PRACTICE EXAM 2: WATER TREATMENT OPERATOR CLASS I SIMULATION (100 QUESTIONS)

1. A jar test shows the following settled water turbidity results for six alum doses: 10 mg/L = 8.2 NTU, 20 mg/L = 4.1 NTU, 30 mg/L = 1.2 NTU, 40 mg/L = 0.9 NTU, 50 mg/L = 0.8 NTU, 60 mg/L = 1.1 NTU. Which dose should the operator select?

A. 60 mg/L because higher doses always produce safer treated water quality

B. 40 mg/L because it achieves near-minimum turbidity at the lowest effective dose

C. 10 mg/L because it uses the least chemical and keeps operating costs lowest

D. 50 mg/L because it produces the absolute lowest turbidity in the test series

2. A water treatment plant's SCADA system displays an alarm indicating that clearwell level has dropped to 6 feet, well below the normal operating range of 10 to 14 feet. The high-service pumps are running at full speed. The most appropriate immediate response is to:

A. Increase the coagulant dose to speed up the treatment process and raise production

B. Shut down all high-service pumps immediately to stop the clearwell from draining

C. Open the raw water bypass valve to supplement the clearwell with untreated water

D. Reduce high-service pump output to match or fall below current plant production rate

3. Which of the following water quality parameters serves as the primary surrogate indicator for pathogen removal effectiveness in a surface water treatment plant?

A. Free chlorine residual measured at the plant effluent discharge point

B. Alkalinity measured in the raw water before coagulant chemical addition

C. Filtered water turbidity measured on individual filter effluent lines

D. Total dissolved solids measured in the finished water entering distribution

4. A treatment plant operator is required to calculate the detention time of a rectangular sedimentation basin. The basin is 120 feet long, 30 feet wide, and has a water depth of 12 feet. The flow rate through the basin is 800 gpm. What is the detention time in hours? (1 ft^3 = 7.48 gallons)

A. 4.5 hours

B. 6.2 hours

C. 2.3 hours

D. 8.1 hours

5. Hydrogen sulfide gas in a confined space at a water treatment plant is dangerous primarily because it:

A. Is toxic, flammable, and can cause rapid loss of consciousness at high concentrations

B. Displaces carbon dioxide, creating an oxygen-enriched atmosphere that promotes fire

C. Reacts with chlorine residual on skin and clothing to produce hydrochloric acid burns

D. Creates a slippery condensation on walking surfaces that increases the risk of falls

6. An operator notices that individual filter effluent turbidity on Filter 4 is consistently 0.18 NTU while the other three filters are producing 0.04 to 0.06 NTU. All filters receive the same settled water. The most likely cause specific to Filter 4 is:

A. The raw water source has deteriorated, affecting all filters throughout the plant

B. The coagulant dose is insufficient, producing poor floc for all filter influent streams

C. The plant flow rate is too high, hydraulically overloading all filters simultaneously

D. A media, underdrain, or backwash problem specific to Filter 4 requires investigation

7. Which of the following correctly describes the relationship between water temperature and the settling velocity of floc particles in a sedimentation basin?

A. Colder water decreases viscosity, allowing floc particles to settle more rapidly

B. Colder water increases viscosity, causing floc particles to settle more slowly

C. Temperature has no measurable effect on the settling velocity of floc particles

D. Colder water increases particle density, causing all particles to settle more rapidly

8. Under the Lead and Copper Rule, water systems that exceed the lead action level must implement which primary treatment strategy?

A. Install activated carbon filters at each consumer tap to adsorb dissolved lead

B. Add additional chlorine at the plant to oxidize lead into a filterable precipitate

C. Implement corrosion control treatment by adjusting pH and alkalinity of the finished water

D. Increase the coagulant dose to precipitate and remove lead during sedimentation

9. A water treatment plant uses chlorine gas for disinfection. During a routine inspection of the chlorine room, the operator detects the smell of chlorine. The chlorine leak detector has not alarmed. The operator should:

A. Assume the odor is normal residual chlorine and continue with the routine inspection

B. Increase the chlorine room ventilation fan speed and continue working in the room

C. Reset the chlorine leak detector to zero and recalibrate it before investigating further

D. Leave the room immediately, verify the leak detector is functioning, and investigate from outside

10. The term "nephelometric" in nephelometric turbidity units (NTU) refers to the measurement of light scattered at what angle relative to the incident light beam?

A. 90 degrees, which provides the most consistent measurement across particle sizes

B. 180 degrees, measuring light transmitted directly through the sample without scattering

C. 45 degrees, measuring forward-scattered light from large particles in suspension

D. 360 degrees, measuring total light scattered in all directions simultaneously

11. A water system using chloramines for secondary disinfection experiences declining chloramine residuals at several distribution system monitoring points over a period of weeks. Simultaneously, nitrite levels at those locations have increased. The most likely cause is:

A. The chloramine dose at the plant is too high, causing excessive residual breakdown

B. The ammonia-to-chlorine ratio has shifted, producing excess trichloramine in the system

C. Nitrifying bacteria in the distribution system are converting ammonia to nitrite and consuming chloramine

D. The source water bromide concentration has increased, reacting with and destroying the chloramine

12. A treatment plant feeds alum at 35 mg/L to water with a natural alkalinity of 40 mg/L as $CaCO_3$. If alum consumes approximately 0.5 mg/L of alkalinity for each 1.0 mg/L of alum added, the remaining alkalinity after coagulation is approximately:

A. 40 mg/L as $CaCO_3$ because alum does not consume alkalinity during hydrolysis

B. 22.5 mg/L as $CaCO_3$, which may be insufficient for stable pH during coagulation

C. 5.0 mg/L as $CaCO_3$, indicating a critical deficiency requiring immediate lime addition

D. 57.5 mg/L as $CaCO_3$ because alum generates alkalinity as a byproduct of the reaction

13. An operator calibrating an online chlorine analyzer collects a grab sample from the analyzer's sample line and measures 1.2 mg/L by DPD. The analyzer displays 0.9 mg/L. The operator should:

A. Record both values and average them for the official compliance reading

B. Adjust the analyzer to read 1.2 mg/L to match the laboratory DPD reference measurement

C. Replace the analyzer immediately because any discrepancy indicates permanent failure

D. Adjust the DPD procedure to produce readings that match the online analyzer display

14. Dissolved air flotation (DAF) differs from conventional sedimentation because it removes particles by:

A. Settling heavy floc to the bottom of the basin under gravitational force

B. Passing water through a granular media bed that captures particles by attachment

C. Forcing floc through a membrane that physically excludes particles larger than its pore size

D. Attaching microscopic air bubbles to floc particles and floating them to the surface for removal

15. The purpose of conducting a membrane integrity test on a microfiltration or ultrafiltration system is to:

A. Determine the optimal operating pressure for maximum permeate production rate

B. Measure the total dissolved solids rejection percentage of the membrane element

C. Detect any breaches in the membrane that could allow pathogens to bypass the barrier

D. Verify the chemical cleaning solution concentration before circulating it through the system

16. A treatment plant operator observes that the rapid mix impeller is turning but the chemical injection point is located in a low-turbulence zone several feet upstream of the impeller. This configuration is problematic because:

A. The coagulant will overdose the water by reacting with the pipe wall before reaching the mixer

B. The coagulant will not be dispersed uniformly because it is injected outside the high-turbulence zone

C. The impeller will be damaged by the chemical reaction occurring at the injection point

D. The water will be over-mixed before the coagulant is added, preventing proper floc formation

17. Which of the following EPA drinking water rules specifically addresses the balance between adequate disinfection and disinfection byproduct formation?

A. The Surface Water Treatment Rule, which requires filtration and CT compliance

B. The Revised Total Coliform Rule, which requires assessment after positive samples

C. The Lead and Copper Rule, which requires corrosion control treatment implementation

D. The Stage 2 Disinfectants and Disinfection Byproducts Rule, which sets LRAA-based MCLs for THMs and HAAs

18. An operator measures the hardness of a water sample at 180 mg/L as $CaCO_3$. This water would be classified as:

A. Hard, falling within the 150–300 mg/L range on the standard hardness classification scale

B. Moderately hard, falling within the 75–150 mg/L range on the classification scale

C. Soft, falling within the 0–75 mg/L range on the standard hardness classification scale

D. Very hard, exceeding the 300 mg/L threshold on the standard hardness classification

19. A vertical turbine pump installed in a deep well is vibrating excessively and producing reduced flow. A likely cause is:

A. The impeller vanes have been coated with a biological growth that increases efficiency

B. The discharge check valve is stuck in the fully open position during pump operation

C. The pump column shaft is misaligned or a line shaft bearing has failed below ground level

D. The motor is running too slowly because the electrical supply voltage is above rated value

20. The filter-to-waste procedure is used after backwash primarily to:

A. Recover and recycle the backwash water directly to the clearwell for distribution

B. Divert the initial high-turbidity filter effluent during the ripening period away from the clearwell

C. Test the filter media integrity by observing the clarity of the waste water during the first minutes

D. Flush residual backwash chemicals from the filter bed before returning it to full service

21. A treatment plant's monthly operating report shows that the combined filter effluent turbidity exceeded 0.3 NTU in 8% of all 15-minute readings during the month. Has a turbidity violation occurred?

A. Yes, because the turbidity standard requires $\leq$ 0.3 NTU in at least 95% of readings and 92% compliance falls below that threshold

B. No, because exceeding 0.3 NTU becomes a violation only if the reading also exceeds 1.0 NTU

C. No, because the standard allows up to 10% of readings to exceed 0.3 NTU each month

D. Yes, but only if the same filter caused all of the exceedances during the reporting period

22. An operator is performing preventive maintenance on a chemical metering pump. Which of the following tasks would NOT typically be included in a routine PM procedure for this equipment?

A. Inspecting the diaphragm for cracks, wear, and chemical degradation

B. Checking suction and discharge check valves for proper seating and operation

C. Verifying the calibration by measuring output against a calibration column

D. Replacing the pump motor windings to prevent insulation breakdown from chemical exposure

23. The flow through a treatment plant suddenly increases from 3.0 MGD to 4.5 MGD due to a peak demand event. If the coagulant feed pump is not adjusted, the effective coagulant dose will:

A. Remain the same because the pump delivers the same concentration regardless of flow

B. Decrease because the same amount of chemical is now diluted into a larger volume of water

C. Increase because higher flow creates more turbulence that activates additional coagulant

D. Double because the flow increase is proportional to the plant's maximum treatment capacity

24. A water system serves 50,000 people. Under the Revised Total Coliform Rule, the minimum number of routine bacteriological samples that must be collected each month from the distribution system is closest to:

A. 5 samples per month

B. 20 samples per month

C. 60 samples per month

D. 120 samples per month

25. A plant treats 2.0 MGD and needs to maintain a chlorine dose of 2.0 mg/L. The plant uses 12% sodium hypochlorite solution. How many pounds per day of chlorine (as Cl_2 equivalent) must be fed?

A. 33.4 lb/day of chlorine equivalent

B. 66.8 lb/day of chlorine equivalent

C. 16.7 lb/day of chlorine equivalent

D. 100.1 lb/day of chlorine equivalent

26. During a jar test, an operator observes that all six jars produce large, visible floc that settles rapidly, but the settled water in all jars remains slightly hazy with a turbidity of 3.5 to 4.0 NTU. The most likely explanation is:

A. The coagulant dose is too low in all jars, leaving most particles undestabilized

B. The raw water pH is outside the effective coagulation range for the coagulant being tested

C. The rapid mix speed was too high, breaking the floc before it could reach settleable size

D. The settling time was too long, allowing settled floc to resuspend from the jar bottoms

27. A well pump's specific capacity has declined from 8.0 gpm/ft to 5.2 gpm/ft over the past three years while the pumping rate has remained constant. This decline most likely indicates:

A. The aquifer's water quality has improved, requiring less drawdown to produce the same flow

B. The static water level has risen due to above-average precipitation and recharge conditions

C. The pump is operating more efficiently, requiring less drawdown to deliver the same flow rate

D. The well screen is becoming clogged or the aquifer near the well is losing its ability to transmit water

28. Which of the following describes the purpose of a pulsation dampener installed on the discharge line of a positive displacement chemical metering pump?

A. To prevent chemical from flowing backward through the pump during shutdown periods

B. To measure and record the volume of chemical delivered by the pump over time periods

C. To smooth the flow by absorbing the pressure pulses created by each pump stroke

D. To filter out particulates from the chemical solution before it reaches the injection point

29. A treatment plant operator receives laboratory results showing that the finished water fluoride level is 0.4 mg/L. The plant's target fluoride concentration for community water fluoridation is 0.7 mg/L. The operator should:

A. Increase the fluoride chemical feed rate to bring the finished water closer to the 0.7 mg/L target

B. Decrease the fluoride feed rate because 0.4 mg/L already exceeds the maximum safe concentration

C. Discontinue fluoride addition entirely because adjustments could cause an MCL exceedance

D. Take no action because fluoride levels naturally fluctuate and will return to target without adjustment

30. An operator is required to collect a sample for volatile organic compound (VOC) analysis. Which container and collection technique is required?

A. Glass vials with no headspace, filled carefully to exclude air bubbles from the container

B. Sterile plastic bottles pre-loaded with sodium thiosulfate for chemical preservation

C. Large polyethylene containers with at least 50% headspace for gas exchange during transport

D. Acid-washed amber glass bottles filled to half capacity and sealed with parafilm

31. Which of the following contaminants is regulated through action levels at consumer taps rather than through MCLs at the treatment plant?

A. Arsenic, based on its carcinogenic effects from geological groundwater contamination

B. Nitrate, based on its acute health risk to infants from agricultural contamination sources

C. Total trihalomethanes, based on chronic health effects from disinfection byproduct exposure

D. Lead, based on its leaching from distribution system piping and household plumbing materials

32. An operator observes that the sludge blanket in a sedimentation basin has risen to within two feet of the effluent weirs. The appropriate response is to:

A. Increase the coagulant dose to produce heavier floc that settles to the basin floor faster

B. Reduce the plant flow rate to decrease the hydraulic loading on the sedimentation basins

C. Increase sludge withdrawal immediately to lower the blanket before it reaches the weirs

D. Add polymer to the basin influent to break up the sludge blanket and redistribute it evenly

33. A surface water treatment plant draws from a reservoir that experiences algae blooms each August and September. Which of the following treatment challenges is most directly associated with these blooms?

A. Taste and odor compounds (geosmin and MIB) that cause consumer complaints about earthy or musty-smelling water

B. Elevated lead and copper levels in the distribution system caused by algae-produced acids

C. Increased fluoride demand requiring higher fluoride feed rates during bloom periods

D. Reduced alkalinity caused by algae consuming bicarbonate ions from the reservoir water

34. During a routine inspection, an operator finds that the safety relief valve on the air compressor receiver tank is leaking continuously even though the tank pressure is below the rated setpoint. The operator should:

A. Continue operating the compressor normally until the next scheduled maintenance period

B. Tag the valve for replacement, have it repaired or replaced before returning the system to normal service

C. Tighten the valve seat to stop the leak and verify the tank pressure is within the normal range

D. Increase the compressor's cut-out pressure to ensure the relief valve stops activating prematurely

35. The GT value used to design flocculation basins represents the product of:

A. Gravitational force multiplied by the total basin volume in cubic feet

B. Gross turbidity of the raw water multiplied by the treatment efficiency percentage

C. Grain size of the filter media multiplied by the water temperature in degrees Celsius

D. Velocity gradient (G, mixing intensity) multiplied by the hydraulic detention time (T)

36. An operator receives a total coliform-positive result from a routine distribution system sample. Repeat samples are collected within 24 hours: one from the original site, one upstream, and one downstream. All three repeat samples test negative for total coliforms and E. coli. Under the RTCR, what is required next?

A. Issue Tier 1 public notification within 24 hours because the original positive result confirmed contamination

B. Collect a second round of repeat samples within 48 hours to confirm the negative results

C. Return to the routine monitoring schedule since the repeat samples were negative and no E. coli was detected

D. Shut down the distribution system in the affected area until three consecutive months of negative results are obtained

37. Which of the following is the correct storage practice for a pH meter electrode when it is not in use?

A. Store the electrode in manufacturer-recommended KCl storage solution to maintain the reference junction

B. Store the electrode submerged in deionized water to keep the glass membrane fully hydrated

C. Store the electrode dry with a protective cap to prevent contamination of the sensing element

D. Store the electrode in pH 7.0 buffer solution to maintain continuous calibration at the zero point

38. A plant operator notices that the chlorine residual at the far end of the distribution system has dropped from 0.5 mg/L to 0.1 mg/L over the past month, while the plant effluent residual has remained constant at 1.2 mg/L. The most likely cause is:

A. The plant's chlorine gas cylinders have been contaminated with an impurity that reduces potency

B. The laboratory's DPD reagent has expired, producing falsely low readings at all sample locations

C. The distribution system flow pattern has shifted, reducing demand on the affected area

D. Increased water age, temperature, or biofilm growth in the distribution system is consuming the residual

39. A peristaltic chemical metering pump operates by:

A. Using compressed air to push chemical through a rigid pipe at a measured flow rate

B. Drawing chemical into a cylinder with a piston and expelling it through a check valve

C. Squeezing a flexible tube with rotating rollers to move chemical through the tubing

D. Spinning an impeller inside a sealed casing to generate centrifugal flow of the chemical

40. An operator must determine whether a chemical storage area has adequate secondary containment. The storage area contains two tanks — one at 5,000 gallons and one at 3,000 gallons. The minimum containment capacity should be:

A. 3,000 gallons, equal to the volume of the smaller tank in the containment area

B. 5,500 gallons, representing 110% of the volume of the largest tank in the area

C. 8,000 gallons, equal to the combined volume of both tanks in the containment area

D. 8,800 gallons, representing 110% of the combined volume of both tanks in the area

41. The primary reason a water treatment plant must maintain a disinfectant residual in the distribution system — beyond what is needed for CT compliance at the plant — is to:

A. Provide ongoing protection against microbial contamination as water travels through pipes to consumers

B. Prevent the formation of disinfection byproducts by maintaining chemical equilibrium in the mains

C. Eliminate the need for flushing programs by continuously cleaning the interior pipe surfaces

D. Satisfy customer expectations for a noticeable chlorine taste that confirms the water has been treated

42. An operator is comparing two coagulants for a plant that treats cold water (2°C) with low alkalinity (15 mg/L as $CaCO_3$). Which coagulant characteristic would be most advantageous for these conditions?

A. A coagulant that requires a narrow pH range of 5.5 to 6.0 for optimal performance

B. A coagulant that produces maximum settled sludge volume per unit dose applied

C. A coagulant that only works effectively in water temperatures above 15°C year-round

D. A coagulant with low alkalinity consumption and effective performance in cold water

43. Which of the following laboratory quality control procedures verifies that the sampling and analytical process produces reproducible results?

A. Running a method blank to confirm that reagents are not introducing detectable contamination

B. Analyzing a spiked sample to verify the method accurately recovers a known concentration

C. Analyzing duplicate samples collected from the same source at the same time and comparing results

D. Calibrating the instrument with traceable standards before beginning the analytical session

44. A water utility's vulnerability assessment identified that its SCADA system is connected directly to the internet through an unprotected connection. The most critical corrective action is to:

A. Install stronger passwords on all SCADA user accounts and require monthly password changes

B. Separate the SCADA network from the internet using firewalls, network segmentation, and access controls

C. Train all operators to avoid clicking suspicious links in emails received on SCADA workstations

D. Install antivirus software on the SCADA server and schedule automatic daily virus definition updates

45. A treatment plant's clearwell has a volume of 400,000 gallons, the plant flow is 2.5 MGD (1,736 gpm), the clearwell has average baffling (factor = 0.5), and the chlorine residual at the outlet is 1.0 mg/L. What is the CT achieved?

A. 57.6 mg·min/L

B. 230.4 mg·min/L

C. 460.8 mg·min/L

D. 115.2 mg·min/L

46. An operator is investigating why a centrifugal pump's discharge pressure has decreased significantly while the motor amperage remains normal. Which of the following is the most likely cause?

A. The impeller is worn or eroded, reducing its ability to transfer energy to the water effectively

B. The discharge valve has been closed too far, restricting flow and increasing back-pressure

C. The motor is drawing excessive current because of a short circuit in the stator windings

D. The suction strainer has been recently cleaned, allowing too much water to reach the pump

47. Trihalomethanes are classified as volatile organic compounds. In the context of DBP monitoring, the significance of their volatility is that:

A. They decompose rapidly in the distribution system, making compliance sampling unnecessary

B. They must be collected in sealed glass vials with zero headspace to prevent loss during transport

C. They evaporate from water into indoor air, contributing to inhalation exposure during showering

D. They can only be formed in water with temperatures above 25°C during the summer months

48. A treatment plant operator needs to convert a hardness reading from mg/L as $CaCO_3$ to grains per gallon (gpg). The hardness is 205 mg/L as $CaCO_3$. What is the conversion factor and the result?

A. Divide by 17.1; the result is approximately 8.4 gpg

B. Divide by 17.1; the result is approximately 12.0 gpg

C. Multiply by 17.1; the result is approximately 3,506 gpg

D. Multiply by 8.34; the result is approximately 1,710 gpg

49. A confined space atmospheric test shows oxygen at 20.8%, LEL at 0%, hydrogen sulfide at 3 ppm, and carbon monoxide at 5 ppm. Based on these readings, the space:

A. Is not safe for entry because the oxygen level exceeds the maximum of 20.5%

B. Requires SCBA for entry because any detectable hydrogen sulfide is immediately dangerous

C. Is not safe because the carbon monoxide reading exceeds the 3 ppm entry threshold

D. Meets the atmospheric requirements for safe entry with all parameters within acceptable ranges

50. An operator is preparing to apply potassium permanganate to raw water at the plant intake. The primary purpose of this pre-oxidant is to:

A. Oxidize dissolved iron, manganese, and taste-and-odor compounds before they enter the treatment process

B. Provide primary disinfection credit by achieving the required CT for Giardia inactivation

C. Replace chlorine entirely as the plant's sole disinfection strategy for pathogen control

D. Coagulate colloidal particles by neutralizing their surface charges through chemical reduction

51. A treatment plant has been operating at 60% of its design capacity. The utility plans to increase production to 90% over the next year due to community growth. Which of the following treatment process impacts should the operator anticipate?

A. Sedimentation basin performance will improve due to higher velocity scouring of accumulated sludge

B. Chemical costs will decrease per gallon treated because of economies of scale at higher production

C. Filter run times will likely shorten because higher flow rates increase the particulate loading on each filter

D. Disinfection CT values will increase because more water will be present in the clearwell at all times

52. An operator notices that a motor-operated valve is making a grinding noise during operation and requires noticeably more time to travel from open to closed. The most appropriate response is to:

A. Increase the motor voltage to provide more torque for faster valve operation

B. Remove the valve from service, inspect the stem, seat, and actuator, and repair before returning to use

C. Lubricate the valve stem externally and return it to service if the noise decreases

D. Continue operating the valve normally because motor-operated valves commonly produce noise

53. Which of the following is the correct order of steps when responding to a chemical spill at a water treatment plant?

A. Contain the spill, then identify the chemical, then contact emergency services for assistance

B. Begin neutralizing the spill immediately, then evacuate the area, then identify the chemical

C. Report the spill to the state agency, then begin cleanup, then don PPE for protection

D. Ensure personal safety and don PPE, then contain the spill, then control the source

54. Total organic carbon (TOC) in raw water is significant to treatment plant operations primarily because it:

A. Serves as the precursor material that reacts with chlorine to form disinfection byproducts

B. Indicates the presence of dissolved heavy metals that require specialized membrane treatment

C. Directly causes the water to exceed the MCL for total dissolved solids at consumer taps

D. Produces hydrogen sulfide gas when chlorinated, creating taste and odor complaints

55. A magnetic flow meter installed on the plant effluent line requires which condition to produce accurate readings?

A. The pipe must contain at least 50% air space above the water for proper signal calibration

B. The flow must be pulsating rather than steady to allow the sensor to distinguish signal changes

C. The pipe must be completely full of water because the meter cannot measure partially filled pipes

D. The water must contain at least 200 mg/L of dissolved minerals for adequate electrical conductivity

56. A treatment plant operates a lime softening process to reduce hardness. The primary residual generated by this process consists of:

A. Aluminum hydroxide floc and captured colloidal particles from the raw water source

B. Ferric hydroxide precipitate and oxidized iron and manganese particles from groundwater

C. Activated carbon granules saturated with adsorbed organic compounds from the raw water

D. Calcium carbonate and magnesium hydroxide precipitates formed during the softening reaction

57. An operator notices that the backwash of Filter 2 is producing uneven bed expansion — one side of the filter bed rises normally while the other side barely moves. The most likely cause is:

A. The filter media has recently been replaced with a different grain size than originally specified

B. A blocked or damaged underdrain lateral is preventing uniform distribution of backwash water

C. The backwash flow rate is too high, causing turbulent conditions throughout the entire bed

D. The coagulant dose is too low, resulting in weak floc that does not distribute evenly during expansion

58. The Safe Drinking Water Act requires that each state with primacy must have a program that is:

A. At least as stringent as the federal requirements, though states may adopt more stringent standards

B. Exactly identical to the federal requirements, with no state-level modifications permitted

C. Less stringent than federal standards to reduce the regulatory burden on small water systems

D. Reviewed and reauthorized by Congress every two years to maintain primacy delegation status

59. A water system's annual Consumer Confidence Report must include which of the following?

A. The names, salaries, and certification levels of all operators employed by the utility

B. Detailed engineering drawings showing the layout of the treatment plant and distribution system

C. Projected capital improvement plans and associated rate increases for the upcoming five years

D. A list of all detected regulated contaminants with their levels, MCLs, and likely sources

60. A plant treating 6.0 MGD needs to feed powdered activated carbon (PAC) at a dose of 15 mg/L to control a seasonal taste and odor event. How many pounds of PAC are needed per day?

A. 375.3 lb/day

B. 500.4 lb/day

C. 250.2 lb/day

D. 750.6 lb/day

61. An operator inspects the chemical feed room and finds a container of calcium hypochlorite stored on a wooden pallet directly adjacent to a drum of an organic degreaser. This storage arrangement is hazardous because:

A. The organic degreaser will dissolve the calcium hypochlorite container over time

B. Calcium hypochlorite is a strong oxidizer that can react with organic materials and cause fire or explosion

C. The wooden pallet will absorb moisture from the calcium hypochlorite and collapse under the weight

D. The degreaser fumes will react with the hypochlorite to form toxic chloramine gas in the air

62. Which of the following water quality parameters is measured using EDTA titration in the laboratory?

A. Total hardness, by chelating calcium and magnesium ions until an indicator color change occurs

B. Total alkalinity, by neutralizing bicarbonate and carbonate ions with a standardized acid solution

C. Free chlorine residual, by reacting the chlorine with a DPD indicator to produce a pink color

D. Turbidity, by comparing the light scattering of the sample against known formazin standards

63. A treatment plant operator is reviewing SCADA trend data and observes that the raw water pH has gradually decreased from 7.2 to 6.4 over the past three weeks. Which downstream treatment impact should the operator anticipate?

A. Increased sedimentation efficiency because lower pH produces denser, heavier floc

B. Improved UV disinfection effectiveness because lower pH enhances UV light transmission

C. Reduced chlorine demand because lower pH converts all chlorine to the more stable OCl^- form

D. Potentially improved coagulation with alum but reduced disinfection efficiency from the higher HOCl-to-OCl^- ratio

64. The attendant stationed outside a permit-required confined space observes the entrant slump to the ground and become unresponsive. The attendant's correct immediate response is to:

A. Enter the space to assess the entrant's condition and provide first aid if needed

B. Close and secure the entry hatch to prevent additional personnel from entering the space

C. Activate the non-entry retrieval system, call for emergency rescue services, and maintain communication attempts

D. Leave the entry point to personally search for additional help within the plant facility

65. A groundwater treatment plant adds fluoride for community water fluoridation. The operator discovers that the fluoride feed pump has been offline for 12 hours due to a mechanical failure. During this period, the finished water fluoride level was essentially zero. This situation:

A. Constitutes an MCL violation because fluoride levels must be maintained above 0.7 mg/L at all times

B. Is not a violation because fluoride underfeed does not exceed the fluoride MCL of 4.0 mg/L

C. Requires Tier 1 public notification within 24 hours because fluoride is a primary contaminant

D. Requires the plant to shut down until the fluoride feed system is repaired and verified operational

66. A treatment plant uses a streaming current monitor installed after the rapid mix chamber. The instrument reading has shifted from its normal setpoint of +0.2 to −1.5 over the past hour. This shift indicates:

A. The coagulant dose is likely insufficient, leaving particles with significant residual negative charge

B. The coagulant is being over-applied, causing charge reversal and particle restabilization

C. The raw water temperature has dropped, which always produces a negative streaming current reading

D. The streaming current monitor needs electrode replacement because negative readings indicate sensor failure

67. A new operator asks why the plant cannot simply increase the chlorine dose to improve disinfection without worrying about DBPs. The most accurate response is that:

A. Increasing chlorine dose without reducing NOM increases both the residual and the DBP formation

B. Chlorine dose has no relationship to DBP formation because byproducts form only in the distribution system

C. Federal regulations allow unlimited chlorine dosing as long as the residual stays below 4.0 mg/L

D. Higher chlorine doses actually reduce DBP formation by oxidizing precursor material before it can react

68. Which of the following correctly describes the difference between a Maximum Contaminant Level (MCL) and a Maximum Contaminant Level Goal (MCLG)?

A. MCLs are voluntary industry guidelines while MCLGs are legally enforceable federal standards

B. MCLs apply only to groundwater systems while MCLGs apply only to surface water systems

C. MCLs are enforceable standards considering feasibility; MCLGs are non-enforceable health-based goals

D. MCLs and MCLGs are identical values set at the level of zero health risk for every contaminant

69. A water treatment plant's emergency generator failed to start during a weekly test. The engine cranked slowly but did not fire. The most likely cause is:

A. The automatic transfer switch has failed and is not sending the start signal properly

B. The starting batteries are weak or discharged, providing insufficient cranking power to turn the engine

C. The generator output voltage regulator is defective, preventing proper electrical generation

D. The generator's cooling system thermostat is stuck open, overcooling the engine block

70. An operator measures the raw water alkalinity at 30 mg/L as $CaCO_3$ before a coagulation jar test. After adding the optimal alum dose, the pH drops from 7.1 to 5.8 — well below the effective coagulation range. The best corrective strategy is to:

A. Add lime or soda ash to increase the alkalinity and buffer capacity before or during coagulant addition

B. Switch to a stronger alum product with a higher aluminum content per unit volume

C. Increase the flocculation detention time to allow more contact between the low-pH water and the floc

D. Decrease the raw water flow rate to reduce the amount of coagulant needed for effective treatment

71. The record retention requirement for chemical analysis results under federal drinking water regulations is:

A. 3 years from the date of the most recent analysis performed on each sample

B. 5 years from the date of the most recent analysis performed on each sample

C. 7 years from the date of the most recent analysis performed on each sample

D. 10 years from the date of the most recent analysis performed on each sample

72. Tube settlers (lamella settlers) installed in a sedimentation basin increase treatment capacity by:

A. Generating micro-air bubbles that attach to particles and float them to the surface for skimming

B. Increasing the velocity of water through the basin to reduce the overall hydraulic detention time

C. Providing additional settling surface area so particles only need to settle a short distance between plates

D. Filtering the water through fine-mesh screens built into each tube to physically strain out particles

73. A water treatment plant operator observes that the chlorine room exhaust fan has failed. No chlorine leak is detected. The operator should:

A. Continue normal operations because the exhaust fan is only needed during active chlorine leaks

B. Repair or replace the exhaust fan before resuming chlorine gas feed operations in the room

C. Open the chlorine room door and windows to provide natural ventilation as a permanent substitute

D. Switch the plant's disinfection system to UV to eliminate the need for the chlorine room fan

74. A water sample is tested for total chlorine and produces a reading of 2.0 mg/L. The same sample tested for free chlorine produces a reading of 2.0 mg/L. This indicates that:

A. All of the chlorine in the sample is free chlorine with no combined chlorine (chloramines) present

B. Half of the chlorine is free and half is combined, producing identical readings by coincidence

C. The DPD test was performed incorrectly because free and total readings can never be equal

D. The sample has already passed the breakpoint and the chloramines have been fully destroyed

75. Which of the following situations would require a water system to conduct a Level 2 assessment under the Revised Total Coliform Rule?

A. A single routine sample tests positive for total coliforms with no E. coli detected

B. The system fails to collect its required number of routine monitoring samples for one month

C. The system's annual Consumer Confidence Report is distributed two weeks late to customers

D. An E. coli MCL violation occurs, or the system triggers a second Level 1 assessment within 12 months

76. During a filter backwash, the operator observes anthracite media particles flowing over the wash troughs into the waste collection system. The immediate corrective action is to:

A. Increase the backwash rate to ensure complete cleaning of the remaining media in the filter

B. Continue the backwash at the current rate because some media loss is normal during cleaning

C. Reduce the backwash flow rate immediately to prevent further loss of filter media

D. Stop the backwash entirely and drain the filter for a complete media inspection and replacement

77. An operator needs to determine the total volume of a cylindrical chemical storage tank that is 8 feet in diameter and 12 feet tall. Using the formula Volume = $\pi \times r^2 \times h$, the volume in cubic feet is approximately:

A. 603 cubic feet

B. 2,413 cubic feet

C. 301 cubic feet

D. 1,206 cubic feet

78. The primary advantage of using a gravimetric dry chemical feeder instead of a volumetric dry chemical feeder is that a gravimetric feeder:

A. Operates at higher feed rates than volumetric feeders of comparable physical size

B. Measures chemical by weight rather than volume, providing more accurate dosing regardless of density changes

C. Requires no electrical power because it operates entirely on the principle of gravity flow

D. Can feed liquid chemicals as well as dry chemicals, providing greater operational flexibility

79. A treatment plant using chloramination experiences a rise in total coliform-positive samples in a specific section of the distribution system. Investigation reveals low chloramine residuals and elevated heterotrophic plate counts in the affected area. The most effective corrective strategy is:

A. Switch the plant to free chlorine disinfection for the entire distribution system permanently

B. Increase the ammonia feed rate to produce higher chloramine residual in the affected mains

C. Reduce the plant production rate to increase the chloramine contact time in the clearwell

D. Conduct targeted flushing of the affected area and temporarily boost the chloramine residual or conduct a free chlorine burn

80. Which of the following sampling errors would most likely produce a false positive total coliform result?

A. Collecting the sample in a bottle that contains too much sodium thiosulfate

B. Flushing the tap for too long before collecting the sample from the distribution point

C. Failing to disinfect the tap spout before collecting the sample in the sterile bottle

D. Cooling the sample to 4°C too quickly after collection, shocking the bacteria in the sample

81. A water treatment operator discovers that the plant has been inadvertently feeding alum at twice the intended dose for the past eight hours due to a metering pump calibration error. The most likely operational consequence is:

A. Excessive sludge production, increased alkalinity consumption, and potential charge reversal affecting turbidity

B. Improved filter performance because higher coagulant doses always produce better particle capture

C. Reduced disinfection byproduct formation because excess alum directly destroys organic precursors

D. No measurable effect because coagulant dose has no impact on downstream treatment performance

82. The maximum holding time for a turbidity sample that has been properly preserved at 1°C to 4°C is:

A. 15 minutes — must be analyzed immediately at the point of collection

B. 48 hours from the time of collection

C. 30 hours from the time of collection, matching the bacteriological holding time

D. 7 days from the time of collection when properly refrigerated

83. An operator reviewing energy usage data notices that the high-service pumps consume 35% less power when operating at 85% speed with VFDs compared to operating at 100% speed with a throttling valve. This energy savings occurs because:

A. The VFD converts excess electrical energy into heat that is captured and recycled by the plant

B. Throttling valves generate electricity that flows back to the power grid, creating a net loss

C. Pump power consumption varies with approximately the cube of the speed, so small speed reductions yield large energy savings

D. The VFD operates the motor at a higher voltage that increases efficiency proportionally

84. A water system that has received a Tier 2 violation for exceeding the THM MCL based on the locational running annual average must issue public notification within:

A. 24 hours using direct delivery, broadcast media, and posting methods

B. 7 days using newspaper publication and direct mail to affected customers

C. 30 days using methods that reach all persons served by the water system

D. One year, typically included in the annual Consumer Confidence Report

85. Which of the following is the correct procedure for draining and disposing of condensate from an air compressor receiver tank?

A. Open the drain valve regularly to remove accumulated water, and dispose of condensate according to facility procedures

B. Leave condensate in the tank because it provides beneficial cooling to the compressed air system

C. Drain condensate into the nearest floor drain without treatment since it contains only water

D. Wait until the tank is completely full of condensate before draining to maximize drainage efficiency

86. The purpose of adding polymer after coagulation and before or during flocculation is to:

A. Replace the primary coagulant entirely, eliminating the need for metal salt chemicals

B. Strengthen floc by bridging between particles, producing larger and faster-settling aggregates

C. Dissolve remaining colloidal particles through chemical reduction of their organic component

D. Lower the pH of the water to the optimal range for alum or ferric chloride coagulation

87. An operator conducting a sanitary survey of a groundwater well site observes that the wellhead cap is cracked, the annular seal appears deteriorated, and a fertilizer storage shed has been constructed 50 feet from the well. Which of these findings presents the most immediate risk of aquifer contamination?

A. The deteriorated annular seal creates a direct pathway for surface contaminants to reach the aquifer

B. The fertilizer storage shed exceeds the maximum allowable proximity for chemical storage near a well

C. The cracked wellhead cap will allow rainwater to enter and dilute the groundwater supply

D. All three findings present equal risk and must be addressed simultaneously in a single work order

88. A plant operator tests the sodium hypochlorite solution and finds it has degraded to 8% strength. The original feed rate was calculated for 12% solution to deliver a dose of 2.5 mg/L at 3.0 MGD. To maintain the same dose with the weaker solution, the operator should adjust the feed rate by what factor?

A. No adjustment is needed because the chemical will naturally compensate for lower strength

B. Reduce the feed rate by 33% because the weaker solution requires less volume to achieve the same dose

C. Increase the feed rate by 50% to compensate for the reduction from 12% to 8% solution strength

D. Increase the feed rate by 100% because an 8% solution is approximately half the original strength

89. A water system's operator receives a laboratory report showing that the arsenic concentration in the finished water is 0.012 mg/L. The arsenic MCL is 0.010 mg/L. What compliance determination and notification are required?

A. The result exceeds the MCL, constituting a violation that requires Tier 2 public notification within 30 days

B. The result is within the acceptable analytical uncertainty range and does not constitute a violation

C. The result requires only a notation in the Consumer Confidence Report under Tier 3 notification

D. The result triggers a Tier 1 notification because arsenic at any detectable level is an acute health hazard

90. The operator at a treatment plant observes that the flocculation paddles in the first stage of a three-stage tapered flocculation system have stopped rotating due to a motor failure. The most appropriate action is to:

A. Continue operating the remaining two stages and treat the failure as a minor efficiency reduction

B. Reduce the plant flow rate or take the affected train offline and arrange for immediate motor repair

C. Increase the coagulant dose to compensate for the reduced flocculation occurring in the basin

D. Increase the mixing speed of the second and third stages to compensate for the loss of the first stage

91. A treatment plant is required to achieve enhanced coagulation for TOC removal. The plant's raw water has a TOC of 6.0 mg/L and an alkalinity of 80 mg/L as $CaCO_3$. According to the enhanced coagulation matrix, what is the general trend for required TOC percent removal?

A. Higher raw water TOC requires a lower percentage removal because dilution effects reduce DBP formation

B. Higher alkalinity always eliminates the requirement for enhanced coagulation regardless of TOC levels

C. Lower raw water TOC with higher alkalinity generally requires a lower percentage removal

D. Higher raw water TOC with lower alkalinity generally requires a higher percentage removal

92. An operator is using a clamp-on ultrasonic flow meter to verify the reading of a permanently installed magnetic flow meter on the same pipe. The ultrasonic meter reads 1,250 gpm while the mag meter reads 1,180 gpm. This discrepancy:

A. Is impossible because both meter types always produce identical readings on the same pipe

B. Indicates the magnetic flow meter has failed and must be replaced immediately without further testing

C. Warrants investigation and may indicate that one or both meters need calibration verification

D. Is expected because ultrasonic meters are always more accurate than magnetic flow meters

93. A surface water treatment plant experiences a sudden, unexpected increase in raw water color from 10 CU to 45 CU. This change will most likely affect the treatment process by:

A. Increasing the coagulant demand and the potential for elevated disinfection byproduct formation

B. Decreasing the need for filtration because color-causing compounds improve floc settling

C. Reducing the chlorine demand because organic color compounds consume dissolved oxygen instead

D. Having no impact because color is only an aesthetic parameter with no treatment significance

94. Which section of the Safety Data Sheet provides information about the chemical's incompatibilities with other substances?

A. Section 4 — First-Aid Measures

B. Section 10 — Stability and Reactivity

C. Section 8 — Exposure Controls / Personal Protective Equipment

D. Section 14 — Transport Information

95. A treatment plant operates three high-service pumps, each rated at 1,500 gpm. During a peak demand period, all three pumps are running but the discharge header pressure is lower than normal. One pump's amperage is significantly below its nameplate rating while its discharge pressure gauge reads near zero. The most likely diagnosis is:

A. The distribution system has experienced a significant pressure increase from reduced consumer demand

B. The power supply voltage to all three pumps has dropped below the minimum operating threshold

C. The low-amperage pump's discharge check valve is stuck closed, preventing it from contributing flow

D. The low-amperage pump has lost prime or has a closed suction valve, running without moving water

96. A water quality report shows the following finished water results: pH 7.2, alkalinity 45 mg/L as $CaCO_3$, calcium hardness 60 mg/L as $CaCO_3$, and temperature 15°C. An experienced operator would evaluate these results in the context of:

A. DBP formation potential by calculating the CT achieved in the clearwell at current temperature

B. Bacteriological compliance by comparing the results against the total coliform standard

C. Corrosion potential by using the values to calculate the Langelier Saturation Index

D. Enhanced coagulation requirements by comparing the alkalinity against the TOC removal matrix

97. An operator is writing a Standard Operating Procedure for filter backwash. Which of the following elements should NOT be included in the SOP?

A. The personal opinions and preferences of the operator who most frequently performs the task

B. Step-by-step instructions for initiating, monitoring, and terminating the backwash sequence

C. Safety precautions, required PPE, and references to related procedures and equipment manuals

D. Documentation requirements specifying what records must be completed after each backwash

98. A water treatment plant using surface water must comply with the Ground Water Rule in addition to the Surface Water Treatment Rule if:

A. The plant does not operate wells and treats only surface water from a reservoir intake

B. The plant supplements its surface water supply with groundwater wells that serve the same system

C. The plant has experienced an algae bloom that contaminated the raw water above 50 NTU

D. The plant's distribution system contains pipes that pass through a designated groundwater recharge area

99. An operator reviewing procurement records notices that the treatment plant has been purchasing 30% more alum this year compared to the same period last year, despite treating approximately the same volume of water. Which of the following is the most likely explanation?

A. The alum supplier has changed the product formulation, reducing the aluminum content per unit

B. Raw water quality has changed — higher turbidity, organic loading, or lower alkalinity is increasing coagulant demand

C. The chemical storage tanks have developed leaks that are allowing alum to escape before use

D. The alum price has decreased, encouraging the plant to purchase larger quantities as inventory

100. The purpose of monitoring weather readings at a water treatment plant, as specified in the WPI Need-to-Know Criteria, is to:

A. Satisfy federal meteorological reporting requirements applicable to all industrial facilities

B. Determine the optimal staffing schedule based on weather-related employee absenteeism

C. Anticipate source water quality changes and treatment challenges associated with weather events

D. Calculate the evaporation rate from open treatment basins to correct daily production totals

Practice Exam 2: Answer Key and Explanations

1. B — The optimal coagulant dose is the lowest dose that achieves near-minimum turbidity, not the absolute lowest turbidity at any cost. At 40 mg/L, the turbidity (0.9 NTU) is nearly as low as the minimum (0.8 NTU at 50 mg/L), while 60 mg/L actually shows rising turbidity from probable charge reversal — confirming that more chemical is not always better.

2. D — When the clearwell level drops critically low, the immediate response is to reduce the outflow (high-service pump output) to match or fall below the plant's current production rate, allowing the clearwell to recover. Shutting down all high-service pumps would interrupt water supply to consumers, and bypassing untreated water is never acceptable.

3. C — Filtered water turbidity is the primary surrogate indicator for pathogen removal because particles and the pathogens attached to or embedded within them are removed together during filtration. Low individual filter effluent turbidity (≤ 0.3 NTU in 95% of readings) demonstrates that the physical treatment barriers are effectively removing particles and the pathogens associated with them.

4. A — Basin volume = length × width × depth = 120 ft × 30 ft × 12 ft = 43,200 ft^3 × 7.48 gal/ft^3 = 323,136 gallons. Detention time = 323,136 gal ÷ 800 gpm = 404 minutes ÷ 60 = approximately 6.7 hours. (Note: The calculated result most closely matches 6.7 hours. Candidates should work through the volume-to-time conversion carefully, applying 7.48 gal/ft^3 and converting minutes to hours.)

5. A — Hydrogen sulfide is a triple-threat gas: it is acutely toxic (causing rapid loss of consciousness and death at concentrations above 100 ppm), it is flammable, and it deadens the sense of smell at higher concentrations, removing the warning that the gas is present. H_2S is one of the leading causes of confined space fatalities in the water industry.

6. D — When one filter consistently underperforms while all others produce excellent effluent from the same settled water, the problem is specific to that filter — not the upstream treatment process. Likely causes include media loss, mudball formation, underdrain damage, inadequate backwash, or a cracked filter wall allowing bypass flow.

7. B — Cold water is more viscous (thicker) than warm water, which creates greater resistance to particle movement and slows settling velocity. This is why sedimentation performance often declines in winter — operators may need to increase coagulant dose, add polymer, or reduce flow to compensate for the reduced settling efficiency.

8. C — The Lead and Copper Rule addresses lead that enters water from distribution and household plumbing corrosion, not from the source. The primary treatment strategy is corrosion control — adjusting finished water pH and alkalinity to minimize the dissolution of lead from pipes, solder, and fixtures.

9. D — Any detectable chlorine odor in a chlorine room warrants immediate caution, even without a detector alarm — the detector may be malfunctioning, improperly calibrated, or positioned away from the leak source. The operator should leave immediately, verify the detector's function, and investigate from a safe location wearing appropriate respiratory protection.

10. A — The "nephelometric" designation refers to the measurement of light scattered at a 90-degree angle to the incident beam. This 90-degree detection angle provides the most consistent and sensitive measurement across the range of particle sizes encountered in water treatment.

11. C — Nitrification is a biological process in which nitrifying bacteria in the distribution system convert the ammonia component of chloramines to nitrite, consuming the chloramine residual in the

process. The simultaneous decline in residual and rise in nitrite is the signature indicator of a nitrification episode.

12. B — Alkalinity consumed = 35 mg/L alum × 0.5 = 17.5 mg/L. Remaining alkalinity = 40 − 17.5 = 22.5 mg/L as $CaCO_3$. This low residual alkalinity may provide insufficient pH buffering, and the operator should monitor pH closely and consider supplemental alkalinity addition if pH drops below the effective coagulation range.

13. B — When calibrating an online chlorine analyzer, the laboratory DPD measurement serves as the reference standard. The analyzer is adjusted to match the DPD result — not the other way around. A 0.3 mg/L discrepancy (25%) exceeds acceptable tolerance and confirms the analyzer has drifted and requires adjustment.

14. D — Dissolved air flotation uses microscopically small air bubbles that attach to floc particles and carry them upward to the water surface, where they are skimmed off. This is the opposite of conventional sedimentation and is particularly effective for removing light floc, algae, and low-density particles that settle poorly.

15. C — Membrane integrity testing detects breaches — broken fibers, pinholes, damaged seals — that would allow unfiltered water and pathogens to bypass the membrane barrier. Because membranes provide absolute rejection only when intact, regular integrity testing is essential to verify that the pathogen removal credit is being maintained.

16. B — The coagulant must be injected directly into the zone of maximum turbulence at the rapid mix unit to achieve instant, uniform dispersion throughout the water. Injecting upstream in a low-turbulence zone causes uneven distribution — some water receives too much coagulant while other portions receive too little, degrading overall coagulation performance.

17. D — The Stage 2 D/DBPR directly addresses the tension between disinfection and DBP formation by establishing LRAA-based MCLs for THMs and HAAs at individual distribution system monitoring locations. This rule, combined with the SWTR's disinfection requirements, creates the regulatory framework that operators must balance simultaneously.

18. A — At 180 mg/L as $CaCO_3$, the water falls within the "hard" classification range of 150 to 300 mg/L. The hardness classification scale is: soft (0–75), moderately hard (75–150), hard (150–300), and very hard (above 300).

19. C — Vertical turbine pumps have long shaft assemblies extending from the motor above ground to the impeller bowls below the water surface. Excessive vibration and reduced flow in this pump type commonly indicate shaft misalignment, a failed line shaft bearing, or a bent shaft — all of which affect the impeller's ability to spin freely and deliver water efficiently.

20. B — Filter-to-waste diverts the initial filter effluent — which has elevated turbidity during the ripening period — away from the clearwell and to waste. This prevents the high-turbidity ripening water from entering the finished water supply while the filter re-establishes the particle-capturing coating on the media grains.

21. A — The SWTR requires CFE turbidity ≤ 0.3 NTU in at least 95% of all measurements each month. If 8% of readings exceeded 0.3 NTU, only 92% were in compliance — falling below the 95% threshold. This constitutes a turbidity treatment technique violation regardless of whether any individual reading exceeded 1.0 NTU.

22. D — Replacing motor windings is a major motor overhaul, not a routine metering pump PM task. Standard PM for a chemical metering pump includes inspecting the diaphragm, checking valve function, verifying calibration, inspecting tubing and fittings, and ensuring proper stroke length and rate settings.

23. B — If the coagulant feed pump delivers the same mass of chemical per minute but the water flow increases by 50% (from 3.0 to 4.5 MGD), the same amount of chemical is distributed into a larger volume, effectively reducing the dose by one-third. Flow-proportional feed control automatically prevents this by adjusting the pump output to match changing flows.

24. C — Under the RTCR, larger systems collect more routine samples per month. A system serving 50,000 people is required to collect approximately 60 routine distribution samples monthly, distributed across representative locations in the distribution system according to a written sample siting plan.

25. A — Feed rate (Cl_2 equivalent) = 2.0 mg/L × 2.0 MGD × 8.34 = 33.4 lb/day. This represents the weight of chlorine delivered to the water. To determine the volume of 12% sodium hypochlorite solution needed, this value would be divided by the solution concentration (0.12).

26. B — When all jars produce visible, fast-settling floc but the supernatant remains hazy, the coagulant is successfully destabilizing and aggregating particles at the tested doses, but a persistent haze indicates colloidal material that the coagulant cannot address at the current pH. The raw water pH is likely outside the effective range for the coagulant being tested.

27. D — Specific capacity declining from 8.0 to 5.2 gpm/ft at the same pumping rate means the drawdown has increased — the aquifer is providing the same flow but with greater difficulty. The most common causes are well screen encrustation (mineral or biological fouling) or aquifer deterioration near the well bore reducing water transmissivity.

28. C — Positive displacement pumps deliver chemical in discrete pulses (one per stroke), creating pressure fluctuations in the discharge line. A pulsation dampener — typically an air-charged chamber — absorbs these pressure pulses, smoothing the flow and reducing the mechanical stress on downstream piping and connections.

29. A — At 0.4 mg/L, the fluoride is below the 0.7 mg/L community fluoridation target. The operator should increase the fluoride feed rate to bring the finished water concentration closer to the target, providing the intended dental health benefit. The MCL for fluoride is 4.0 mg/L — a 0.7 mg/L target is well within the safe range.

30. A — VOC samples must be collected in glass vials filled completely with no headspace and sealed with PTFE-lined septum caps. Any air space in the vial allows volatile compounds to escape from the water into the gas phase (headspace), producing falsely low results. The glass prevents compound adsorption to the container walls.

31. D — Lead is regulated through action levels (0.015 mg/L) at consumer taps under the Lead and Copper Rule because lead enters water from the distribution system and household plumbing, not from the source or treatment process. This tap-based monitoring approach targets the actual point of consumer exposure.

32. C — When the sludge blanket rises dangerously close to the effluent weirs, the immediate response is to increase sludge withdrawal to lower the blanket. A high sludge blanket can be carried over the weirs by hydraulic currents, degrading settled water quality and overloading the filters with excess particulate matter.

33. A — Algae blooms produce geosmin and MIB — organic compounds that cause earthy, musty taste and odor detectable at parts-per-trillion concentrations. These compounds are the most common cause of seasonal consumer complaints and require treatment with oxidants (permanganate, ozone) or adsorption (activated carbon).

34. B — A safety relief valve that leaks below its rated setpoint has either a worn seat, a weakened spring, or internal corrosion preventing proper sealing. The valve must be tagged out of service, repaired or replaced by qualified personnel, and tested to verify proper operation before the system returns to normal service.

35. D — The GT value is the product of the velocity gradient G (mixing intensity, in sec^{-1}) and the hydraulic detention time T (in seconds). It represents the total mixing energy applied during flocculation and is a standard design parameter, with typical values ranging from 20,000 to 200,000 for conventional treatment.

36. C — When all repeat samples test negative for both total coliforms and E. coli, the system returns to its routine monitoring schedule. The original positive result triggered the required repeat sampling, which demonstrated that the contamination was not persistent or widespread in the distribution system.

37. A — pH electrodes must be stored in the manufacturer-recommended KCl storage solution (typically 3M to 4M concentration) to maintain the reference junction's electrolyte concentration and keep the glass membrane hydrated. Storage in deionized water draws ions from the reference element, damaging the electrode and causing measurement drift.

38. D — When plant effluent residual is stable but distribution system residuals decline at distant points, the chlorine is being consumed between the plant and the monitoring location. Increased water age (longer residence time), elevated summer temperatures, and biofilm growth in pipes all accelerate chlorine consumption in the distribution system.

39. C — A peristaltic pump moves fluid by squeezing a flexible tube with rotating rollers. As the rollers compress the tube, they push the fluid ahead of the compression point. The only wetted component is the tubing itself, making peristaltic pumps easy to maintain and ideal for corrosive or viscous chemical solutions.

40. B — Secondary containment must hold at least 110% of the volume of the largest single tank in the containment area. The largest tank is 5,000 gallons, so the minimum containment is 5,000 × 1.10 = 5,500 gallons. This provides a safety margin above the tank volume to account for precipitation and other incidental liquid.

41. A — A distribution system residual provides ongoing antimicrobial protection as water travels through potentially miles of piping over hours or days before reaching the consumer. Without a residual,

microbial contamination from cross-connections, main breaks, or biofilm could compromise water quality after it leaves the treatment plant.

42. D — Cold water and low alkalinity are two of the most challenging conditions for coagulation. A coagulant with low alkalinity consumption (such as polyaluminum chloride) and effective cold-water performance would be most advantageous because it avoids the alkalinity depletion and sluggish floc formation that conventional alum produces under these conditions.

43. C — Duplicate samples — collected simultaneously from the same source and analyzed independently — test whether the sampling and analytical process produces consistent, reproducible results. Good agreement between duplicates (typically within 10–20% relative percent difference) confirms that the results reflect actual water quality rather than random analytical variation.

44. B — A direct, unprotected internet connection to the SCADA network is a critical vulnerability that could allow remote unauthorized access to the plant's control systems. The highest-priority corrective action is network separation using firewalls, segmentation, and access controls — the other options are important but secondary to eliminating the direct exposure.

45. D — Theoretical DT = 400,000 gal ÷ 1,736 gpm = 230.4 minutes. T_{10} = 230.4 × 0.5 = 115.2 minutes. CT = 1.0 mg/L × 115.2 min = 115.2 mg·min/L. This calculated CT is then compared against the required CT from regulatory tables for the target pathogen at the specific temperature and pH.

46. A — A worn or eroded impeller cannot transfer energy to the water as efficiently, resulting in reduced discharge pressure and flow. Since the impeller is doing less hydraulic work, the motor load (amperage) may remain near normal or even decrease slightly, distinguishing this condition from problems like a closed valve that would increase amperage.

47. C — THMs are volatile, meaning they escape from water into air. During activities like showering, bathing, and dishwashing, THMs volatilize into indoor air where they can be inhaled — creating an exposure route beyond just drinking the water. This inhalation pathway contributes significantly to total consumer exposure.

48. B — Hardness in mg/L as $CaCO_3$ is converted to grains per gallon by dividing by 17.1. Therefore, 205 ÷ 17.1 = 12.0 gpg. The gpg unit is still commonly used in the water softening industry, so operators should be comfortable with this conversion.

49. D — All four parameters are within safe limits: oxygen 20.8% (within 19.5–23.5%), LEL 0% (below 10%), H_2S 3 ppm (below 10 ppm), and CO 5 ppm (below 25 ppm). The atmosphere meets the requirements for safe entry, though continuous monitoring must be maintained throughout the entry period.

50. A — Potassium permanganate is a pre-oxidant applied at the plant intake to oxidize dissolved iron and manganese to their filterable forms, destroy taste and odor compounds (geosmin and MIB), and provide limited pathogen inactivation. It is not a substitute for primary disinfection but reduces the burden on downstream treatment processes.

51. C — Increasing production from 60% to 90% of design capacity significantly increases the hydraulic loading on filters, which means more particles per unit time must be captured by each filter. Higher loading causes faster headloss buildup, shorter filter runs, and more frequent backwashing — operators must plan for increased backwash water usage and potentially higher chemical doses.

52. B — Grinding noise and extended travel time in a motor-operated valve indicate mechanical deterioration — worn gears, a bent stem, seat corrosion, or actuator problems. Continuing to operate a damaged valve risks complete failure in either the open or closed position, potentially causing a treatment disruption or safety hazard.

53. D — The correct spill response sequence prioritizes personal safety first (don PPE), then containment (prevent spread to drains and waterways), then source control (stop the leak if safely possible), then cleanup and reporting. Acting before donning PPE or before identifying the chemical creates unnecessary risk to the responder.

54. A — Total organic carbon is the naturally occurring organic matter that reacts with chlorine during disinfection to form trihalomethanes and haloacetic acids. Higher TOC means more precursor material available for DBP formation, which is why enhanced coagulation targets TOC removal before disinfection.

55. C — Magnetic flow meters require the pipe to be completely full of water because the measurement principle depends on a conductive fluid filling the entire cross-section of the flow tube. A partially filled pipe produces inaccurate readings because the electromagnetic field interacts with air instead of water in the unfilled portion.

56. D — Lime softening removes hardness by precipitating calcium as calcium carbonate ($CaCO_3$) and magnesium as magnesium hydroxide ($Mg(OH)_2$). These precipitates constitute the primary residual from

the softening process and are typically denser and easier to dewater than alum or ferric coagulation sludge.

57. B — Uneven bed expansion — one side expanding normally while the other barely moves — is the signature symptom of a blocked or damaged underdrain lateral. The blocked lateral cannot distribute backwash water to its section of the filter floor, leaving that area of media unwashed and compacted while the rest expands normally.

58. A — The SDWA requires that primacy states maintain programs at least as stringent as the federal requirements. States may adopt more stringent standards — lower MCLs, additional contaminant regulations, more frequent monitoring — but they cannot be less protective than the federal baseline.

59. D — The CCR must include a list of all detected regulated contaminants with their measured levels, the applicable MCLs and MCLGs, the likely source of each contaminant, and health effects information for any contaminant exceeding its MCL. The CCR is designed to inform consumers about the quality of their drinking water in plain, accessible language.

60. D — Feed rate = 15 mg/L × 6.0 MGD × 8.34 = 750.6 lb/day. This is the weight of dry PAC needed per day. PAC is typically fed as a slurry, so the operator would also need to calculate the slurry volume based on the PAC concentration in the slurry mixture.

61. B — Calcium hypochlorite is a strong oxidizer that can spontaneously ignite or explode when it contacts organic materials — including the organic degreaser, the wooden pallet, and even accumulated dust or grease. Oxidizers must be stored completely separated from organic materials, combustibles, and flammable liquids.

62. A — EDTA titration is the standard method for measuring total hardness. EDTA chelates (binds) the calcium and magnesium ions in the sample, and the endpoint is detected by a color change in an indicator dye (Eriochrome Black T changes from wine-red to blue when all divalent cations have been chelated).

63. D — A pH decrease from 7.2 to 6.4 moves the raw water closer to alum's optimal coagulation range (potentially improving coagulation), but lower pH also shifts the chlorine equilibrium toward a higher percentage of HOCl — which is actually the more effective disinfectant form. However, if the pH is adjusted upward after filtration for corrosion control, the net disinfection impact may vary.

64. C — The attendant must never enter the confined space — this is an absolute rule. The correct response is to activate the non-entry retrieval system (tripod and winch) to attempt to extract the entrant without entering the space, immediately call for emergency rescue services, and continue attempting to communicate with the entrant.

65. B — Fluoride underfeed (producing finished water below the target of 0.7 mg/L) does not constitute an MCL violation because the fluoride MCL is 4.0 mg/L — set to protect against excessive fluoride, not insufficient fluoride. While the fluoride feed should be restored promptly, the interruption does not violate any health-based standard.

66. A — A streaming current reading shifting from the normal setpoint of +0.2 to −1.5 indicates that particles in the water have become significantly more negatively charged — meaning the coagulant dose is insufficient to neutralize the particle charges. The operator should increase the coagulant dose and perform a jar test to optimize.

67. D — Increasing chlorine dose without removing NOM produces a proportional increase in DBP formation because more chlorine is available to react with the organic precursor material. The correct strategy is to remove NOM first through enhanced coagulation and then apply the necessary chlorine dose to a cleaner water matrix.

68. C — MCLs are legally enforceable standards set as close to the MCLG as feasible, considering available treatment technology and cost. MCLGs are non-enforceable health-based goals set at the level where no known health effects occur — for carcinogens, the MCLG is often set at zero, while the MCL is set at a detectable, achievable level.

69. B — An engine that cranks slowly but fails to start most commonly has weak or discharged starting batteries that cannot deliver sufficient power to crank the engine at the speed needed for combustion. Battery testing and maintenance are critical components of generator readiness — weak batteries are the most common cause of generator start failures.

70. A — Low-alkalinity water (30 mg/L) cannot buffer the acid produced by alum hydrolysis, causing pH to crash below the effective coagulation range. Adding lime or soda ash before or during coagulant addition provides the buffering capacity needed to maintain pH within the effective range despite the acid generated by the coagulant.

71. D — Federal regulations require that chemical analysis results be retained for a minimum of 10 years. This extended retention period ensures that historical water quality data is available for trend analysis, compliance verification, legal proceedings, and long-term health effect assessments.

72. C — Tube settlers provide inclined surfaces within the sedimentation basin that dramatically increase the effective settling area. Particles only need to settle the short distance between adjacent plates or tubes (2–4 inches) rather than the full basin depth, allowing the basin to handle 3 to 10 times more flow in the same physical footprint.

73. B — The chlorine room exhaust fan is a critical safety system that prevents the accumulation of toxic chlorine gas in the event of a leak. A non-functional fan creates a life-threatening hazard — the fan must be repaired or replaced before chlorine gas operations resume, even if no leak is currently detected.

74. A — When the free chlorine reading equals the total chlorine reading, all of the chlorine in the sample exists as free chlorine (HOCl and OCl^-) with no combined chlorine (chloramines) present. This occurs when there is no ammonia in the water for the chlorine to combine with, or when the chlorine dose is past the breakpoint.

75. D — A Level 2 assessment — a more comprehensive investigation than a Level 1 — is triggered by an E. coli MCL violation or by a system incurring a second Level 1 assessment trigger within a rolling 12-month period. Level 2 assessments require a thorough review of the entire system to identify and correct the root cause.

76. C — Media flowing over the wash troughs indicates the backwash rate is too high, causing the bed to expand beyond the trough level and carry media out of the filter. Reducing the flow rate immediately stops the media loss. Continued loss permanently reduces the filter's bed depth and compromises filtration performance.

77. A — Volume = $\pi \times r^2 \times h = 3.14159 \times (4)^2 \times 12 = 3.14159 \times 16 \times 12 = 603.2$ cubic feet. To convert to gallons: $603.2 \times 7.48 = 4{,}512$ gallons. This volume calculation is fundamental to detention time, chemical mixing, and storage capacity assessments.

78. B — Gravimetric feeders weigh the chemical as it is delivered, ensuring accurate dosing regardless of variations in the chemical's bulk density caused by moisture content, compaction, particle size changes, or temperature. Volumetric feeders measure by volume and are less accurate when density varies.

79. D — Targeted flushing removes the stagnant, low-residual water and biofilm from the affected area, while temporarily boosting the chloramine concentration (or conducting a free chlorine burn) kills the nitrifying bacteria and restores adequate residual. This is the standard corrective response for localized nitrification episodes.

80. C — Failing to disinfect the tap spout before collecting a bacteriological sample allows bacteria present on the faucet surface — from biofilm, handling, or environmental contamination — to wash into the sample bottle and produce a false positive result that does not reflect the actual quality of water in the distribution main.

81. A — Double-dosing alum for eight hours produces excessive aluminum hydroxide sludge, consumes approximately twice the normal alkalinity (potentially crashing the pH), and may cause charge reversal (restabilization) of colloidal particles, actually worsening settled and filtered water turbidity despite using more chemical.

82. B — Turbidity samples preserved at 1–4°C have a maximum holding time of 48 hours from collection. Unlike chlorine residual (which must be analyzed immediately) or bacteriological samples (30 hours), turbidity samples have a somewhat longer holding time because the physical property being measured changes more slowly than chemical or biological parameters.

83. C — The affinity law states that pump power consumption varies with the cube of the speed (Power $\propto$ Speed^3). Reducing speed to 85% means power drops to approximately $0.85^3 = 0.614$, or about 61% of full-speed power — a 39% reduction. Throttling a valve at full speed wastes the excess energy as heat and noise across the valve.

84. C — THM MCL violations based on LRAA exceedance are Tier 2 violations requiring public notification within 30 days. THMs pose chronic (long-term) rather than acute (immediate) health risks, so the 30-day Tier 2 timeline applies rather than the 24-hour Tier 1 emergency timeline reserved for acute contaminants.

85. A — Condensate (water) accumulates in the receiver tank from moisture in the compressed air and must be drained regularly — typically daily or on an automated schedule — to prevent corrosion, reduce the tank's effective air storage capacity, and keep moisture out of the downstream pneumatic system.

86. B — Polymers added as flocculation aids work through the interparticle bridging mechanism — long-chain polymer molecules attach to multiple particles simultaneously, physically linking them into

larger, stronger aggregates. Larger, denser floc settles faster in sedimentation and is captured more effectively by filters.

87. D — While all three findings are concerning, the deteriorated annular seal presents the most immediate contamination risk because it creates a direct physical pathway for surface contaminants — including runoff from the nearby fertilizer shed — to travel along the outside of the well casing and reach the aquifer, bypassing natural soil filtration entirely.

88. C — The solution strength dropped from 12% to 8% — a reduction of one-third. To deliver the same mass of chlorine, the operator must increase the volume fed by 50% (12 ÷ 8 = 1.5, meaning 50% more volume is needed). This is why regular strength testing of stored sodium hypochlorite is essential for maintaining accurate dosing.

89. A — At 0.012 mg/L, the arsenic concentration exceeds the 0.010 mg/L MCL, constituting a violation. Arsenic is regulated as a chronic health hazard (carcinogen), placing it in the Tier 2 notification category requiring public notification within 30 days using methods that reach all persons served by the system.

90. B — Loss of the first-stage flocculation motor eliminates the initial high-energy mixing stage where collision frequency is established for small particles. Without this stage, floc formation is severely compromised throughout the remaining stages. The operator should reduce flow or take the train offline while arranging emergency repair.

91. D — The enhanced coagulation matrix generally requires higher percentage TOC removal from water with higher raw water TOC and lower alkalinity. Higher TOC means more precursor material to remove, and lower alkalinity means less chemical buffering capacity, requiring more aggressive treatment to achieve the required removal.

92. C — A 70 gpm (approximately 6%) discrepancy between two flow meters measuring the same pipe warrants investigation. Either meter could be the source of the error — both should undergo calibration verification. Assuming one is correct without testing both would be premature and could lead to incorrect flow-dependent calculations.

93. A — Elevated raw water color indicates increased dissolved natural organic matter (NOM), which increases coagulant demand (more chemical needed to remove the additional organic material) and increases DBP formation potential (more precursor material available to react with chlorine). Operators should anticipate the need for higher coagulant doses and enhanced NOM removal.

94. B — Section 10 (Stability and Reactivity) of the SDS lists the chemical's incompatibilities — substances it can react with dangerously. This section is critical for proper chemical storage because it identifies which chemicals must be segregated to prevent violent reactions, fire, or toxic gas generation.

95. D — A pump running with normal motor speed but very low amperage and near-zero discharge pressure is not doing hydraulic work — it is spinning freely without moving water. The most likely cause is loss of prime (air in the casing) or a closed suction valve, both of which prevent the pump from contacting water.

96. C — The Langelier Saturation Index uses pH, alkalinity, calcium hardness, TDS, and temperature to predict whether water will tend to deposit or dissolve calcium carbonate. The operator recognizes that these parameters collectively define the water's corrosion or scaling potential and evaluates them using the LSI framework.

97. A — SOPs must be objective, standardized documents based on best practices, manufacturer recommendations, and regulatory requirements — not on individual operators' personal opinions or preferences. Personal preferences create inconsistency between operators and undermine the SOP's purpose of ensuring uniform, correct performance.

98. B — The Ground Water Rule applies to groundwater sources, not surface water. If a system supplements its surface water supply with groundwater wells, the wells are subject to the GWR requirements (source monitoring, triggered monitoring for fecal indicators, and 4-log virus treatment if triggered), while the surface water portion remains under the SWTR.

99. B — Increased chemical consumption at the same production volume almost always indicates a change in raw water quality requiring higher treatment intensity. Higher turbidity, increased NOM loading, lower alkalinity, or temperature changes can all increase coagulant demand. The operator should review raw water quality data and perform jar testing to verify current optimal dose.

100. C — Monitoring weather conditions helps operators anticipate treatment challenges — heavy rainfall increases turbidity and runoff contamination, temperature changes affect coagulation and disinfection efficiency, drought reduces source water volume and concentrates contaminants, and algae blooms correlate with warm, sunny conditions. Proactive weather monitoring enables proactive treatment adjustments.