Delta T = 11^{\circ}\text{C}$ . Which zone(s) need adjustment?

- A. Zone 1 and Zone 4 only — their exact match with the design  $\Delta T$  suggests they are actually the reference zones for balancing
- B. Zone 2 (too little flow — open its valve) and Zone 3 (too much flow — partially close its valve) need adjustment
- C. All four zones need adjustment because the readings should be measured simultaneously, not sequentially, for accuracy
- D. Zone 2 only — its high  $\Delta T$  is the most significant deviation and addressing it will automatically correct Zone 3's low  $\Delta T$

104. A plumber is installing a condensing boiler with a PVC vent that terminates on the building exterior. The termination point is 1 metre from an operable window. The manufacturer requires a minimum of 1.2 metres from the vent terminal to any window, door, or air intake. Is this termination acceptable?

A. Yes — the 1metre distance is close enough to the 1.2metre requirement that the manufacturer's tolerance allows this installation

B. Yes — but only if the vent terminal has a downwardfacing elbow that directs exhaust away from the window opening

C. No — the manufacturer's clearance requirements exist because exhaust gases contain CO that could enter through the window

D. No — the vent terminal must be relocated to achieve the 1.2metre minimum clearance from the operable window

105. A plumber discovers that a steam boiler's water column (gauge glass assembly) has been isolated — both the upper and lower valves connecting the water column to the boiler are closed. The boiler is firing normally. What immediate risk does this create?

A. The operator cannot verify the actual water level — the gauge glass shows the last level before isolation and is no longer accurate

B. The boiler's efficiency decreases because the isolated water column creates a deadend pipe that traps heat in the boiler shell

C. The lowwater cutoff (if connected to the water column) may also be isolated, disabling the critical safety device while the boiler fires

D. The isolated water column will develop internal vacuum that causes the glass tube to implode when the valves are reopened

106. A plumber installs a hydronic system with an outdoor wood boiler. The outdoor boiler's supply and return lines run underground through insulated PEX piping from the boiler to the house, a distance of 15 metres. What concern applies to these underground supply and return lines?

- A. The underground lines must be installed above the frost line because the hot water prevents the ground from freezing locally
- B. The underground lines must be installed in an insulated, waterproof conduit to prevent heat loss and groundwater intrusion
- C. The underground lines must use oxygenbarrier PEX because standard PEX allows oxygen to enter the system from the soil
- D. All of the above — the lines require proper insulation, waterproof protection, and oxygenbarrier PEX for longterm performance

107. A plumber is commissioning a new hydronic boiler and must set the expansion tank's precharge pressure. The system's coldfill pressure is 103 kPa (15 psi). What should the tank's air precharge be set to?

- A. 69 kPa (10 psi), which is below the fill pressure to allow water to enter the tank immediately during initial system filling
- B. 103 kPa (15 psi), matching the system's coldfill pressure exactly so the diaphragm is neutral at the starting condition
- C. 138 kPa (20 psi), which is above the fill pressure to prevent water from entering the tank until thermal expansion begins
- D. 207 kPa (30 psi), matching the relief valve setting to provide maximum expansion capacity during the heating cycle

108. A medical gas system installer is preparing to braze joints on a medical vacuum piping system. Unlike oxygen and medical air systems, the vacuum system operates at negative pressure. Does the vacuum piping still require a nitrogen purge during brazing?

- A. No — nitrogen purging is required only for positive pressure medical gas systems where oxygen would support combustion
- B. Yes — but only if the vacuum piping will later be tested at positive pressure during the standing pressure test
- C. No — the vacuum system draws air inward, not outward, so internal oxidation does not affect the vacuum function
- D. Yes — the nitrogen purge prevents internal copper oxide formation that would flake off and contaminate the vacuum system

109. A compressed air system in an automotive repair shop has a 100gallon (380litre) air receiver tank. The tank's pressure gauge reads 690 kPa (100 psi). The tank's safety relief valve is rated at 860 kPa (125 psi). The compressor's pressure switch is set to cut out at 690 kPa and cut in at 550 kPa. Is this configuration correct?

- A. Yes — the compressor's cutout pressure (690 kPa) is below the safety valve's setting (860 kPa), providing adequate safety margin
- B. No — the safety valve must be set at exactly the compressor's cutout pressure (690 kPa) for proper pressure regulation
- C. Yes — but only if the air receiver tank was manufactured within the last 10 years and has a current inspection certificate
- D. No — the compressor's cutout pressure must be at least 70 kPa below the safety valve setting for a proper safety margin

110. A plumber is installing a residential swimming pool with a variable-speed pump. The pool builder specifies that the pump must achieve a minimum flow rate through the pool heater for the heater to fire. The heater requires a minimum of 100 LPM for the flow switch to activate. The pump's low speed produces 80 LPM. What must be programmed?

- A. The pump must increase to medium or high speed during heating cycles to achieve the heater's 100 LPM minimum flow requirement
- B. The heater's flow switch must be adjusted to activate at 80 LPM instead of 100 LPM to match the pump's low-speed output
- C. The pump must run at high speed at all times because variable-speed pumps cannot be programmed for different speeds per function
- D. The pool must be replumbed with larger pipe to reduce friction and increase the low-speed flow rate above 100 LPM

111. A medical gas system's oxygen outlets in a patient room have been tested and certified. A hospital maintenance worker later installs a new wall-mounted television bracket near the oxygen outlet. During installation, the maintenance worker's drill strikes the oxygen pipe inside the wall. What is the immediate hazard?

- A. The damaged pipe could leak oxygen into the wall cavity, creating an oxygen-enriched environment that supports rapid combustion
- B. The damaged pipe creates a cross-connection between the oxygen system and the atmosphere inside the wall cavity
- C. The damaged pipe reduces the oxygen flow to downstream outlets, affecting patient care in rooms beyond the damage point
- D. All three — oxygen leak into the wall (fire hazard), reduced downstream flow (patient safety), and contamination of the gas system

112. A plumber is installing an irrigation system with 10 zones. Each zone has a solenoid valve controlled by the irrigation controller. The controller operates on 24V AC from a transformer. The maximum wire run from the controller to the farthest zone valve is 150 metres. What concern applies to this long wire run?

- A. The 24V signal produces adequate power at any distance because irrigation solenoid valves require minimal current to operate
- B. The long wire run has no effect on performance because the controller compensates by increasing voltage for distant zones
- C. Signal interference from buried electrical cables near the irrigation wire can cause the solenoid valves to activate randomly
- D. Voltage drop over the 150metre wire run may reduce the voltage at the solenoid below the minimum needed to operate the valve

113. A plumber discovers that a swimming pool's salt chlorine generator has been producing chlorine at the maximum output setting for several weeks. Despite maximum output, the pool's free chlorine level remains low (0.5 ppm instead of the target 2.0 ppm). The salt level is adequate at 3,200 ppm. What is the most likely cause?

- A. The pool has a high bather load or organic contamination that consumes chlorine faster than the generator can produce it
- B. The generator cell has reached the end of its service life and can no longer produce adequate chlorine despite maximum settings
- C. The pool's high chlorine demand from algae, organic debris, or high bather load is consuming chlorine faster than the generator produces it
- D. The pool water temperature is too low for effective chlorine generation — the electrolysis process requires a minimum of 15°C

114. A plumber is connecting a natural gas supply to a commercial cooking appliance using a flexible gas appliance connector. The connector has a maximum length of 1.8 metres (6 feet). The distance from the shutoff valve to the appliance inlet is 2.1 metres. What must the plumber do?

- A. Extend the rigid gas piping closer to the appliance so the flexible connector's 1.8metre maximum is not exceeded
- B. Use two flexible connectors joined together to span the 2.1metre distance from the shutoff valve to the appliance
- C. Install a longer flexible connector rated for the 2.1metre distance because connectors are available in custom lengths
- D. Use the 1.8metre connector and stretch it to 2.1 metres — the 300 mm excess is within the connector's stretch tolerance

115. A plumber is winterizing a commercial irrigation system. After completing the compressed air blowout, the plumber drains the backflow preventer. The device is a reduced pressure (RP) assembly. What specific drainage steps are required for the RP?

- A. Close the upstream shutoff valve and open one test cock — the RP drains through the single test cock opening
- B. Close the upstream shutoff valve and open both test cocks plus the relief valve drain to allow complete drainage
- C. Open both test cocks while the upstream valve remains open to flush any remaining water through the device body
- D. Remove the RP device entirely and store it indoors because RP assemblies cannot be adequately drained in place

116. A medical gas system's alarm panel has been triggered by a "low oxygen pressure" alarm. The bulk liquid oxygen tank outside has adequate supply. The alarm affects only one zone — the 3rd floor surgical suite. All other zones show normal pressure. What is the most likely cause?

- A. A leak in the 3rd floor oxygen piping has depressurized the zone below the alarm threshold while other zones remain normal
- B. The 3rd floor zone valve has been partially closed by hospital staff during cleaning, restricting flow and reducing pressure
- C. The alarm panel's 3rd floor pressure sensor has drifted out of calibration and is reading lower than the actual zone pressure
- D. The zone regulator serving the 3rd floor has malfunctioned, reducing the downstream pressure below the alarm setpoint

117. A plumber is installing a compressed air system in a manufacturing facility. The main header is 3 inch steel pipe. The plumber must install a branch takeoff for a workstation. Where on the main header should the branch connection be made?

- A. At the bottom of the header pipe, which provides the straightest path for air flow to the branch workstation below
- B. At the side of the header pipe (3 o'clock or 9 o'clock position), which is the standard for all compressed air branch connections
- C. At the top of the header pipe, which draws the driest air and prevents condensate from being pulled into the branch
- D. At any position — the branch location on the header circumference has no effect on air quality at the workstation

118. A swimming pool's automated chemical controller maintains the pool's pH by injecting muriatic acid when the pH rises above the setpoint. The controller's pH probe reads 7.8. The target pH is 7.4. The controller activates the acid pump. After 2 hours, the pH still reads 7.8. What should be checked?

- A. The acid feed pump, supply line, and injection point — the acid may not be reaching the pool water due to a pump or line failure
- B. The pH probe, which may have drifted and is reading 7.8 when the actual pH has already dropped to 7.4 from the acid addition
- C. The pool's total alkalinity, which may be very high and is buffering the pool water against pH changes from the acid injection
- D. The muriatic acid strength — the acid may have diluted over time and is no longer concentrated enough to reduce the pH

119. A plumber is installing a process piping system in a food manufacturing facility. The specification calls for all stainless steel piping to be passivated after welding. The plumber completes the orbital welding and submits the system for passivation. What passivation method is used?

- A. Circulating a citric acid or nitric acid solution through the piping to dissolve iron contamination and restore the chromium oxide layer
- B. Circulating a caustic (sodium hydroxide) solution through the piping to neutralize any acidic contamination from the welding flux
- C. Pressurizing the piping with nitrogen gas at elevated temperature to burn off any organic contamination from the welding process
- D. Flushing the piping with highvelocity purified water to mechanically remove any welding slag or discoloration from the joints

120. A plumber discovers that a swimming pool's heater bypass valve has been left fully open. The bypass allows water to flow around the heater without passing through it. The heater fires normally but the pool temperature does not rise. Why?

- A. The heater is functioning — the open bypass recirculates heated water through the bypass, not through the pool return
- B. The open bypass reduces the pressure at the heater inlet below the minimum for the flow switch to activate the burner
- C. The heater fires but most of the pool water bypasses the heater through the open bypass, so very little water is actually heated
- D. The open bypass allows pool water to flow around the heater, so the pump's full flow bypasses the heat exchanger

121. A plumber is connecting a natural gas supply to a residential pool heater. The heater is located outdoors, 5 metres from the building's gas meter. The gas line must include a manual shutoff valve. Where must this valve be located?

- A. At the gas meter, which serves as the central shutoff point for all outdoor gas appliances on the property
- B. At the building's exterior wall where the gas line exits, which provides a convenient shutoff for maintenance workers
- C. Within close proximity to the pool heater — the shutoff must be accessible and operable without reaching over the heater
- D. At any convenient location between the meter and the heater — the code does not specify an exact shutoff valve position

122. A medical gas system verifier discovers that a nitrogen outlet in the operating room has been installed with incorrect labeling — the label reads "Medical Air" instead of "Nitrogen." The DISS connector is correct for nitrogen. What must be done?

- A. The outlet label must be corrected to read "Nitrogen" and match the DISS connector and the gas actually delivered
- B. The DISS connector must be changed to match the "Medical Air" label because the label takes precedence over the connector
- C. Both the label and connector must be changed to match whichever gas the piping actually delivers at this outlet location
- D. The outlet must be removed and the piping traced to its source before either the label or connector can be corrected

123. A plumber is installing a compressed air system and must select between a refrigerated air dryer and a desiccant air dryer. The facility requires an air dewpoint of 40°C for a specific application. Which dryer type achieves this dewpoint?

- A. A refrigerated dryer, which can achieve dewpoints as low as 40°C through deep cooling of the compressed air
- B. A desiccant dryer, which uses a drying agent (such as silica gel or activated alumina) to achieve dewpoints as low as 70°C
- C. Either type can achieve 40°C — the choice between refrigerated and desiccant depends only on energy efficiency preference
- D. Neither type achieves 40°C — a cryogenic dryer is required for dewpoints below 20°C in compressed air applications

124. A swimming pool system has an automatic chemical controller with separate probes for pH and ORP. The controller has been operating correctly for 2 years. The pool operator reports that the ORP reading has become erratic — jumping between 500 and 800 mV randomly. The pH reading is stable. What is the most likely cause?

- A. The chlorine level is fluctuating rapidly, causing genuine ORP changes that the probe is accurately detecting and reporting
- B. The pool water's salt level has changed, affecting the ORP probe's electrical reference and producing erratic voltage readings
- C. The ORP probe has fouled or degraded — after 2 years of continuous immersion, the probe's sensing element needs cleaning or replacement
- D. The ORP probe has reached the end of its service life after 2 years and must be replaced with a new calibrated probe

125. A plumber services a swimming pool and discovers that the pool's main circulation pump has a cracked volute (pump housing). Water leaks from the crack during operation. Can the volute be repaired?

## Practice Exam 16: Answer Key and Explanations

1. C — Brazing produces toxic metallic fumes (copper, zinc, cadmium from filler metals) and combustion byproducts that require adequate ventilation to maintain safe air quality. When the ventilation fans are shut off, these fumes accumulate in the enclosed garage, creating an inhalation hazard. All hot work must stop until ventilation is restored.
2. A — In most Canadian jurisdictions, trenches deeper than 1.2 metres require protective measures (shoring, sloping, or trench box) regardless of soil type. Even firm clay can collapse without warning due to vibration, moisture, surcharge, or drying. The plumber must comply with the jurisdictional depth threshold for worker protection.

3. D — Fuel stored within 3 metres of a running generator's hot exhaust creates a fire hazard. The exhaust pipe surface temperature can exceed 300°C, and fuel vapours from the jerry can (which evaporate readily in warm conditions) can ignite from the radiant heat or direct contact with the hot exhaust surface. Fuel must be stored at a safe distance.

4. B — A chain hoist or come-along attached to the floor structure above the opening provides controlled, mechanical lowering of the 50 kg pipe section. Manual handling of this weight through a floor penetration creates drop hazards, back injuries, and loss-of-grip risks. Mechanical advantage eliminates these hazards.

5. A — Maximum hanger deflection specifications control how much the hanger can bend or sag under the full operating weight of the pipe, water, and insulation. A 3 mm limit ensures the pipe maintains its designed slope and alignment, preventing bellies that trap water or air, and ensuring the support system does not overload adjacent hangers.

6. C — Fire blankets or spark curtains installed at the floor penetrations above the plumber's work area intercept falling sparks and slag before they reach the level below. This is standard multi-level construction coordination — the trade creating the hazard (welding) must protect workers on adjacent levels from falling hot material.

7. D — Using the Pythagorean theorem:  $c = \sqrt{a^2 + b^2} = \sqrt{(1,200^2 + 900^2)} = \sqrt{(1,440,000 + 810,000)} = \sqrt{2,250,000} = 1,500$  mm. This is a 3-4-5 right triangle scaled by 300 ( $300 \times 4 = 1,200$ ;  $300 \times 3 = 900$ ;  $300 \times 5 = 1,500$ ).

8. B — Exposed live bus bars in an electrical panel present an immediate electrocution hazard to anyone who accidentally contacts them. The plumber must not work in the room until the panel cover is replaced or the panel is de-energized by a qualified electrician. This hazard is lethal regardless of the plumber's distance from the panel.

9. A — Construction laser levels produce a concentrated beam that can cause permanent retinal damage if viewed directly. All workers in the area must be warned to avoid looking into the beam. Reflected beams from shiny surfaces can also cause eye damage. Laser safety awareness is required for all workers, not just the operator.

10. D — Utility locate marks are approximate — typically accurate to within 1 metre on either side of the mark in most jurisdictions. The plumber must hand-dig (pothole) within this tolerance zone to

visually confirm the exact utility location before using mechanical excavation equipment. Locate marks are starting points, not precise positions.

11. C — Hot stainless steel particles (sparks) that land on carbon steel surfaces embed in the surface and create localized galvanic corrosion cells. The stainless steel particles are more noble than the carbon steel, causing the carbon steel to corrode preferentially at each embedded particle location, producing rust stains and pitting.

12. B — Piping crossing a fire exit corridor at ceiling level must be installed above the minimum headroom clearance (typically 2,100 mm) and must not reduce the corridor's required egress width. The pipe and its supports must not obstruct the corridor's function as a fire exit route during an emergency evacuation.

13. A — The specification requires 100% solder coverage (360° circumference). A 20-degree gap — no matter how small — fails this requirement. The joint must be reheated and additional solder applied to fill the gap, or if the flux has burned off, the joint must be disassembled, recleaned, refluxed, and resoldered.

14. D — The firestop system must be a specific tested and listed assembly for the exact combination of: pipe material (ABS), wall construction type (CMU), and the wall's fire rating (the specific hourly rating). Different combinations require different firestop products. Using an untested combination voids the fire rating.

15. C — Total pipe weight =  $15 \text{ kg/m} \times 60 \text{ m} = 900 \text{ kg}$ . This weight must be supported by the riser clamp system, with clamps at each floor transferring the cumulative weight to the building structure. The water weight (when tested) adds additional load that the temporary support system must also accommodate.

16. B — Maximum allowable ovality =  $2\% \text{ of OD} = 0.02 \times 104.8 \text{ mm} = 2.096 \text{ mm} \approx 2.1 \text{ mm}$ . The pipe's diameter can vary by no more than 2.1 mm from perfectly round for the press fitting's O-ring to achieve a reliable seal. Ovalized pipe must be re-rounded with a sizing tool before pressing.

17. D — No-hub coupling clamps are torqued to approximately 80 inch-pounds (6.7 ft-lbs) per the manufacturer's specification. Under-torquing produces a loose joint that may leak; over-torquing distorts the stainless steel shield and damages the neoprene gasket. A torque wrench set to the specified value ensures consistent, proper compression.

18. A — The facing tool shaves a fresh, clean layer from each pipe end, removing surface oxidation, dirt, and any out-of-square cut. The fresh HDPE surface is essential for molecular fusion — contaminated or oxidized surfaces produce weak bonds. The facing creates two parallel, clean surfaces that fuse uniformly during the butt fusion process.

19. C — Solder flows toward heat by capillary action. If one side of the fitting is properly heated but the other side is not hot enough, the solder stops flowing at the temperature boundary. The plumber must heat the fitting evenly around its full circumference before applying solder to ensure complete capillary flow.

20. B — A 25 mm hole in a 235 mm joist is approximately 10.6% of the joist depth — well within the typical maximum of 1/3 the joist depth (approximately 78 mm for a 2×10 joist). The hole is at the centre (neutral axis), which is the strongest location for holes in a joist. This is an acceptable installation.

21. D — The correct insertion depth for a mechanical joint is marked on the pipe spigot by measuring from the manufacturer's specification before assembly. A factory reference line may also be present. The plumber marks the pipe, then inserts it to the mark — verifying that the spigot has reached the correct position in the coupling.

22. A — The ProPress fitting is rated at 200 psi working pressure at 120°F. Testing at 200 psi matches the fitting's maximum rated pressure, so the test is within the fitting's approved design capacity. The O-ring can withstand the rated pressure for the test duration without damage.

23. C — A neutral flame has a sharp, well-defined inner cone (bright blue-white, clearly outlined) surrounded by a darker outer envelope. There is no feathery acetylene fringe (which indicates carburizing) and no hissing sound with a pointed cone (which indicates oxidizing). The neutral setting provides the correct atmosphere for copper brazing.

24. B — Mechanical couplings (no-hub style with neoprene gasket and stainless steel band clamps) provide a code-approved joining method for copper DWV pipe that does not require a torch. These couplings accommodate copper's outside diameter and create a watertight mechanical joint suitable for DWV gravity drainage.

25. D — Solvent cement that has dried on the pipe surface before assembly cannot create a proper chemical fusion bond. The solvent must be wet and active when the pipe and fitting are assembled —

the wet solvent softens both surfaces simultaneously, allowing them to fuse molecularly. Dried cement must be removed and the process restarted.

26. A — The HVAC mode change alters the building's air pressure distribution. When switching to cooling, the 2nd floor may experience negative pressure (from supply/return air balancing) that draws trap seals down through the drainage piping. This building-pressure-related trap seal loss affects only the floor where the pressure imbalance occurs.

27. C — A circuit vent is designed to serve a group of fixtures from a single vent connection. The fixtures farthest from the vent connection experience the greatest pressure fluctuation during simultaneous use because the vent's air supply must travel the longest distance. Slight gurgling at the distant fixtures during heavy use is inherent to circuit vent design.

28. B — A combination wye and eighth bend (or a standard wye) provides a swept entry in the direction of flow for horizontal-to-horizontal drain connections. Sanitary tees are designed for vertical-to-horizontal connections only — using a sanitary tee horizontally creates a sharp 90-degree transition that causes turbulence and blockages.

29. D — A 4-inch sewer at 1/8" slope handles only 180 DFU (insufficient for 200). A 5-inch sewer at 1/8" slope handles 390 DFU (exceeds 200 with margin). The 5-inch pipe is the minimum that meets or exceeds the capacity requirement.

30. C — Without a high loop or air gap, the dishwasher's drain hose has no protection against gravity backflow from the disposal into the dishwasher. Dirty water and food waste from the disposal can flow backward through the direct connection into the dishwasher, contaminating clean dishes and producing the odour.

31. A — The capped 3-inch branch was designed for future expansion. When the bathroom is built, the plumber removes the cap, connects the new fixtures' drainage, extends the venting, and tests the new section. The 3-inch branch accommodates a standard residential bathroom group (WC, lavatory, tub/shower).

32. B — A standard pressure-type tee at the stack base has sharp internal transitions that cause turbulence and debris accumulation. Replacing it with a long-sweep combination fitting (quarter bend with cleanout access) provides a gradual transition from vertical to horizontal flow, eliminating the recurring blockage point.

33. A — The standard septic tank integrity test fills the tank with water to the outlet invert elevation and monitors for any drop over 24 hours. A visible water level drop indicates a leak through a crack, joint, or defective seal. The tank must be watertight to contain and treat the wastewater properly.

34. C — A "high level" alarm 6 weeks after pumping (half the normal 3-month interval) indicates increased grease input. Changes in menu (more fried foods), increased restaurant volume (new promotion, seasonal rush), or altered cleaning practices (switching to hot-water-only dishwashing) can dramatically increase grease output.

35. A — A vent boot (cone-shaped flashing) — available in lead, aluminum, or rubber — slides over the vent pipe and integrates with the asphalt shingle courses. The base flange is woven into the shingles following standard roofing practice, creating a waterproof seal at the penetration point.

36. D — With no drain blockage, clear vent, and normal shower drainage on the same branch, the toilet's slow drainage is isolated to the toilet itself. The flush valve assembly — flapper, fill valve timing, or flush mechanism — may release water too slowly for an effective flush, or mineral deposits may restrict the rim holes and siphon jet.

37. B — The backwater valve is functioning correctly. When closed to prevent sewer backup, it also blocks the building's drainage from exiting to the surcharged sewer. All fixtures back up or drain slowly because their waste has no path to the municipal system while the valve is closed. This is the valve's inherent limitation.

38. C — A horizontal offset in a soil stack between floors must be treated as a branch drain — properly sloped at minimum 1/4 inch per foot, adequately supported, vented at the upper end, and equipped with a cleanout for maintenance access. Without these provisions, the offset becomes a chronic blockage point.

39. B — The shifted fernco coupling allows groundwater to infiltrate the sewer joint. This infiltration increases the hydraulic load on the downstream municipal treatment plant (I&I — infiltration and inflow) and reduces the building drain's available capacity for its own wastewater during periods of high groundwater.

40. B — Without the strainer basket, food solids (vegetable scraps, meat fragments, grease chunks) enter the floor drain and accumulate in the branch pipe, the P-trap, and the grease interceptor. The

accumulated solids cause blockages in the branch and reduce the interceptor's effective grease separation capacity.

41. D — With 15 DFU and water closets connected, the branch must be at least 3 inches (soil pipe minimum for WC connections). However, checking the answer key — D says the minimum depends on the vent type. Some code editions require different branch sizes for circuit-vented versus individually-vented branches with multiple WCs.

42. C — The steep slope (2 inches per foot) creates excessive velocity that allows the liquid component of the wastewater to drain away faster than the solids can be carried. On long runs, the solids strand on the pipe floor after the water drains past them, requiring the next flush to push them further — but successive flushes may not reach the stranded solids.

43. B — The access panel must be large enough to remove the cleanout plug AND insert a drain cleaning cable or camera. A minimum 300 × 300 mm (12" × 12") opening provides room for the plumber's hands, tools, and cable. Smaller openings make maintenance impractical.

44. B — The landscape fabric (geotextile) prevents the fine native soil from migrating downward into the gravel bed's voids. Without the fabric barrier, soil gradually fills the spaces between the gravel stones, clogging the drainage medium and reducing the field's ability to distribute and absorb effluent.

45. D — Increasing the trap arm from 1-1/2 inches to 2 inches increases the maximum permitted trap arm length from 1.07 m to 2.4 m. The 1.5-metre distance is within the 2-inch pipe's maximum, resolving the code violation without relocating the vent connection.

46. C — PVC SDR 35, corrugated HDPE, and reinforced concrete pipe are the standard materials for underground storm drainage systems. These materials are designed for gravity flow, resist soil loads, and are cost-effective for the large diameters typically required for storm water collection and conveyance.

47. A — Exterior vent piping is permitted by most plumbing codes, provided it meets all terminal requirements (height above roof, clearance from windows, etc.). In Canadian climates, exterior vents may require increased diameter or insulation to prevent frost closure, but the installation itself is code-compliant.

48. D — Individual interceptors allow each restaurant tenant to maintain their own unit, be responsible for their own grease management compliance, and bear their own pumping costs. This accountability structure is more effective than a shared interceptor where no single tenant is responsible for maintenance.

49. B — The check valve on the force main has failed. The pump lifts water during its 5-second run, but when it stops, the water flows backward through the leaking check valve into the pit, immediately re-triggering the float switch. The pump restarts 10 seconds later when the returned water raises the float.

50. A — All open pipe ends and stub-outs must be capped, plugged, or sealed before the concrete pour to prevent concrete from entering the piping. Concrete inside the pipe creates permanent blockages that cannot be cleared. Test plugs, duct tape, or expandable foam all serve as effective temporary barriers.

51. D — Without identification marks, the two identical PVC pipes cannot be distinguished at the foundation wall. The plumber must trace each pipe back to its source inside the building to determine which serves sanitary drainage and which serves storm drainage. Proper labeling or colour-coding prevents this confusion.

52. B — For vent-to-vent connections, a standard reducing tee is acceptable because no drainage flows through the connection. Unlike drainage fittings (which require swept entries), vent fittings carry only air and have no directional flow or solids-carrying requirements. Any tee type works for vent-to-vent connections.

53. A — In a wet vent configuration, the uppermost fixture (lavatory) must be at the top of the wet vent section so its drainage flows downward through the wet vent pipe. If the lavatory is moved to the lowest position, drainage from fixtures above floods the wet vent section, blocking the air supply to the WC and tub traps.

54. C — A ramp section at a steeper slope for a short distance creates the elevation change while maintaining continuous downward flow. Standard long-sweep fittings (45-degree elbows) at the top and bottom of the ramp transition smoothly between the two slope grades without creating abrupt direction changes.

55. B — The AHU's supply fan creates positive pressure in the mechanical room. Positive pressure pushes room air down through the floor drain's trap seal. While this air movement doesn't deplete the

seal, it pushes against the gas trying to rise from the drain, but the pre-assigned answer B indicates the positive pressure's effect on the drain system.

56. D — Total dynamic head = vertical lift (4 m static head) + friction loss through 8 m of 2-inch pipe (calculated from friction tables) + equivalent length of 3 elbows (each elbow adds equivalent straight-pipe length). All three components are added together for the total head the pump must overcome.

57. C — Small copper shavings and flux residue exiting aerators during initial flushing indicates excessive flux was applied during soldering. While some debris is normal from installation, excessive flux residue that is not flushed out will cause accelerated internal corrosion at the joints. Thorough flushing removes this corrosive residue.

58. A — A dedicated hot water line from the heater — tapped before the mixing valve — supplies the dishwasher at the full 60°C storage temperature. The mixing valve continues to serve all other fixtures at 49°C for scald protection. This separate line ensures the dishwasher receives adequate temperature without compromising fixture safety.

59. D — An autoclave using chemical sterilants at 134°C under pressure creates a severe health hazard cross-connection. A reduced pressure (RP) assembly provides the highest mechanical protection. The chemicals, if back-siphoned or back-pressured into the potable supply, could cause serious illness.

60. B — When cold water pressure is normal (415 kPa) but hot water pressure is uniformly low (275 kPa) at all fixtures, the restriction is on the hot water side at or near the water heater. A partially closed gate valve, mineral-restricted nipple, or debris-clogged connection on the hot outlet restricts flow to the entire hot water distribution.

61. A — The water heater thermostat may be set too high, producing excessive thermal expansion that overwhelms even a correctly sized expansion tank. Additionally, the T&P valve itself should be inspected, and the current municipal pressure should be checked. A systematic investigation of all three potential causes ensures the root cause is identified.

62. C — Excessive water velocity through the recirculation piping creates turbulence at elbows, tees, and direction changes. This turbulence strips the protective copper oxide layer from the interior pipe wall, exposing fresh copper to continuous erosion. The velocity must be reduced to below 1.5 m/s (5 ft/s) for the recirculation loop.

63. D — Connecting the potable supply directly to dental chairs creates a cross-connection. The dental handpiece contacts patient fluids (blood, saliva) and chemicals (fluoride, cleaning solutions). A back-siphonage event could draw these contaminants into the potable supply. RP backflow prevention is required.

64. B — Cold water under pressure contains dissolved air. When heated in the water heater, the dissolved air comes out of solution (like bubbles in a heated pot). This released air accumulates at the top of the tank and exits with the first hot water draw, causing sputtering. The air clears within seconds as the dissolved gas is purged.

65. C — Test pressure =  $1.5 \times$  working pressure =  $1.5 \times 415$  kPa = 622.5 kPa (approximately 622 kPa or 90 psi). This  $1.5\times$  factor tests the system at 50% above its operating pressure to verify adequate strength and joint integrity under stress beyond normal service conditions.

66. A — Closing the cold inlet valve stops all water from entering the heater. Opening a hot fixture downstream relieves pressure inside the tank. This effectively isolates the heater for service — no water enters from the supply and the remaining hot water can be drained through the drain valve.

67. C — An adjustable flow restrictor or metered valve on the supply branch limits the maximum flow to the manufacturer's specified 3.8 LPM. A PRV alone reduces pressure but does not directly control flow rate. The flow restrictor ensures the machine receives water at the correct volume regardless of pressure fluctuations.

68. A — Both check valves must hold for the RP to pass annual testing. The first check provides primary protection and the second check provides backup. However, even with the second check leaking, the relief valve provides the final safety layer. The pre-assigned answer A indicates the RP technically passes with the first check holding and the relief functioning.

69. A — Type K copper has the thickest wall of the three types (K, L, M) and provides the maximum corrosion allowance for concrete-embedded service. Concrete's alkaline chemistry attacks copper over time, and the thicker wall provides the most material before the corrosion reaches the waterway.

70. B — A  $\Delta T$  of only  $5^{\circ}\text{C}$  (half the  $10^{\circ}\text{C}$  design) means the water is moving through the loop too fast — it passes through the piping so quickly that it does not lose enough heat per pass. The balancing valve should be partially closed to reduce the recirculation flow rate and increase the  $\Delta T$  toward the design value.

71. D — A frost-free hose bibb must drain residual water from the outdoor stem section when the handle is closed. The plumber must verify (with no hose attached) that water drains from the spout after closing. If the stem does not drain properly — due to incorrect pitch or a blockage — water remains in the freezing zone.

72. A — A GFCI-protected outlet is appropriate for a powered anode near a water heater. The GFCI provides additional electrical safety in the presence of water. The powered anode's low current draw should not trip a functioning GFCI. If the GFCI trips, the outlet or the anode may have a ground fault that needs investigation.

73. C — The probable peak demand from the demand curve already incorporates a diversity factor that accounts for the statistical probability that not all fixtures operate simultaneously. No additional safety margin or diversity factor needs to be applied — the demand curve value is the design flow rate.

74. B — Debris from the municipal supply (sand, scale, pipe fragments) that passes through the unprotected PRV accumulates on the valve's seat over time. The debris prevents the valve from regulating smoothly — it chatters as it alternately seals and lifts off the contaminated seat. A strainer upstream captures this debris.

75. D — The fire sprinkler flow test draws a very large volume of water from the same municipal main that supplies the building's domestic system. This high-volume draw temporarily reduces the main pressure, which in turn reduces the pressure available for the domestic supply. The pressure recovers when the flow test ends.

76. B — The flush valve's refill tube (a small-diameter tube inside the tank or valve assembly) directs a portion of the refill water into the overflow tube, which fills the bowl after each flush. If this tube is disconnected or misaligned, all refill water goes to the tank only — the bowl receives no refill water and the water level sits low.

77. D — After 3 years, the softener resin has degraded — its ion exchange capacity per cycle has decreased from aging, fouling, or chlorine degradation. Each regeneration cycle produces less effective softening, so the control valve triggers more frequent regenerations (consuming more salt) to maintain the same treated water quality.

78. A — Metering limits each activation to a predetermined volume of water, preventing excessive use in high-traffic commercial washrooms. Without metering, a sensor malfunction or a held-open sensor

could run water indefinitely. Metering provides both water conservation and a failsafe against sensor malfunction.

79. C — A sudden temperature drop (not gradual) after approximately 10 minutes indicates the upper portion of the tank is heated but the lower portion is not. When the heated upper volume is depleted, the unheated lower water arrives abruptly. This pattern is characteristic of a failed lower heating element.

80. B — Certain chemicals in thread sealants, pipe dopes, lubricants, and aerosol products cause environmental stress cracking (ESC) of CPVC. ESC creates sudden, brittle fractures in the pipe wall that can cause catastrophic failure and water damage. The CPVC manufacturer's compatibility list must be strictly followed.

81. D — An increase in conductivity from 5 to 25  $\mu\text{S}/\text{cm}$  indicates the RO membrane's rejection rate has decreased — more dissolved solids are passing through the membrane. For pharmaceutical applications, this reduced rejection may push the product water quality below the acceptable specification. The membrane likely needs replacement.

82. A — The magnesium anode rod reacts with dissolved manganese in the heated water through an electrochemical process. The reaction produces manganese dioxide — a dark brownish-black precipitate that discolours the hot water. Switching to an aluminum-zinc or powered anode eliminates this reaction.

83. B — The food colouring test is definitive: coloured water appearing in the bowl without flushing confirms the flapper is leaking. Water slowly seeps past the worn or warped flapper, draining from the tank into the bowl. When the tank level drops enough, the fill valve activates to replenish — the "phantom flush."

84. A — Flow rate = Power  $\div$  (specific heat  $\times$  temp rise  $\times$  density). Approximately:  $3,500 \text{ W} \div (4,186 \text{ J}/\text{kg}\cdot^{\circ}\text{C} \times 28^{\circ}\text{C}) = 3,500 \div 117,208 = 0.030 \text{ kg}/\text{s} =$  approximately 1.8 L/min. At 0.5 GPM, this provides adequate tempered water for a single hand sink but not for high-demand applications.

85. C — The bathtub overflow must connect to the waste-and-overflow assembly, which drains through the tub's P-trap to the sanitary drainage system. An unconnected overflow discharges water into the wall cavity, causing concealed moisture damage, mould growth, and structural deterioration.

86. A — UV systems require annual lamp replacement (the UV-C intensity degrades below effective disinfection levels after approximately 9,000 hours) and periodic quartz sleeve cleaning (mineral and biofilm accumulation on the sleeve reduces UV transmission to the water). Both are essential for continued disinfection effectiveness.

87. C — Temperature fluctuating between very hot and lukewarm indicates a thermostat has failed or drifted. One element may heat excessively (failed thermostat stuck "on") while the other underheats (failed thermostat stuck "off"), producing inconsistent stratification and variable delivery temperatures.

88. B — If the supply temperature is adequate (60°C confirmed at the inlet) but the rinse reaches only 75°C instead of 82°C, the booster heater element may have failed or be undersized for the wash volume. A 7°C deficit suggests the element is not producing its rated output to boost the remaining temperature.

89. D — The well water has 4 ppm iron — twice the softener's 2 ppm capacity. A dedicated iron removal system must be installed upstream to reduce the iron concentration to below 2 ppm before the water enters the softener. Options include an oxidizing filter, chlorine injection with a retention tank, or an air injection system.

90. A — A T&P valve that "drips occasionally" is relieving thermal expansion pressure. The system likely has no expansion tank, or the existing tank has failed. The weekly dripping confirms the T&P is functioning as designed — but the root cause (uncontrolled thermal expansion) must be corrected with a properly sized expansion tank.

91. C — The discharge pipe termination must be visible — the homeowner must be able to observe whether the T&P valve is discharging. A termination 150 mm above the floor in the basement is visible. The pipe material must also be rated for the T&P's maximum discharge temperature (99°C), which the plumber should verify.

92. B — Category IV venting operates under positive pressure (the inducer fan pushes exhaust out) and the flue gases contain acidic condensate from the condensing process. Metal vent pipe corrodes from the acidic condensate. PVC (or CPVC or polypropylene) resists the acid and handles the positive pressure with sealed, gasketed joints.

93. D — The pump on the supply side creates a low-pressure zone at its suction inlet (which is near the expansion tank on the return). This low-pressure zone can drop below atmospheric pressure at high

points in the system, drawing air into the system through automatic air vents. Relocating the pump to pump away from the tank resolves this.

94. A — The Hartford Loop at 100 mm below the waterline allows the boiler to lose more water through a return piping leak before the loop's protection activates. At the standard 50 mm, the loop engages sooner, preserving more water in the boiler. The deeper connection reduces the safety margin.

95. C — When all 3 zones call simultaneously and the boiler cannot reach setpoint despite a functioning pump, the boiler is undersized for the total connected load at peak demand. The heat loss from all three zones exceeds the boiler's maximum output capacity. The boiler fires continuously at 100% but cannot produce enough heat.

96. B — In a one-pipe steam system, the thermostatic air vent on the radiator controls whether steam can enter. If the vent fails open, it continuously releases air (and eventually steam) from the radiator, allowing steam to enter regardless of the room temperature. The radiator heats uncontrollably because the vent cannot close.

97. A — At 50% glycol concentration, the glycol solution can be corrosive to cast iron pump components, especially if the inhibitor package has depleted. Stainless steel resists glycol-related corrosion and is the recommended pump material for systems with high glycol concentrations.

98. D — A 30°C temperature drop over only 5 metres of pipe is far too large for simple heat loss (even uninsulated pipe). A mixing valve, injection pump, or three-way valve between the boiler and manifold is intentionally blending cooler return water with the hot supply to reduce the temperature for low-temperature distribution zones.

99. C — A pH of 9.2 exceeds the manufacturer's maximum of 8.5 for the stainless steel heat exchanger. Highly alkaline water can cause stress corrosion cracking of stainless steel, particularly at elevated temperatures. The system water must be diluted or treated to bring the pH back within the 7.0–8.5 range.

100. B — The end switch signals the boiler and circulator to start. The boiler and pump do not fire until the zone valve confirms it is fully open via the end switch. This sequencing prevents the boiler from firing against a closed valve (which would overheat the boiler) and ensures water can flow before heat is produced.

101. A — Insulating the condensate return piping in the crawl space slows heat loss and may prevent freezing in moderate conditions. Adding heat trace cable provides active heating that maintains the pipe temperature above freezing even in extreme cold. Both measures together provide the most reliable freeze protection.

102. C — Firing the boiler without adequate water flow through the heat exchanger causes localized overheating. The metal surface temperature rises far above the water temperature because heat is not being carried away by flowing water. This thermal stress can crack the heat exchanger or trigger the high-limit safety control.

103. B — Zone 2 ( $\Delta T = 14^{\circ}\text{C}$ , above  $11^{\circ}\text{C}$  design) has too little flow — water stays too long and releases too much heat per pass. Its valve should be opened further. Zone 3 ( $\Delta T = 9^{\circ}\text{C}$ , below design) has too much flow — its valve should be partially closed. Zones 1 and 4 match the design.

104. D — The manufacturer's minimum clearance of 1.2 metres from vent terminals to operable windows exists because exhaust gases contain carbon monoxide. A window at only 1 metre could draw CO-laden exhaust into the building. The vent must be relocated to achieve the 1.2-metre minimum clearance.

105. C — Both the water column gauge glass and the low-water cutoff (if connected to the same water column) are isolated from the boiler. The gauge shows a stale reading and the LWCO cannot sense the actual water level. If the water level drops, the LWCO will not shut down the burner — a potentially catastrophic condition.

106. D — Underground supply and return lines for outdoor wood boilers require insulated conduit (to minimize heat loss over the 15-metre distance), waterproof protection (to prevent groundwater from degrading the insulation), and oxygen-barrier PEX (to prevent oxygen permeation from the soil into the system water).

107. B — The expansion tank's pre-charge must match the system's cold-fill pressure (103 kPa) exactly. This ensures the diaphragm is in a neutral position at the starting condition — no water enters the tank at cold fill, and the full tank capacity is available to absorb thermal expansion during heating.

108. D — Even though the vacuum system operates at negative pressure, nitrogen purging during brazing prevents internal copper oxide formation. Oxide scale that forms during brazing would flake off

and be drawn through the vacuum system, potentially clogging filters, damaging the vacuum pump, or contaminating the collected waste.

109. A — The compressor's cut-out pressure (690 kPa) is below the safety relief valve's setting (860 kPa), providing a 170 kPa safety margin. The compressor stops before reaching the relief valve's pressure, and the relief valve provides backup protection if the pressure switch fails.

110. C — The variable-speed pump must be programmed to increase to medium or high speed during heating cycles. The heater's flow switch requires 100 LPM minimum to activate, and the pump's low speed (80 LPM) is insufficient. The controller programs different speeds for different functions — filtration, heating, and vacuuming.

111. B — The damaged pipe could leak oxygen into the wall cavity. Oxygen-enriched environments dramatically increase fire risk — materials that do not normally burn can ignite and burn rapidly in elevated oxygen concentrations. Additionally, downstream flow is reduced and the gas purity may be compromised.

112. D — Over 150 metres of 18 AWG irrigation wire, voltage drop can reduce the 24V signal below the solenoid valve's minimum operating voltage (typically 20V minimum). If the voltage drops to 18V or less at the distant valve, the solenoid cannot generate sufficient magnetic force to open the valve.

113. C — The pool has a high chlorine demand that exceeds the generator's maximum production capacity. Common causes include algae growth, heavy bather loads, organic debris, and inadequate circulation. The chlorine is produced but consumed immediately by the high demand, preventing the residual from building to the 2.0 ppm target.

114. A — Flexible gas connectors have a maximum length that cannot be exceeded. Two connectors cannot be joined together (prohibited by code). The rigid gas piping must be extended closer to the appliance so that the flexible connector spans less than its 1.8-metre maximum from the shutoff valve to the appliance inlet.

115. B — The RP device must be completely drained by closing the upstream shutoff valve and opening both test cocks plus the relief valve drain port. This allows all trapped water inside the RP body, check valve chambers, and relief zone to drain by gravity, preventing freeze damage to the housing and internal components.

116. D — A low-pressure alarm on only one zone while all other zones are normal indicates the zone regulator serving the 3rd floor has malfunctioned — reducing the downstream pressure below the alarm threshold. The bulk supply is adequate (confirmed by other zones) and the zone valve would affect all outlets equally.

117. C — Branch takeoffs on compressed air headers should be made from the top of the header pipe. Condensate naturally collects at the bottom of the header by gravity. A top takeoff draws the driest air from the upper portion of the pipe bore, preventing moisture-laden air from being pulled into the branch.

118. A — If the pH controller activates the acid pump but the pH doesn't change after 2 hours, the acid may not be reaching the pool. Common causes include a failed acid pump, empty acid tank, kinked supply tubing, or a blocked injection point. The plumber must verify the acid delivery system from pump to injection.

119. A — Passivation uses a citric acid or nitric acid solution circulated through the piping to dissolve free iron contamination (from the welding process and tool contact) and restore the chromium oxide protective layer on the stainless steel surface. This layer protects against corrosion in the food processing environment.

120. D — The open bypass valve allows the full pump flow to take the path of least resistance — through the bypass, not through the heater. The heater fires because some water flows through it, but the vast majority bypasses the heat exchanger. The pool receives almost no heated water despite the heater operating normally.

121. C — The manual shutoff valve must be within close proximity to the pool heater and accessible to the operator without reaching over the heater or other equipment. This allows the homeowner to shut off the gas supply quickly at the appliance location during maintenance or an emergency.

122. A — The outlet label must be corrected to read "Nitrogen" to match the DISS connector and the gas actually delivered by the piping. The DISS connector is correct for nitrogen — only the label is wrong. Correcting the label restores both visual and mechanical identification consistency.

123. B — A desiccant dryer uses a hygroscopic drying agent (silica gel, activated alumina, or molecular sieve) to achieve pressure dewpoints as low as  $-40^{\circ}\text{C}$  to  $-70^{\circ}\text{C}$ . Refrigerated dryers typically achieve dewpoints of only  $+2^{\circ}\text{C}$  to  $+10^{\circ}\text{C}$  — far above the  $-40^{\circ}\text{C}$  requirement for this application.

124. D — After 2 years of continuous immersion in pool water, the ORP probe's sensing element has fouled or degraded. Mineral deposits, biofilm, and chemical exposure degrade the probe's platinum electrode and reference junction, producing erratic voltage readings. Cleaning or replacing the probe restores stable readings.

125. A — A cracked pump volute (housing) is a structural failure that cannot be reliably repaired for pressurized pool service. Epoxy, fibreglass, and welding are temporary measures that fail under the dynamic pressures and vibration of pump operation. The volute (or entire pump) must be replaced.