

Water Distribution Operator Requirements

	Level I	Level II	Level III	Level IN
System Information/Components	9%	9%	9%	9%
Monitor, Evaluate, and Adjust Disinfection	11%	11%	10%	10%
Laboratory Analysis	21%	21%	21%	20%
Install Equipment	5%	5%	5%	5%
Operate Equipment	18%	18%	18%	18%
Perform Maintenance	20%	20%	20%	21%
Perform Security, Safety, and Administrative Procedures	16%	16%	17%	17%

1 Distribution System Information/Components

System Information/ Components	Level I	Level II	Level III	Level IN
Assess system demand	Application	Application	Analysis	Analysis
Install joint restraints	Application	Application	Application	Analysis
Install shoring	Comprehension	Application	Application	Analysis
Install thrust blocks	Comprehension	Application	Application	Analysis
Layout system	N/A	N/A	Application	Application
Map system	Comprehension	Comprehension	Comprehension	Comprehension
Perform pressure readings	Application	Application	Application	Analysis
Preparedness contingency/ Contingency plan	Comprehension	Comprehension	Application	Analysis
Read blueprints, readings, and maps	Application	Application	Application	Analysis
Select materials	Comprehension	Comprehension	Application	Application
Select type of pipes	Comprehension	Comprehension	Application	Analysis
Size mains	Comprehension	Comprehension	Application	Analysis
Write plans	Comprehension	Application	Application	Analysis

2 Required Capabilities

3 Knowledge of:

- Approved backflow methods and devices
- Biological science
- Blueprint readings

- Building codes
- Corrosion control process (including cathodic protection)
- Fire flow requirements
- Function of recordkeeping system
- General hydraulic principles
- Hydrology - Local codes and ordinances
- Measuring instruments
- Mechanical drafting
- Operation and maintenance practices Pipe fittings and joining methods
- Piping material, type, and size
- Potential causes of disasters in facility
- Potential impact of disasters in facility
- Regulations
- Standards
- Watershed management

4 Ability to:

- Adjust equipment
- Assess likelihood of disaster occurring
- Generate a written safety program
- Generate capital plans
- Generate long- and short-term plans
- Interpret data
- Organize information - Perform distribution math
- Perform impact assessments
- Perform physical measurements
- Record information
- Write policies and procedures
- Review reports

5 System Information/Components

6 Sample Questions for Level I

7 Answers on page 339

1. Head is measured in
 - a. absolute pressure.
 - b. gauge pressure.
 - c. feet.
 - d. foot-pounds.

8 A plat is

- a. a map.
 - b. a corrosion point on a pipe.
 - c. organelle found in some protozoans.
 - d. a highly corrosive soil type.
-
3. Which type of valve will prevent the collapse of a pipe?
 - a. Pressure-relief valve
 - b. Needle valve
 - c. Pinch valve
 - d. Air-and-vacuum relief valve
 4. The highest degree of protection for the exterior of a coated steel pipe is
 - a. cathodic protection.
 - b. bituminous materials.
 - c. plastic coatings.
 - d. polyethylene tapes.
 5. At which time of day is the age of the water stored in the distribution system the highest?
 - a. Early morning
 - b. Late morning
 - c. Early afternoon
 - d. Late evening

9 Sample Questions for Level II

10 Answers on page 339

1. The amount of liquid that can be raised vertically by a given pressure is called
 - a. pressure head.

- b. total head.
 - c. velocity head.
 - d. pump head.
2. The amount of energy in feet that a pump supplies to a fluid is called
 - a. velocity head.
 - b. pump head.
 - c. total head.
 - d. pressure head.
 3. The C-value is a measure of a pipe's wall
 - a. smoothness.
 - b. smoothness giving even flow.
 - c. smoothness that retards turbulent flow.
 - d. roughness that retards flow due to friction.
 4. Which one of the following is a type of joint for ductile iron piping?
 - a. Expansion joint
 - b. Push-on joint
 - c. Bell and spigot with rubber o-ring
 - d. Rubber gasket joint
 5. The correct protective methods for backflow-prevention devices in order of decreasing effectiveness are
 - a. air gap, VB, RPZ, and DCVA.
 - b. air gap, VB, DCVA, and RPZ.
 - c. air gap, RPZ, VB, and DCVA.
 - d. air gap, RPZ, DCVA, and VB.

11 Sample Questions for Level III

12 Answers on page 340

1. As the total head on a system increases, the volume that a centrifugal pump delivers is reduced
 - a. directly.
 - b. indirectly.
 - c. proportionately.
 - d. disproportionately.
2. Which type of distribution system configuration surrounds the distribution area with large-diameter mains?
 - a. Grid system
 - b. Dendritic system
 - c. Arterial-loop system
 - d. Tree system
2. Which type of distribution system configuration has interconnected mains?
 - a. Grid system

- b. Dendritic system
 - c. Arterial-loop system
 - d. Tree system
3. In general, areas that require high fire flow capacity require the minimum static pressure to be
 - a. 25 psi or greater.
 - b. 30 psi or greater.
 - c. 35 psi or greater.
 - d. 40 psi or greater.
 4. Which type of joint should be used for ductile iron piping in unstable soils?
 - a. Flanged joint
 - b. Restrained joint
 - c. Flexible ball joint
 - d. Push-on joint

13 Sample Questions for Level IV

14 Answers on page 340

1. The arrangement of pumps in parallel is typically used
 - a. when head is not sufficient and more flow is required.
 - b. to increase discharge head without increasing flow.
 - c. to increase flow.
 - d. to increase pump efficiency.
2. Which of the following is a disadvantage for using steel pipe?
 - a. It has the potential for both internal and external corrosion
 - b. It is difficult to fabricate but inexpensive to transport
 - c. It is easy to install due to weight
 - d. It is very inexpensive
3. Friction head loss can be calculated using tables based on
 - a. Charles' equation.
 - b. Graham's formula.
 - c. the Hazen-Williams formula.
 - d. Russell's calculations.
4. Water behind a dam and above a water treatment plant has energy by virtue of its elevation. This difference in elevation is called elevation head or
 - a. kinetic energy.
 - b. velocity head.
 - c. potential energy.
 - d. pressure head.
4. Although velocity head can usually be ignored, it should be considered when it is to ___ percent of the pressure head.

- a. 1; 2
- b. 3; 4
- c. 5; 8
- d. 5; 10

15 Monitor, Evaluate, and Adjust Disinfection

Monitor, Evaluate, and Adjust Disinfection	Level I	Level II	Level III	Level IV
Monitor Disinfection				
Calcium hypochlorite disinfection	Application	Application	Application	Application
Chlorine gas disinfection	Comprehension	Comprehension	Application	Analysis
Sodium hypochlorite disinfection	Application	Application	Application	Application
Calcium hypochlorite disinfection	Application	Application	Application	Application
Chlorine gas disinfection	Comprehension	Comprehension	Application	Analysis
Sodium hypochlorite disinfection	Application	Application	Application	Application
Evaluate Disinfection				
Calcium hypochlorite disinfection	Analysis	Analysis	Analysis	Analysis
Chlorine gas disinfection	Analysis	Analysis	Analysis	Analysis
Sodium hypochlorite disinfection	Analysis	Analysis	Analysis	Analysis
Adjust Disinfection				
Calcium hypochlorite disinfection	Analysis	Analysis	Analysis	Analysis
Chlorine gas disinfection	Analysis	Analysis	Analysis	Analysis
Sodium hypochlorite disinfection	Analysis	Analysis	Analysis	Analysis
Calcium hypochlorite disinfection	Analysis	Analysis	Analysis	Analysis
Inspect Source Water				
Identify and evaluate potential sources of source water contamination	Analysis	Analysis	Analysis	Analysis
Wells	Application	Application	Application	Application

16 Required Capabilities

17 Knowledge of:

- Proper chemical handling and storing
- Regulations
- Reporting requirements
- Safe Drinking Water Act (SDWA)
- Safety procedures
- Sampling requirements
- Testing instruments
- Watershed management
- 40 CFR 141 Subpart C: Monitoring and Analytical Requirements (turbidity, coliforms, organic contaminants, organic contaminants)
- 40 CFR 141 Subpart D: Reporting and Recordkeeping Requirements
- 40 CFR 141 Subpart F: Maximum Contaminant Level Goals and Maximum Residual Disinfectant Level Goals
- 40 CFR 141 Subpart G: National Primary Drinking Water Regulations:

18 Ability to:

- Adjust equipment
- Adjust flow patterns
- Adjust system units
- Calibrate equipment
- Calibrate instruments Maximum Contaminant Levels and Maximum Residual Disinfectant Level
- 40 CFR 141 Subpart H: Filtration and Disinfection
- 40 CFR 141 Subpart L: Disinfectant Residuals, Disinfection Byproducts, and Disinfection Byproduct Precursors
- 40 CFR 141 Subpart P: Enhanced Filtration and Disinfection Systems . Serving 10,000 or More People

- 40 CFR 141 Subpart T: Enhanced Filtration and Disinfection Systems = Serving Fewer Than 10,000 People
- 40 CFR 141 Subpart U: Initial Distribution System Evaluations
- 40 CFR 141 Subpart V: Stage 2 Disinfection Byproducts Requireme =

19 Monitor, Evaluate, and Adjust Disinfection

- Interpret data
- Perform distribution math
- Recognize normal and abnormal analytical results

20 Sample Questions for Level I

21 Answers on page 341

1. One of chlorine's advantages is that it
 - a. is not influenced much by pH changes.
 - b. does not produce chlorinated by-products.
 - c. has a persistent residual.
 - d. does not cause taste and odor problems.
2. Chlorine gas is times heavier than air.
 - a. 1.5
 - b. 2.5
 - c. 3.5
 - d. 4.5
3. After a water storage tank has been chlorinated, which bacteriological test must prove negative before the tank is put back into service?
 - a. Gram negative test
 - b. HPC test
 - c. Coliform test
 - d. Chloramine test
3. Which is the best and most reliable method for finding a very small chlorine leak?
 - a. Use soap on possible areas of leak and watch for bubbles
 - b. Use a strong ammonia solution on a cloth swab and place it by the suspected leak
 - c. Use methane gas and watch for a dark brown smoke
 - d. Use a chlorine gas detector and place it next to any area suspected of leaking

4. The minimum required free chlorine residual anywhere in the distribution system is
 - a. a detectable level.
 - b. 0.2mg/L.
 - c. 0.4mg/L.
 - d. 0.5mg/L.

22 Sample Questions for Level II

23 Answers on page 341

1. Sodium hypochlorite (NaOCl) solution is available with available chlorine.
 - a. 2 to 5%
 - b. 5 to 20%
 - c. 25 to 50%
 - d. 50 to 70%
2. Booster chlorination is chlorine added
 - a. in the coagulation mixing chamber.
 - b. before the filters.
 - c. at the clearwell.
 - d. somewhere in the distribution system.
3. According to AWWA Standard C651, disinfection of water mains requires 24-hour exposure to which minimum free chlorine residual?
 - a. 10mg/L
 - b. 25mg/L
 - c. 50mg/L
 - d. 100mg/L
4. Which must be measured at least at the same time and at the same sampling points in the distribution system that total coliforms are sampled for a water system that only uses surface water?
 - a. pH
 - b. Langelier Index
 - c. Residual disinfectant concentration
 - d. Heterotrophic bacteria
5. Hypochlorous acid is
 - a. a weak acid.
 - b. a strong acid.
 - c. easily dissociatable.
 - d. hydrophobic.

24 Sample Questions for Level III

25 Answers on page 341

1. Which chemical oxidant would be most effective for controlling biological growth?
 - a. Chloramines
 - b. Chlorine
 - c. Ozone
 - d. Potassium permanganate
2. Which is the Maximum Residual Disinfectant Level for chlorine?
 - a. 4.0mg/L
 - b. 4.5mg/L
 - c. 5.0mg/L
 - d. 6.0mg/L
3. Which is the most common hypochlorinator problem?
 - a. Clogged equipment
 - b. Cracked pump head
 - c. Corrosion
 - d. Broken plunger
4. Which reaction will take longer with chlorine?
 - a. Hydrogen sulfide
 - b. Ammonia
 - c. Organic material
 - d. Calcium sulfide
5. If the continuous monitoring of the residual disinfectant concentration for water entering the distribution system fails, how often must grab samples be collected in lieu of continuous monitoring until the problem is repaired?
 - a. Every hour
 - b. Every 4 hours
 - c. Every 8 hours
 - d. Every 12 hours

26 Sample Questions for Level IV

27 Answers on page 342

1. Which organisms have the greatest resistance to chlorine?
 - a. Viruses
 - b. Bacteria
 - c. Nematodes
 - d. Giardia cysts

2. Which is the maximum residual for chlorine dioxide to avoid taste and odor complaints?
 - a. 0.4 to 0.5mg/L
 - b. 0.9 to 1.0mg/L
 - c. 1.3 to 1.5mg/L
 - d. 1.9 to 2.0mg/L
3. If secondary chlorine is added to a distribution system that uses chloramines, the chlorine may be added to a desired chlorine to ammonia-nitrogen ratio of
 - a. 3.0 : 1 to 3.5 : 1
 - b. 3.5 : 1 to 4.0 : 1
 - c. 4.0 : 1 to 4.5 : 1
 - d. 4.5 : 1 to 5.0 : 1
4. Gaseous chlorine dioxide is generated from
 - a. oxygen + chlorine gas + heat (energy).
 - b. aqueous chlorine + oxygen + heat (energy).
 - c. sodium chlorite + chlorine at low pH values.
 - d. hypochlorous acid + oxygen + organic catalyst.
5. Which is the most probable solution if sulfur bacteria are causing corrosion in the distribution system?
 - a. Minimize pump activity
 - b. Acidification and cleaning
 - c. Optimize coagulation, flocculation, and filtration
 - d. Routine use of disinfectant and penetrant

28 Laboratory Analysis

Laboratory Analysis	Level I	Level II	Level III	Level IV
Collect and Preserve Samples				
Chlorine demand	Application	Application	Analysis	Analysis
Chlorine residual	Application	Application	Analysis	Analysis
Coliforms	Application	Application	Analysis	Analysis
Lead/copper	Application	Application	Analysis	Analysis
Nitrate	Application	Application	Analysis	Analysis
Nitrite	Application	Application	Analysis	Analysis
pH	Application	Application	Analysis	Analysis
Radionuclides	Application	Application	Analysis	Analysis
Synthetic organic chemicals (SOC)	Application	Application	Analysis	Analysis
Temperature	Application	Application	Analysis	Analysis
Volatile organic chemicals (VOC)	Application	Application	Analysis	Analysis
Perform Laboratory Analysis				
Chlorine demand	Application	Application	Analysis	Analysis
Chlorine residual	Application	Application	Analysis	Analysis
pH	Application	Application	Analysis	Analysis
Temperature	Application	Application	Analysis	Analysis
Interpret Laboratory Analyses				
Chlorine demand	Application	Application	Analysis	Analysis
Chlorine residual	Application	Application	Analysis	Analysis
Coliforms	Application	Application	Analysis	Analysis
Hardness	Application	Application	Analysis	Analysis
Iron	Application	Application	Analysis	Analysis
Lead/copper	Analysis	Analysis	Analysis	Analysis
Nitrates	Application	Application	Analysis	Analysis
Nitrites	Application	Application	Analysis	Analysis
pH	Application	Application	Application	Analysis
Radionuclides	Application	Application	Analysis	Analysis

Synthetic organic chemicals (SOC)	Application	Application	Analysis	Analysis
Temperature	Application	Application	Application	Analysis
Turbidity	Application	Application	Application	Analysis
Volatile organic chemicals (VOC)	Application	Application	Analysis	Analysis

29 Required Capabilities

30 Knowledge of:

- Biological science
- Disinfection concepts
- Disinfection design parameters
- Disinfection process
- General chemistry
- Laboratory equipment
- Monitoring requirements
- Normal characteristics of water
- Physical science
- Proper chemical handling and storing
- Proper sampling procedures
- Quality control/quality assurance practices
- Record keeping policies
- Regulations
- Reporting requirements
- Safe Drinking Water Act (SDWA)
- Safety procedures
- Sampling requirements
- Testing instruments
- 40 CFR 141 Subpart B: Maximum Contaminant Levels (arsenic, nitrate, turbidity)
- 40 CFR 141 Subpart C: Monitoring and Analytical Requirements (turbidity, coliforms, organic contaminants, organic contaminants)

31 Ability to:

- Calibrate equipment
- Calibrate instruments
- Determine what information needs to be recorded
- Diagnose/troubleshoot equipment
- Follow written procedures
- Interpret data
- Interpret Material Safety Data Sheets - 40 CFR 141 Subpart D: Reporting and Recordkeeping Requirements
- 40 CFR 141 Subpart E: Special Regulations, Including Monitoring Regulations and Prohibition on Lead Use
- 40 CFR 141 Subpart F: Maximum Contaminant Level Goals and Maximum Residual Disinfectant Level Goals
- 40 CFR 141 Subpart G: National Primary Drinking Water Regulations: Maximum Contaminant Levels and Maximum Residual Disinfectant Levels
- 40 CFR 141 Subpart H: Filtration and Disinfection
- 40 CFR 141 Subpart I: Control of Lead and Copper
- 40 CFR 141 Subpart L: Disinfectant Residuals, Disinfection By-products, and Disinfection By-product Precursors
- 40 CFR 141 Subpart S: Ground Water Rule
- 40 CFR 141 Subpart V: Stage 2 Disinfection By-products Requirements - Organize information
- Recognize normal and abnormal analytical results
- Record information
- Review reports
- Transcribe data
- Translate technical language into common terminology

32 Laboratory Analysis

33 Sample Questions for Level I

34 Answers on page 343

1. First draw samples for the analysis of lead and copper water must be collected from taps where the water has stood motionless in the plumbing for at least
 - a. 4 hours.
 - b. 6 hours.
 - c. 8 hours.
 - d. 24 hours.
2. Samples to be tested for coliforms are collected in plastic bottles that must contain
 - a. sodium thiocarbonate.
 - b. sodium thiooxalate.
 - c. sodium thiosulfate.
 - d. sodium thiocyanate.
3. The volume of a sample for coliform compliance is
 - a. 100 mL.
 - b. 200 mL.
 - c. 300 mL.
 - d. 0 ; there is no volume compliance for coliforms.
4. If a water sample is not analyzed immediately for chlorine residual, it is acceptable if it is analyzed within
 - a. 10 minutes.
 - b. 15 minutes.
 - c. 20 minutes.
 - d. 30 minutes.
5. Which may be substituted for the analysis of residual disinfectant concentration, when total coliforms are also sampled at the same sampling point?
 - a. Heterotrophic plate count (HPC)
 - b. Fecal coliforms
 - c. Giardia lamblia
 - d. Combined chlorine

35 Sample Questions for Level II

36 Answers on page 343

1. Which water quality parameter requires a grab sample because it cannot be collected as a composite sample?
 - a. pH
 - b. Iron
 - c. Nitrate
 - d. Zinc
2. One chemical characteristic of an acid is that it will
 - a. accept an electron pair.
 - b. donate an electron pair.
 - c. accept a proton.
 - d. accept a neutron.
3. Which chemical contains calcium?
 - a. Soda ash
 - b. Lime
 - c. Caustic soda
 - d. Sodium bicarbonate
4. The best choice to collect a water sample from a customer's faucet in regards to a complaint would be a
 - a. faucet without threads.
 - b. faucet that can swivel.
 - c. single-lever handle faucet.
 - d. faucet with an aerator.
5. When measuring for free chlorine residual, which method is the quickest and simplest?
 - a. DPD color comparater
 - b. Orthotolidine method
 - c. Amperometric titration
 - d. 1, 2 nitrotoluene di-amine method

37 Sample Questions for Level III

38 Answers on page 343

1. Water that is to be analyzed for inorganic metals should be acidified with
 - a. dilute hydrochloric acid.
 - b. concentrated hydrochloric acid.
 - c. dilute nitric acid.
 - d. concentrated nitric acid.

2. If a public water system does not continuously monitor turbidity, how often must it collect a grab sample to measure turbidity from the system's filtered water?
 - a. Every 2 hours
 - b. Every 4 hours
 - c. Every 8 hours
 - d. Every 12 hours
3. If a water system uses chlorine for disinfection, but does not provide filtration, which daily parameters following each point of disinfection are required for determining CT calculations?
 - a. Lowest value for chlorine residual, pH and temperature, and highest alkalinity
 - b. Lowest value for chlorine residual and contact time, lowest temperature, and highest pH
 - c. Lowest value for chlorine residual, lowest pH, and lowest temperature
 - d. Lowest value for chlorine residual and contact time, pH and alkalinity, and highest temperature
4. A water system exceeds the lead action level if the concentration in more than 10% of tap water samples collected during any monitoring period conducted is greater than
 - a. 0.010mg/L.
 - b. 0.012mg/L.
 - c. 0.015mg/L.
 - d. 0.020mg/L.
4. A water system can reduce its monitoring of total organic carbon (TOC), if it achieves which of the following?
 - a. TOC < 1.0mg/L for 1 year or < 0.5mg/L for 6months
 - b. TOC < 2.0mg/L for 1 year or < 1.0mg/L for 6months
 - c. TOC < 2.0mg/L for 2 years or < 1.0mg/L for 1 year
 - d. TOC < 3.0mg/L for 2 years or < 2.0mg/L for 1 year

39 Sample Questions for Level IV

40 Answers on page 344

1. Under the Lead and Copper Rule of the Safe Drinking Water Act, how is the 90th percentile of lead determined for a water system serving fewer than 100 people if the system collects only 5 samples per monitoring period?
 - a. By taking the average of the highest and second highest concentrations
 - b. By allowing the sample result with the highest concentration to be the 90th percentile value
 - c. By allowing the system 2 monitoring periods before reporting
 - d. By multiplying the two highest values by 0.9, then taking the average of this result

2. A surface water system can reduce the number of samples for total trihalomethanes (TTHM) and the sum of five haloacetic acids (HAA5), if it has monitored for at least one year and
 - a. $TTHM \leq 0.020\text{mg/L}$ and $HAA5 \leq 0.010\text{mg/L}$.
 - b. $TTHM \leq 0.030\text{mg/L}$ and $HAA5 \leq 0.020\text{mg/L}$.
 - c. $TTHM \leq 0.040\text{mg/L}$ and $HAA5 \leq 0.030\text{mg/L}$.
 - d. $TTHM \leq 0.060\text{mg/L}$ and $HAA5 \leq 0.040\text{mg/L}$.
3. A water system that uses chlorine dioxide may reduce the sampling frequency in the distribution system from one three-sample set per month to after one year of monitoring where no individual chlorite sample collected in the distribution system exceeded the chlorite MCL.
 - a. one three-sample set per quarter
 - b. one six-sample set semi-annually
 - c. one three-sample set annually
 - d. one six-sample set annually
4. If a water system collects at least 40 samples per month for the analyses of total coliforms, which percent of total coliform positive samples are acceptable for the system to remain in compliance with the maximum contaminant level for total coliforms?
 - a. No more than 2%
 - b. No more than 3%
 - c. No more than 4%
 - d. No more than 5%
5. If a water system changes its disinfection sampling point, disinfection type, process, or any other modification identified by the state, it must
 - a. perform a sanitary survey.
 - b. develop a disinfection benchmark.
 - c. develop a disinfection profile.
 - d. start over or go back to routine monitoring of disinfection by-products.

41 Install Equipment

Install Equipment	Level I	Level II	Level III	Level IV
Backflow prevention devices	Comprehension	Comprehension	Comprehension	Comprehension
Hydrants	Comprehension	Application	Application	Application
Meters	Application	Application	Application	Application
Piping	Comprehension	Application	Application	Application
Service connections	Comprehension	Application	Application	Application
Taps	Comprehension	Application	Application	Analysis
Valves	Comprehension	Application	Application	Analysis
Water mains	Comprehension	Application	Application	Analysis

42 Required Capabilities

43 Knowledge of:

- Approved backflow methods and devices
- Blueprint readings
- Building codes
- Corrosion control process (including cathodic protection)
- Dechlorination process
- Different types of cross-connections
- Different types of joints, restraints, and thrust blocks

44 Ability to:

- Demonstrate safe work habits
- Diagnose/troubleshoot equipment
- Identify potential safety hazards
- Inspect pumps
- Operate safety equipment - Function of tools
- Personal protective equipment
- Pipe fittings and joining methods
- Piping material, type, and size
- Pneumatics
- Proper lifting techniques
- Protective coatings and paints
- Safety procedures - Perform distribution math
- Recognize unsafe work conditions
- Select safety equipment
- Use hand tools
- Use power tools

45 Install Equipment

46 Sample Questions for Level I

47 Answers on page 345

1. It is standard practice to install fire hydrants on mains that are at a minimum or larger.
 - a. 6 inches
 - b. 8 inches
 - c. 10 inches
 - d. 12 inches
2. A corporation stop is used for a
 - a. service line.
 - b. pump discharge line.
 - c. tank inlet.
 - d. tank outlet.
3. When PVC pipe is stacked loose, it should not be stacked more than how high?
 - a. 2.0 feet
 - b. 3.0 feet
 - c. 5.0 feet
 - d. 7.5 feet
4. Which is the most common cause for pipe joint failure (leaking) in newly laid pipe
 - a. The use of a cracked gasket
 - b. Not pushing the spigot end the full distance into the bell
 - c. Not having the joint completely clean
 - d. An incorrect trench bedding angle
5. Which should be installed at a dead-end water main?
 - a. Vacuum valve
 - b. Air valve
 - c. Blowoff valve
 - d. Water quality sampling station

48 Sample Questions for Level II

49 Answers on page 345

1. Compression fittings used with copper or plastic tubing seal by means of
 - a. beveled sleeve.

- b. compression ring.
 - c. compressed beveled gasket.
 - d. compressed o-rings located at either end of the fitting's beveled neck.
2. The breaking of a buried pipe when it is unevenly supported is called
- a. stress breakage.
 - b. shear breakage.
 - c. beam breakage.
 - d. flexural breakage.
2. Thrust from a water surge almost always acts pushes against. to the inside surface that it
- a. vertically
 - b. horizontally
 - c. perpendicular
 - d. vertically and horizontally
3. Which thrust control is easy to use, especially in locations where existing utilities or structures are numerous?
- a. Restraining fittings
 - b. Tie rods
 - c. Thrust anchors
 - d. Thrust blocks
4. The backfill material for a pipe installation should contain enough to allow for thorough compaction.
- a. moisture
 - b. sand
 - c. gravel
 - d. mixed sizes

50 Sample Questions for Level III

51 Answers on page 345

- 1. A bypass valve would be used with a
 - a. gate valve.
 - b. butterfly valve.
 - c. needle valve.
 - d. diaphragm valve.
- 2. Where ground frost is expected, the riser pipes in a meter pit should be at least how far away from any wall of the meter box to prevent freezing?
 - a. 1 to 2 inches
 - b. 2 to 4 inches
 - c. 4 to 6 inches
 - d. 6 to 8 inches
- 3. How can a distribution operator tell if a new pipe

with no obvious cracks or chips is good before it is placed in the trench for installation?

- a. By conducting a pressure test
 - b. By gently tapping the length of the pipe with a hammer; the pipe should ring or hum clearly
 - c. By attaching a sonic meter at one end and listening at other end with headphones; any defects will give crackling sounds
 - d. By placing a sonic meter at one end and an oscilloscope at the other end; defects will show up as sharp peaks and valleys as pitch is varied; no defects if only have smooth curves as pitch is varied
3. Which is the recommended trench width for a 42-inch diameter ductile-iron pipe?
 - a. 58 inches
 - b. 60 inches
 - c. 66 inches
 - d. 72 inches
 4. The first layer of backfill if compaction is required for a newly installed pipe should come up to
 - a. the bottom of the pipe.
 - b. one-third up the bottom of the pipe.
 - c. the centerline of the pipe.
 - d. the top of the pipe.

52 Sample Questions for Level IV

53 Answers on page 346

1. If special bedding material is required by the design engineer due to poor local soil conditions, the material should not contain granular material greater than
 - a. $\frac{1}{4}$ inch.
 - b. $\frac{1}{2}$ inch.
 - c. $\frac{3}{4}$ inch.
 - d. 1 inch.
2. How much will a flexible disk coupling compensate for in parallel misalignment?
 - a. $\frac{1}{32}$ inch
 - b. $\frac{1}{16}$ inch
 - c. $\frac{1}{8}$ inch
 - d. $\frac{1}{4}$ inch
3. Which will a flexible diaphragm coupling compensate for in angular movement?

- a. 1.0 degree
 - b. 2.0 degrees
 - c. 3.7 degrees
 - d. 4.0 degrees
4. When a pressure reducing and a pressure sustaining valve are used in combination, one valve can keep a constant pressure even with fluctuating demand, while the other valve holds the pressure at a minimum predetermined
- a. upstream; flow
 - b. upstream; pressure
 - c. downstream; flow
 - d. downstream; pressure
4. If backsiphonage occurs with a reduced-pressure device and the pressure drops below 2 psi, which process will occur?
- a. A vacuum will occur between the check valves, closing the check valve on the customer's side and fully opening the relief valve
 - b. A vacuum will occur on the supply side closing both check valves and fully opening the relief valve
 - c. The customer's check valve will close due to atmospheric pressure between the check valves, causing the relief valve to fully open
 - d. The relief valve will remain fully open and an air gap (atmospheric pressure) will form between the check valves, closing them both

54 Operate Equipment

Operate Equipment	Level I	Level II	Level III	Level IV
Blowers and compressors	Comprehension	Comprehension	Comprehension	Comprehension
Chemical feeders	Comprehension	Comprehension	Comprehension	Comprehension
Chlorinators	Comprehension	Comprehension	Application	Application
Computers	Comprehension	Application	Application	Application
Drives	Comprehension	Application	Application	Analysis
Electrical motors	Comprehension	Application	Analysis	Analysis
Electronic testing equipment	Comprehension	Comprehension	Application	Analysis
Engines	Comprehension	Application	Application	Application
Generators	Comprehension	Application	Application	Application
Hand tools	Application	Application	Application	Application
Heavy equipment	Comprehension	Comprehension	Application	Analysis
Hydrants	Application	Application	Application	Application
Hydraulic equipment	Comprehension	Comprehension	Application	Application
Instrumentation	Comprehension	Application	Application	Analysis
Leak correlators/detectors	Comprehension	Application	Application	Analysis
Pipe locators	Application	Application	Application	Analysis
Power tools	Comprehension	Application	Application	Application
Pumps	Application	Application	Application	Analysis
Samplers	Comprehension	Application	Application	Analysis
SCADA	Comprehension	Application	Application	Analysis
Tapping equipment	Comprehension	Application	Application	Analysis
Telemetry system	Comprehension	Application	Analysis	Analysis
Valve locators	Application	Application	Application	Analysis
Valves	Application	Application	Analysis	Analysis

55 Required Capabilities

56 Knowledge of:

- Facility operation and maintenance
- Function of tools
- General electrical principles
- General hydraulic principles
- General mechanical principles

- Internal combustion engines
- Lubricant and fluid characteristics
- Operation and maintenance practices

57 Ability to:

- Adjust equipment
- Adjust flow patterns
- Adjust system units
- Calibrate equipment
- Calibrate instruments
- Demonstrate safe work habits
- Operate safety equipment - Pipe fittings and joining methods
- Piping material, type and size
- Pneumatics
- Quality control/quality assurance practices
- Start-up and shut down procedures
- Testing instruments

58 Operate Equipment:

59 Sample Questions for Level I

60 Answers on page 347

1. The "heart" of a pump is called the
 - a. volute case.
 - b. impeller.
 - c. motor.
 - d. pump.
- Perform distribution math
 - Perform physical measurements
 - Recognize unsafe work conditions

- Select safety equipment
 - Use hand tools
 - Use power tools
2. Which device serves the same function as the packing?
 - a. Inline suction gland
 - b. Packing gland
 - c. Mechanical seal
 - d. Lantern seal
 3. Which is used to stop air leakage into the casing around a pump shaft?
 - a. Packing gland
 - b. Lantern ring
 - c. Seals
 - d. Shaft sleeves
 4. Which is at the top of a stuffing box?
 - a. Packing gland
 - b. Lantern ring
 - c. Mechanical seal
 - d. Seal cage
 5. Which assembly holds the lantern ring and packing?
 - a. Shaft assembly
 - b. Casing ring assembly
 - c. Packing gland casing
 - d. Stuffing box

61 Sample Questions for Level II

62 Answers on page 347

1. Which of the following prevents the impeller of a pump from turning on the shaft?
 - a. Lock nut on threaded shaft
 - b. Key
 - c. Steel pin
 - d. Caliper pin
2. Which type of valve is used to isolate a pump on the suction side?
 - a. Butterfly valve
 - b. Globe valve
 - c. Gate valve
 - d. Ball valve
3. Water hammer can be described as
 - a. particle waves.

- b. acoustic waves.
 - c. rogue waves.
 - d. longitudinal waves.
4. When fully opened, which valve will have the highest head loss?
 - a. Gate valve
 - b. Plug valve
 - c. Globe valve
 - d. Ball valve
 5. Which type of pressure sensor uses a wire fastened to a diaphragm?
 - a. Bellows sensor
 - b. Strain gauge
 - c. Helical sensor
 - d. Diaphragm element

63 Sample Questions for Level III

64 Answers on page 348

1. Which two forces determine the behavior of electricity?
 - a. Static and dynamic forces
 - b. Dynamic and induced forces
 - c. Electric and magnetic forces
 - d. Amperage and voltage forces
2. The height a liquid can be raised vertically by a given pressure is called
 - a. pressure head.
 - b. total head.
 - c. velocity head.
 - d. pump head.
2. A split case pump has three impellers. Which type of multistage pump is this?
 - a. One stage
 - b. Two stage
 - c. Three stage
 - d. Six stage
3. A split case pump has two equal smaller impellers placed on either side of two equally sized large impellers. How many stages does this pump have?
 - a. One stage
 - b. Two stages
 - c. Four stages
 - d. Eight stages
4. A pump loses its prime because the suction line has an air pocket. Which is the best solution?

- a. Check pump's amperage and be sure pump's strainer is clean
- b. Clean or repair priming unit
- c. Open suction piping air bleed-off valves
- d. Check external water seal unit

65 Sample Questions for Level IV

66 Answers on page 348

1. The lowest pressure point in the pump is the
 - a. center of the impeller.
 - b. outermost part of the impeller.
 - c. suction side of the pump.
 - d. discharge side of the pump.
2. The shaft's main function is to transmit from the motor to the impeller.
 - a. centrifugal force
 - b. torque
 - c. kinetic energy
 - d. thrust
3. Which is the range of specific speeds for a propeller pump?
 - a. 500 to 5,000rpm
 - b. 5,000 to 9,000rpm
 - c. 9,000 to 15,000rpm
 - d. 12,000 to 18,000rpm
4. A vertical turbine pump would most likely have a specific speed of
 - a. 3,000 rpm.
 - b. 6,000 rpm.
 - c. 9,000rpm.
 - d. 12,000rpm.
4. Which is the most common cause for surges in the distribution system?
 - a. Power failure shutting down a pump suddenly
 - b. Valve opening and closing
 - c. Failure of flow on pressure regulation
 - d. Pump start-up

67 Perform Maintenance

Perform Maintenance	Level I	Level II	Level III	Level IV
Blowers and compressors	N/A	N/A	N/A	Application
Chemical feeders	Application	Application	Application	Analysis
Chlorinators	Application	Application	Analysis	Analysis
Corrosion control	Application	Application	Analysis	Analysis
Cross-connection control	Application	Application	Analysis	Analysis
Drives	N/A	N/A	N/A	Analysis
Electric motors	Application	Application	Application	Application
Electrical grounding	Application	Application	Application	Application
Engines	Comprehension	Comprehension	Application	Analysis
Evaluate Operation of Equipment	Application	Application	Analssis	Analysis
Facility inspection	Application	Application	Analysis	Analysis
Generators	Comprehension	Comprehension	Application	Application
Hydrants	Application	Application	Analysis	Analysis
Hydraulic equipment	N/A	N/A	Application	Analysis
Hypochlorinators	Application	Analysis	Analysis	Analysis
Instrumentation	Comprehension	Application	Application	Analysis
Leak detection	Application	Application	Analysis	Analysis
Lock-out/tag-out	Application	Application	Application	Application
Meters	Application	Application	Application	Analysis
Pressure sensors	Application	Application	Analysis	Analysis
Pumps	Application	Application	Analysis	Analysis
Service connection	Comprehension	Application	Application	Analysis
Service pipes	Comprehension	Comprehension	Application	Application
Valves	Application	Application	Application	Analysis
Water mains	Application	Application	Analysis	Analysis
Water storage facility	Application	Application	Analysis	Analysis

68 Required Capabilities

69 Knowledge of:

- Approved backflow methods and devices
- Blueprint readings
- Building codes
- Corrosion control process (including cathodic protection)

- Different types of cross-connections
- Different types of joints, restraints, and thrust blocks
- Facility operation and maintenance
- Facility security
- Function of tools
- General electrical principles
- General hydraulic principles
- General mechanical principles
- Internal combustion engines
- Laboratory equipment
- Local codes and ordinances
- Lubricant and fluid characteristics

70 Ability to:

- Adjust equipment
- Adjust flow patterns
- Adjust system units
- Assess likelihood of disaster occurring
- Assign work to proper trade
- Calibrate equipment
- Calibrate instruments
- Demonstrate safe work habits
- Diagnose/troubleshoot equipment
- Diagnose/troubleshoot system units
- Differentiate between preventative/ corrective maintenance
- Discriminate between normal/abnormal conditions
- Evaluate facility performance
- Evaluate operation of equipment

- Evaluate system units
- Identify potential safety hazards
- Inspect pumps
- Interpret data
- Interpret Material Safety Data Sheets
- Maintain inventory control system - Measuring instruments
- Operation and maintenance practices
- Personal protective equipment
- Pipe fittings and joining methods
- Piping material, type, and size
- Pneumatics
- Potential causes of disasters in facility
- Potential impact of disasters in facility
- Proper chemical handling and storing
- Proper lifting techniques
- Protective coatings and paints
- Quality control/quality assurance practices
- Record keeping policies
- Safety procedures
- Sanitary survey processes
- Start-up and shut down procedures
- Testing instruments
- Well-head protection
- Maintain system in normal operating condition
- Monitor electrical equipment
- Monitor mechanical equipment
- Obtain unbiased data
- Operate safety equipment

- Organize information
- Perform distribution math
- Perform general maintenance
- Perform general repairs
- Perform physical measurements
- Recognize normal and abnormal analytical results
- Recognize unsafe work conditions
- Record information
- Review reports
- Select safety equipment
- Translate technical language into common terminology
- Use hand tools
- Use power tools

71 Perform Maintenance

72 Sample Questions for Level I

73 Answers on page 349

1. Why is it so important to monitor the speed of a variable-speed pump?
 - a. To prevent excessive temperatures from developing
 - b. To prevent vibration from developing
 - c. To prevent speed oscillation from occurring
 - d. To prevent cavitation from occurring
2. Which basic electrical unit is used to measure a material's opposition to the flow of electricity?
 - a. Ampere
 - b. Ohm
 - c. Volts
 - d. Resistance or impedance
3. The first oil change on a new pump should be done
 - a. after the first two weeks of operation.
 - b. after one month of operation.
 - c. after three months of operation.
 - d. after six months of operation.

4. How often should the temperature of centrifugal pump motor bearings be checked with a thermometer?
 - a. Every day
 - b. Once a week
 - c. Twice a month
 - d. Once a month
5. All sensors that respond to liquid pressure will perform poorly if enter(s) the sensor.
 - a. air
 - b. corrosive chemicals from water treatment processes
 - c. corrosive chemicals from piping
 - d. iron bacteria

74 Sample Questions for Level II

75 Answers on page 349

1. Packing replacement is usually performed when
 - a. water leakage sprays out of the pump housing.
 - b. no further tightening can be done on the packing gland.
 - c. the packing gland bolts are exposed by more than $2^{1/2}$ inches above the nut.
 - d. the packing has completely disintegrated.
2. Which device changes alternating current to direct current by allowing the electric current to flow in one direction but blocking flow in the opposite direction?
 - a. Regulator
 - b. Converter
 - c. Inverter
 - d. Rectifier
2. To ease installation of impeller wear rings, they can be
 - a. lubricated with a light oil.
 - b. greased with lithium.
 - c. heated.
 - d. cooled.
3. Packing is designed to
 - a. add lubricant to the shaft.
 - b. expand and deteriorate with normal use.
 - c. protect the shaft.
 - d. wear and deteriorate with normal use.
4. Bearings on a line shaft turbine can be lubricated with
 - a. oil or water.
 - b. grease or oil.

- c. lithium or grease.
- d. graphite or grease.

76 Sample Questions for Level III

77 Answers on page 349

1. Insulators usually fail because of
 - a. abnormally high voltages.
 - b. excessive heat.
 - c. switching surges.
 - d. mechanical failure.
2. Although some phase imbalance will occur in any system, in general, it should not exceed
 - a. 5%.
 - b. 10%.
 - c. 15%.
 - d. 20%.
3. Nitrification in the distribution system can best be described as the
 - a. breakdown of ammonia by certain bacteria.
 - b. utilization of nitrogen in ammonia by certain bacteria.
 - c. oxidation of ammonia to nitrites then to nitrates.
 - d. reduction of ammonia to nitrites then to nitrates.
4. Which type of rigid coupling is easy to install and remove?
 - a. Split coupling
 - b. Jaw coupling
 - c. Gear coupling
 - d. Flexible disc coupling
4. Which is the correct equation for Ohm's Law?
 - a. Volts = (amps)(ohms)
 - b. Ohms = (volts)(amps)
 - c. Ohms = amps/volts
 - d. Amps = (volts)(ohms)

78 Sample Questions for Level IV

79 Answers on page 350

1. Which are the basic components of every telemetry system?
 - a. Transmitter, signal, receiver, and indicator
 - b. Transmitter, receiver, and indicator

- c. Transmitter, transmission channel, and receiver
 - d. Sensor, transmitter, transmission channel, and receiver
2. The anodes placed in a water storage tank for cathodic protection usually last , and should be inspected every
 - a. 10 years; 6 months
 - b. 10 years; year
 - c. 15 years; 6 months
 - d. 20 years; year
 3. In general, the current drawn by a motor the instant it is connected to the power source, called the locked-motor current, is usually times the normal fullload current of the motor.
 - a. 1.5 to 2.0
 - b. 2.0 to 3.0
 - c. 3.0 to 5.0
 - d. 5.0 to 10.0
 4. Most telemetry equipment transmit information by
 - a. digital signals.
 - b. analog signals.
 - c. audio signals.
 - d. electrical pulses.
 5. Control systems consist of the following distinct components:
 - a. Signal conditioners and control elements
 - b. Signal conditioners, actuators, and control elements
 - c. Signal conditioners, actuators, control elements, and indicators
 - d. Sensors, signal conditioners, actuators, control elements, and indicators

80 Perform Security, Safety, and Administrative Procedures

Perform Security, Safety, and Administrative Procedures	Level I	Level II	Level III	Level IV
Manage System				
Administer safety/compliance program	Comprehension	Application	Application	Analysis
Conduct cross-connection surveys	Application	Application	Analysis	Analysis
Develop budget	N/A	N/A	Analysis	Analysis
Develop operation and maintenance plan	Comprehension	Application	Analysis	Analysis
Develop/maintain sample site plan	Application	Application	Analysis	Analysis
Participate in sanitary surveys	Application	Application	Application	Application
Regulatory reporting	Analysis	Analysis	Analysis	Analysis
Promote Public Relations				
Promote customer service program	N/A	Application	Analysis	Analysis
Respond to complaints	Application	Application	Application	Application
Safety Program				
Chemical safety	Application	Application	Application	Analysis
Confined space entry	Application	Application	Application	Application
Excavation, shoring and trenching	Application	Application	Application	Application
General Safety	Application	Application	Application	Application
Personal protective equipment	Application	Application	Application	Application
Public protection	Application	Application	Application	Application
Recordkeeping				
Compliance	Application	Application	Application	Application
Corrective actions to system deficiencies	Application	Application	Application	Application
Equipment repair/replacement	Application	Application	Application	Analysis
Laboratory	Application	Application	Application	Analysis
Maintenance	Application	Application	Application	Application
System operation	Application	Application	Analysis	Analysis

81 Required Capabilities

82 Knowledge of:

- Biological science
- Blueprint readings

- Building codes
- Data acquisition techniques
- Disciplinary procedures
- Emergency plans
- Employment laws
- Facility security
- Function of recordkeeping system
- General chemistry
- General electrical principles
- General hydraulic principles
- General mechanical principles
- Human resource practices
- Hydrology
- Local codes and ordinances
- Memorandums of understanding and agreements
- Monitoring requirements
- Potential causes of disasters in facility
- Potential impact of disasters in facility
- Principles of finance
- Principles of general communication
- Principles of management
- Principles of measurement
- Principles of public relations

83 Ability to:

- Assess likelihood of disaster occurring
- Assign work to proper trade
- Communicate in writing
- Communicate verbally
- Conduct meetings
- Conduct training programs
- Coordinate emergency response with other water organizations relative to the distribution system
- Determine what information needs to be recorded
- Develop a staffing plan
- Develop a work unit
- Evaluate facility performance
- Evaluate promotional materials
- Evaluate proposals
- Follow written procedures
- Generate a written safety program
- Generate capital plans - Principles of supervision
- Public notification requirements
- Public participation requirements
- Quality control/quality assurance practices
- Record keeping policies
- Regulations
- Reporting requirements
- Risk management
- Safe Drinking Water Act (SDWA)
- Sanitary spring design
- Sanitary survey processes

- Standards
- Water reuse
- Watershed management
- 40 CFR 141 Subpart A: General (definitions, coverage, variances and exemptions, siting requirements, and effective dates)
- 40 CFR 141 Subpart D: Reporting and Recordkeeping Requirements
- 40 CFR 141 Subpart O: Consumer Confidence Reports
- 40 CFR 141 Subpart Q: Public Notification of Drinking Water Violations
- Generate long- and short-term plans
- Identify potential safety hazards
- Interpret data
- Negotiate contracts
- Obtain unbiased data
- Organize information
- Perform distribution math
- Perform impact assessments
- Prepare proposals
- Recognize normal and abnormal analytical results
- Recognize unsafe work conditions
- Record information
- Review reports
- Select safety equipment
- Transcribe data
- Translate technical language into common terminology
- Write policies and procedures

84 Perform Security, Safety, and Administrative Procedures

85 Sample Questions for Level I

86 Answers on page 351

1. Which agency sets legal limits on the concentration levels of harmful contaminants in potable water distributed to customers?
 - a. National Primary Drinking Water Regulations
 - b. United States Environmental Protection Agency
 - c. United States Public Health Service
 - d. Occupational Health and Safety Organization
2. Which violations are the most serious?
 - a. Tier I
 - b. Tier II
 - c. Tier III
 - d. Tier IV
3. A positive fecal coliform test must be reported to the primacy agency within
 - a. 8 hours.
 - b. 12 hours.
 - c. 24 hours.
 - d. 48 hours.
4. The number of monthly distribution system bacteriological samples required is
 - a. based on water withdrawal permit limit.
 - b. based on system size.
 - c. based on population served.
 - d. different for each state.
5. Which is the approximate angle of repose for average soils when using the sloping method for the prevention of cave-ins? (Note: horizontal to vertical distance, respectively)
 - a. 0.5 : 1.0
 - b. 1.0 : 1.0
 - c. 1.5 : 1.0
 - d. 2.0 : 1.0

87 Sample Questions for Level II

88 Answers on page 351

1. Which is the Maximum Contaminant Level for total trihalomethanes (TTHMs)?
 - a. 0.040mg/L
 - b. 0.060mg/L
 - c. 0.080mg/L
 - d. 0.100mg/L
2. A system that fails to collect water samples in their distribution system would fall under which public notification requirement?
 - a. Tier I
 - b. Tier II
 - c. Tier III
 - d. Tier IV
2. Under the Surface Water Treatment Rule, disinfection residuals must be collected at the same location in the distribution system as
 - a. coliform samples.
 - b. total trihalomethanes.
 - c. disinfection by-products.
 - d. alkalinity, conductivity, and pH for corrosion studies.
3. Iron can cause "red water" and thus customer complaints when its concentration is above its secondary maximum contaminant level of
 - a. 0.01mg/L.
 - b. 0.05mg/L.
 - c. 0.10mg/L.
 - d. 0.30mg/L.
4. Which chemical may encourage the growth of algae and microorganisms?
 - a. Lime
 - b. Sodium bicarbonate
 - c. Sodium hydroxide
 - d. Zinc orthophosphate

89 Sample Questions for Level III

90 Answers on page 351

1. Water systems that collect samples for coliform testing must not find more than percentage of the samples they collect each month to be coliform positive.
 - a. 2%
 - b. 4%
 - c. 5%
 - d. 10%

2. Which is the Maximum Contaminant Level for nitrate as measured as nitrogen?
 - a. 1.0mg/L
 - b. 2.0mg/L
 - c. 5.0mg/L
 - d. 10.0mg/L
3. How much time does a community water system have for public notification if they have any Tier III violation?
 - a. 60 days
 - b. 3 months
 - c. 6 months
 - d. 12 months
4. Cohesive soil would contain a lot of
 - a. water.
 - b. clay.
 - c. clay and silt.
 - d. clay, silt, and sand.
4. The lead and copper rule requires lead to be less than 0.015mg/L in which percentage of the total samples collected?
 - a. 75%
 - b. 90%
 - c. 95%
 - d. 99%

91 Sample Questions for Level IV

92 Answers on page 352

1. Who should inspect the work of a water storage painting contractor?
 - a. The water utility supervisor
 - b. A water operator or operators responsible for the area the tank is located in
 - c. At least two competing painting contractors
 - d. A qualified third party
2. Aviation warning lights on water storage tanks have an FAA regulation that requires the bulbs to be replaced before they reach what percentage of their normal life expectancy?
 - a. 50%
 - b. 60%
 - c. 75%
 - d. 80%
3. The most expensive part of a pipe installation is/are the
 - a. pipe fittings.

- b. valves.
 - c. excavation.
 - d. engineers' design.
4. Which of the following is a potential biological biotoxin threat?
 - a. Sarin
 - b. Ricin
 - c. Taban
 - d. 3-quinuclidinyl benzilate
 5. The IDLH (Immediately Dangerous to Life and Health) value for chlorine, set by the National Institution of Occupational Safety and Health, is
 - a. 10ppm.
 - b. 15ppm.
 - c. 25ppm.
 - d. 30ppm.

93 Additional Distribution Operator Practice Questions

94 Answers on page 353

1. At which time of day is the age of the water stored in the distribution system the lowest?
 - a. Early morning
 - b. Late morning
 - c. Early afternoon
 - d. Late evening
2. Which type of maps should not overlap each other?
 - a. Index maps
 - b. Comprehensive maps
 - c. Construction maps
 - d. Sectional maps
3. Which one of the following is a type of joint for ductile iron piping?
 - a. Welded joint
 - b. Expansion joint
 - c. Flexible ball joint
 - d. Bell and spigot with rubber o-ring
4. The amount of energy in feet required to overcome resistance to flow in a pipe is called
 - a. pump head.
 - b. cutoff head.
 - c. pressure head.
 - d. friction head.

5. The fire insurance underwriters recommend that no main should have a diameter less than
 - a. 3 inches.
 - b. 4 inches.
 - c. 6 inches.
 - d. 8 inches.
6. Water velocities through pipe should be limited to 5ft/sec in order to
 - a. minimize friction loss.
 - b. reduce the number of pressure reducing stations.
 - c. minimize destruction of piping appurtenances.
 - d. reduce the amount of corrosion inhibitors applied to piping.
7. Which of the following is a type of joint for polyvinyl chloride piping?
 - a. Bell and spigot type
 - b. Thermal butt-fusion
 - c. Expansion joint
 - d. Restrained joint
7. Which of the following is a type of joint for high-density polyethylene piping?
 - a. Bell and spigot type
 - b. Thermal butt-fusion
 - c. Push-on joint
 - d. Restrained joint
8. Which of the following is a type of joint for ductile iron piping?
 - a. Welded joint
 - b. Restrained joint
 - c. Expansion joint
 - d. Rubber gasket joint
9. Which of the following is a type of joint for ductile iron piping?
 - a. Welded joint
 - b. Bell and spigot joint
 - c. Expansion joint
 - d. Flanged joint
10. The height of water in three differently shaped tanks is 22.4 feet. Which tank will have the highest psi at the bottom?
 - a. The square tank
 - b. The rectangular tank
 - c. The cylindrical tank
 - d. It will be the same in all three tanks
11. A water tank has a glass tube on its side showing the water level in the tank. What is this surface called?
 - a. Hydraulic grade line
 - b. Piezometric surface

- c. Potentiometric surface
 - d. Potential surface
12. Minor head losses are caused by
 - a. slime growths and corrosion or scaling.
 - b. corrosion and tuberculation.
 - c. type of pipe material and "C" factor.
 - d. sudden changes in direction or velocity of flow.
 13. Water mains should primarily be sized based on
 - a. earthquake size potential.
 - b. peak domestic and commercial demands.
 - c. peak commercial and industrial demands.
 - d. adequate fire flow at an appropriate pressure.
 15. The most desirable residential pressure ranges from
 - a. 20 to 35 psi.
 - b. 35 to 50 psi.
 - c. 50 to 75 psi.
 - d. 75 to 90 psi.
 14. Which is pipe strength expressed in?
 - a. Hydrostatic potential
 - b. Psi and durability
 - c. Tensile and flexural strength
 - d. Baud units
 15. The resistance of a material to longitudinal pulling forces before it breaks is called
 - a. flexural strength.
 - b. shear strength.
 - c. ductile strength.
 - d. tensile strength.
 16. Most water systems use hydrants with two nozzles with diameters of and one nozzle with a diameter of
 - a. 2.0 inches; 3.0 inches
 - b. 2.0 inches; 4.0 inches
 - c. 2.5 inches; 3.5 inches
 - d. 2.5 inches; 4.5 inches
 17. Which type of pipe is durable and strong, has high flexural strength and good corrosion resistance, and is easily tapped?
 - a. High-density polyethylene
 - b. Steel
 - c. Ductile iron
 - d. Reinforced concrete
 18. Which of the following is a type of joint for concrete piping?
 - a. Expansion joint

- b. Push-on joint
 - c. Bell and spigot type
 - d. Flanged joint
19. Precipitative softening water treatment plants try to end up with distribution system water that is
- a. slightly scale forming.
 - b. moderate scale forming.
 - c. neutral.
 - d. in equilibrium.
20. Which is a closed fire line?
- a. Broken fire hydrant or pipeline that feeds a fire hydrant
 - b. Unmetered connection for a fire protection system
 - c. Closed valve to a fire hydrant
 - d. Closed valve to a fire sprinkler system
23. Comprehensive maps of medium to large systems generally have scales ranging from
- a. 250 to 500 feet to 1 inch.
 - b. 500 to 1,000 feet to 1 inch.
 - c. 1,000 to 1,500 feet to 1 inch.
 - d. 1,500 to 2,000 feet to 1 inch.
21. Sectional maps generally have scales ranging from
- a. 50 to 100 feet to 1 inch.
 - b. 100 to 200 feet to 1 inch.
 - c. 200 to 250 feet to 1 inch.
 - d. 250 to 400 feet to 1 inch.
22. Which type of centrifugal pumps are the most common?
- a. Axial flow impellers
 - b. Radial flow impellers
 - c. Mixed flow impellers
 - d. Vertical flow impellers
23. Which of the following is a type of joint for steel piping?
- a. Flexible ball joint
 - b. Restrained joint
 - c. Expansion joint
 - d. Push-on joint
24. Which of the following is a type of joint for steel piping?
- a. Flexible ball joint
 - b. Rubber gasket joint
 - c. Restrained joint
 - d. Galvanized steel ring
25. The pressure during fire flow conditions should not drop below
- a. 15 psi.

- b. 20 psi.
 - c. 25 psi.
 - d. 30 psi.
26. During a fire flow event, the residual pressure in a large main should be greater than
- a. 15 psi.
 - b. 20 psi.
 - c. 25 psi.
 - d. 35 psi.
27. Which type of distribution system configuration has smaller mains that generally terminate as dead-ends?
- a. Grid system
 - b. Dendritic system
 - c. Arterial-loop system
 - d. Tree system
31. Which is applied to electrodes placed in the water of a water storage tank?
- a. AC current
 - b. DC current
 - c. An electrolytic inhibitor around the seals where the wires enter the electrodes
 - d. Nothing
28. The frequent starting of distribution system pumps probably indicates
- a. pump is overheating.
 - b. inadequate supply to pump or check valve leaking back.
 - c. inadequate distribution storage.
 - d. pump is in need of maintenance.
29. Which needs to be determined first when designing a pump station?
- a. Discharge requirements
 - b. Head requirements
 - c. Power requirements
 - d. Capacity requirements
30. Which is plotted on the horizontal scale (x-axis) of a pump curve?
- a. Efficiency
 - b. Capacity (flow rate)
 - c. Total head
 - d. Power
31. Hydraulics is the study of
- a. fluid pressure in pipes or conduits.
 - b. the force of fluids in motion.
 - c. the pressure of fluids in motion.
 - d. fluids in motion and at rest.

32. Which type of pipe joint consists of two machined surfaces?
- Restrained joint
 - Push-on joint
 - Flanged joint
 - Mechanical joint
33. Which type of pipe joint requires a movable follower ring?
- Flanged joint
 - Grooved joint
 - Restrained joint
 - Mechanical joint
34. What is the height limit to which siphoned water can be lifted at sea level?
- 22.4 feet
 - 32.0 feet
 - 33.9 feet
 - 34.0 feet
39. How many feet of water will equal the atmospheric pressure at sea level?
- 28
 - 30
 - 32
 - 34
35. Which type of impeller is best to use for pumping water with low volumes of solids?
- Closed
 - Open
 - Semi-open
 - Radial
36. Which type of pump has the ability to rotate its discharge 360° ?
- End suction pump
 - Split case pump
 - Vertical pump
 - Jet pump
37. How many times higher than the normal operating pressure should the pressure rating of distribution system piping be?
- 1.0 to 2.0 times
 - 2.5 to 4.0 times
 - 4.0 to 5.0 times
 - 5.0 to 7.0 times
38. Which type of pipe has been banned in the water industry?
- Ductile iron
 - Steel
 - Asbestos cement
 - High-density polyethylene

39. Which of the following types of pipe comes in diameters as large as 168 inches (14 feet)?
 - a. Cast-iron pipe
 - b. Reinforced concrete
 - c. Ductile iron
 - d. Prestressed concrete
40. Which type of pipe has the highest normal maximum working pressure?
 - a. Reinforced concrete
 - b. Ductile iron
 - c. Polyvinyl chloride
 - d. High-density polyethylene
41. Which type of pipe has the lowest normal maximum working pressure?
 - a. Reinforced concrete
 - b. Ductile iron
 - c. Polyvinyl chloride
 - d. High-density polyethylene
47. Ductile iron piping using flexible ball joints is most appropriate for
 - a. low-pressure applications.
 - b. high-pressure applications.
 - c. river crossings or rugged terrain.
 - d. all locations.
42. Ductile iron piping using push-on or mechanical joints is most appropriate
 - a. for low-pressure applications.
 - b. for high-pressure applications.
 - c. for river crossings or rugged terrain.
 - d. where flexibility is required.
43. Polyvinyl chloride piping using solvent weld joints is most appropriate
 - a. only for small lines.
 - b. for high pressure applications.
 - c. where flexibility is required.
 - d. where valves or fittings are to be attached.
44. Concrete piping using bell and spigot type joints is appropriate
 - a. for all locations.
 - b. where expansion or contraction will occur.
 - c. under low-pressure applications.
 - d. under high-pressure applications.
45. Which type of pipe joint is available in both bolted and boltless flexible pipe joint designs?
 - a. Ball and socket joint
 - b. Push-on joint
 - c. Grooved joint
 - d. Shouldered joint

46. Which type of pipe joint permits flexible pipe alignment, is inexpensive to manufacture, and is easy to assemble?
- a. Mechanical joint
 - b. Push-on joint
 - c. Grooved joint
 - d. Ball and socket joint
47. Which type of pipe joint has machined ends?
- a. Restrained joint
 - b. Flanged joint
 - c. Mechanical joint
 - d. Shouldered joint
48. New polyvinyl chloride pipe has a C-value of about
- a. 125 .
 - b. 125 to 128 .
 - c. 135 .
 - d. 150+.
55. Which of the following water storage facilities is most likely to contain non-potable water?
- a. Standpipe
 - b. Buried storage tanks
 - c. Emergency storage tanks
 - d. Elevated tanks using a riser; one way in and one way out
49. Which type of valve is used on hydraulic lines connected to valve actuators?
- a. Pinch valve
 - b. Needle valve
 - c. Pressure-relief valve
 - d. Vacuum-relief valve
50. Which type of valve would be particularly useful for throttling the flow of corrosive liquids?
- a. Diaphragm valve
 - b. Butterfly valve
 - c. Gate valve
 - d. Pinch valve
51. Water meter pits are usually used in
- a. areas where flooding will most likely occur.
 - b. areas where flooding is very rare.
 - c. cold climates.
 - d. hot climates.
52. A horizontal load, parallel to a pump shaft is called a
- a. shear load.
 - b. thrustload.

- c. radial load.
 - d. stress load.
53. Manufacturers typically design pumps such that the first critical speed is at least higher or lower than rated speed.
- a. 10%
 - b. 20%
 - c. 25%
 - d. 30%
54. Regarding fire flow, mains smaller than 6 inches should only be used
- a. in residential areas.
 - b. in low-value districts.
 - c. in rural areas.
 - d. to complete a grid.
55. Which type of pipe requires special external protection in high-chloride soils?
- a. Reinforced concrete
 - b. Ductile iron
 - c. Steel
 - d. High-density polyethylene
56. Which type of pipe would most likely collapse or become distorted under a partial vacuum?
- a. Asbestos-cement
 - b. Steel
 - c. Cast iron
 - d. Plastic
57. Casing pipe used to house a large water main under a railroad crossing should have a diameter that is larger than the outside diameter of the water main bells.
- a. less than 2 inches
 - b. 2 to 8 inches
 - c. 8 to 6 inches
 - d. 6 to 8 inches
58. Data manipulations using the basic elements of an automatic mapping (MS)/Facility mapping (FM)/Geographic Information Systems (GIS) would include
- a. collection and storage.
 - b. collection and management.
 - c. modeling and analysis.
 - d. retrieval, display, and storage.
59. Which data category for water utility data sets includes the following map layers: Control information, planimetric features, and hydrology features?
- a. Land records data
 - b. Natural resources data

- c. Watershed resources data
 - d. Base data
59. Which of the following chlorine species is called HTH ?
- a. Hypochlorous acid
 - b. Sodium hypochlorite
 - c. Calcium hypochlorite
 - d. Hypotrichloro-hydrocarbon
60. Which is the proper detention time for disinfecting a water storage tank that is filled with already chlorinated water such that the free chlorine residual is 10mg/L after the proper detention time is completed?
- a. 4 hours
 - b. 6 hours
 - c. 8 hours
 - d. 24 hours
61. Which is the proper detention time for disinfecting a water storage tank with water that is mixed with hypochlorite already in the tank such that the free chlorine is 10mg/L after proper detention time is complete?
- a. 6 hours
 - b. 8 hours
 - c. 12 hours
 - d. 24 hours
70. The disinfectant residual in treated water entering the distribution system must not be less than
- a. 0.2mg/L at anytime.
 - b. 0.2mg/L for more than 4 hours during periods when the system is serving water to the public.
 - c. 0.4mg/L at anytime.
 - d. 0.4mg/L for more than 5% of the time that the system is serving water to the public.
62. The chemical formula for Hypochlorous acid is
- a. OCl^- .
 - b. NaOCl .
 - c. HOCl .
 - d. $\text{Ca}(\text{OCl})_2$.
63. Usually the best disinfectant to use in large-diameter pipes or very long pipelines is
- a. calcium hypochlorite.
 - b. sodium hypochlorite.
 - c. chlorine gas.
 - d. chloramines.
64. Which method for controlling nitrification problems in a distribution system would result in a temporary increase in trihalomethanes?
- a. Increasing the chlorine to nitrogen weight ratio

- b. Superchlorinating reservoirs and storage tanks
 - c. Decreasing chlorine detention time in reservoirs and distribution pipelines
 - d. Flushing the distribution pipelines
65. Which is the available chlorine concentration used for disinfecting a water storage tank using a method that involves spraying or painting of all the interior tank surfaces?
- a. 50mg/L
 - b. 100mg/L
 - c. 200mg/L
 - d. 250mg/L
66. When following a two-step process for disinfecting a water storage tank, the initial dosage of 50mg/L available chlorine should be held in the partially filled tank for
- a. at least 6 hours.
 - b. at least 10 hours.
 - c. at least 24 hours.
 - d. at least 3 days.
67. Why are altitude valves used on water storage tanks?
- a. To allow water to pass in and out of the tank as pressure fluctuates
 - b. To stop the flow of water into the tank when it is full
 - c. To allow overflow water to flow out of the tank
 - d. To shut the flow of water to the tank off for maintenance and inspection
77. If iron bacteria are causing corrosion problems in the distribution system, which is the most probable solution?
- a. Flushing
 - b. Use a corrosion chemical as treatment
 - c. Use a surfactant dispersion chemical
 - d. Acidify the system, then flush
68. Which type of chlorine gas feeder is most commonly used?
- a. Pressure
 - b. Combination water and pressure
 - c. Vacuum
 - d. Combination pressure and vacuum
69. When concentration cell corrosion occurs in iron pipes the electrons will move through the
- a. water from the anode to the cathode.
 - b. water from the cathode to the anode.
 - c. iron pipe from the anode to the cathode.
 - d. iron pipe from the cathode to the anode.
70. Which type of corrosion occurs when two dissimilar metals are electrically connected and immersed in a common flow of water, where one metal becomes the anode and the other the cathode?

- a. Concentration cell corrosion
 - b. Localized corrosion
 - c. Uniform corrosion
 - d. Galvanic corrosion
71. Which is the main purpose(s) of the meter yoke?
- a. Cushion against stress
 - b. Cushion against stress and strain
 - c. Provide electrical conductivity
 - d. Proper alignment and support for meter
72. The minimum cover over a water main below a road in a warm climate with no possibility of frost is
- a. 2.0 feet.
 - b. 2.5 feet.
 - c. 3.0 feet.
 - d. 3.5 feet.
73. The minimum cover over a water service below a road in a warm climate with no possibility of frost is
- a. 12 inches.
 - b. 18 inches.
 - c. 24 inches.
 - d. 30 inches.
99. What is the maximum joint deflection for full lengths of standard 48-inch ductile iron push-joint pipe?
- a. 3 degrees
 - b. 6 degrees
 - c. 8 degrees
 - d. 10 degrees
74. Large meters are usually tested at which percentage of their operating range?
- a. 5 to 10%
 - b. 10 to 20%
 - c. 20 to 25%
 - d. 25 to 33%
75. Which one of the following types of pipe is most prone to sliding out of a push-on joint if not firmly restrained?
- a. Asbestos-cement pipe
 - b. Plastic pipe
 - c. Ductile-iron pipe
 - d. Cast-iron pipe
76. Which is the best mechanical compacting equipment for deep narrow trenches?
- a. Hand-controlled plate tampers
 - b. Vibratory compactors

- c. Irregular drum tampers
 - d. Boom-mounted plate tampers
77. The lantern ring is also known as the
- a. packing ring.
 - b. seal cage.
 - c. packing seal.
 - d. mechanical seal.
78. How is the capacity of a centrifugal pump related to total head?
- a. Directly
 - b. Indirectly
 - c. Linear
 - d. Disproportionately
79. The bearings that maintain the radial positioning of a shaft are called
- a. radial bearings.
 - b. rolling bearings.
 - c. sleeve bearings.
 - d. thrust bearings.
80. When the discharge of a velocity pump is blocked, head builds up, typically greater than the pressure generated during pumping. When this occurs, water recirculates within the pump impeller and casing. This flow condition is called
- a. run-around.
 - b. skirting.
 - c. slip.
 - d. bypass.
107. Which valves can be used to throttle flow for only a short period of time?
- a. Butterfly valves
 - b. Altitude valves
 - c. Self-actuating valves
 - d. Plug valves
81. Which type of valve operates similar to a diaphragm valve?
- a. Vacuum relief valve
 - b. Globe valve
 - c. Pressure relief valve
 - d. Butterfly valve
82. Which valve can go from fully open to fully closed with 1/4 turn?
- a. Plug valve
 - b. Needle valve
 - c. Globe valve
 - d. Pinch valve
83. Foot valves are a special type of
- a. relief valve.

- b. control valve.
 - c. check valve.
 - d. plug valve.
84. Usually, which type of hydrant is a flush hydrant?
- a. Warm-climate hydrant
 - b. Wet-barrel hydrant
 - c. Dry-barrel hydrant
 - d. Standpipe-barrel hydrant
85. Which type of temperature sensor uses two wires of different materials?
- a. Thermistors
 - b. Thermo-resistors
 - c. Thermocouples
 - d. Thermo-conductors
86. Which type of temperature sensor uses a semi-conductive material?
- a. Thermistors
 - b. Thermo-resistors
 - c. Thermocouples
 - d. Thermo-conductors
87. The amount of energy in feet that a pump supplies to a fluid is called
- a. velocity head.
 - b. pump head.
 - c. total head.
 - d. pressure head.
115. Which is the most frequent cause of hydraulic transients in water distribution systems?
- a. Controlled pump shutdown
 - b. Flow demand changes
 - c. Pump startup
 - d. Valve opening and closing
88. Which type of valve should be used for filling an elevated tank if full system pressure would overflow the tank?
- a. Pressure-relief valve
 - b. Altitude valve
 - c. Pressure-reducing valve
 - d. Globe valve
89. One form of a differential-pressure flow meter is $a(n)$
- a. propeller.
 - b. proportional.
 - c. velocity-type.
 - d. orifice plate.
90. If a centrifugal pump with a single volute is operated at more than of its design capacity, an excess radial load will result, causing premature

- bearing failure.
 - a. 110%
 - b. 120%
 - c. 125%
 - d. 135%
- 91. How many inches of mercury is a total vacuum at sea level?
 - a. 14.7 inches
 - b. 30.0 inches
 - c. 34.0 inches
 - d. 39.6 inches
- 92. How many feet of water will equal the atmospheric pressure at sea level?
 - a. 28 feet
 - b. 30 feet
 - c. 32 feet
 - d. 34 feet
- 93. Pressure gauges connected to both suction and discharge sides of a pump should be connected
 - a. 2 to 3 feet on either side of a pump, unless there is a change in direction it can go closer.
 - b. 1 foot and 2 feet from the pump on the suction side and discharge side, respectively.
 - c. next to the pump on the suction side and just before the check valve on the discharge valve.
 - d. to the pressure taps supplied on the pump.
- 122. Which are the two principal types of throttling valves?
 - a. Throttling and pressure-reducing valves
 - b. Butterfly and relief valves
 - c. Butterfly and altitude valves
 - d. Pressure-reducing and altitude valves
- 94. Which valve would be best to use to precisely throttle flow?
 - a. Globe valve
 - b. Butterfly valve
 - c. Rotary valve
 - d. Needle valve
- 95. SCADA systems consist of the following distinct components:
 - a. Remote terminal units (RTUs), communications, and human machine interface (HMI)
 - b. Sensing instrument, RTUs, communications, and HMI
 - c. Sensing instrument, RTUs, communications, master station, and HMI
 - d. RTUs, communications, master station, and HMI
- 96. Stray-current corrosion is caused by
 - a. corrosive soils.

- b. acidic soils.
 - c. AC currents.
 - d. DC currents.
97. When a metal is galvanized, it is coated with
- a. zinc.
 - b. aluminum.
 - c. aluminum oxide.
 - d. aluminum hydroxide.
98. Which system would provide for a "soft start" to a motor?
- a. Wound-rotor induction motor and a controller
 - b. Synchronous motor and a variable frequency controller
 - c. A variable frequency drive and a squirrel-cage induction motor
 - d. Squirrel-cage induction drive and a variable frequency drive
99. Which type of relay is frequently used to detect power loss and initiate a switchover to another power source?
- a. Loss-of-phase relays
 - b. Voltage relays
 - c. Frequency relays
 - d. Circuit breaker relays
100. Which type of relays are placed on each phase of a power supply to open up a control circuit and stop a motor, if the current becomes excessive?
- a. Thermal-overload relays
 - b. Frequency relays
 - c. Voltage relays
 - d. Differential relays
130. Which type of relay is often used where local power generation is involved and on synchronous motor starters to sense when the motor has reached synchronizing speed?
- a. Speed sensor relay
 - b. Differential relay
 - c. Frequency relay
 - d. Voltage relay
101. Which type of relay is frequently used on large equipment to check whether all the current entering a system comes back out of the system?
- a. Voltage relay
 - b. Over-current relay
 - c. Reverse-current relay
 - d. Differential relay
102. Which is the correct sequence of a telemetry signal?
- a. Indicator, sensor, transmission channel, receiver, transmitter, and signal
 - b. Sensor, transmitter, transmission channel, receiver, and indicator

- c. Signal, indicator, transmitter, transmission channel, receiver, and sensor
 - d. Signal, sensor, transmission channel, transmitter, receiver, and indicator
103. Which type of instrument is used to measure the average power of a load over a specific time interval?
- a. Demand meter
 - b. Voltmeter
 - c. Ammeter
 - d. Wattmeter
104. Sacrificial anodes are also called
- a. corrosion anodes.
 - b. corrosion cells.
 - c. galvanic anodes.
 - d. decaying anodes.
105. Which is becoming the most common, and is one of the least dangerous, methods of thawing a water service line?
- a. Hot water
 - b. Electrical
 - c. Small torch
 - d. Steam vibration
106. When a control switch operated by pressure changes is located too close to a pump station, erratic operation can occur. This problem is known as
- a. pulsing.
 - b. seesaw arching.
 - c. racking.
 - d. roaming.
137. Which is the electronic standard range?
- a. 4 to 20 mADC
 - b. 4 to 20 mAAC
 - c. 0 to 100%
 - d. 0 to 1 binary
107. Which is the chemical makeup of a tubercle?
- a. $\text{Mn}(\text{OH})_2$ on the inside and $\text{Ca}(\text{HCO}_3)_2$ on the outside
 - b. $\text{Mn}(\text{OH})_2$ on the outside and $\text{Ca}(\text{HCO}_3)_2$ on the inside
 - c. $\text{Fe}(\text{OH})_2$ on the inside and $\text{Fe}(\text{OH}_3)$ on the outside
 - d. $\text{Fe}(\text{OH})_2$ on the outside and $\text{Fe}(\text{OH}_3)$ on the inside
108. Which device consists of a pair of metallic plates that are separated by an insulating material called a dielectric?
- a. Storage battery
 - b. Voltage regulator
 - c. Rectifier
 - d. Capacitor

109. The current rating of a fuse should be the current rating of the circuit or device that it protects.
- slightly lower than
 - 15% greater than
 - equal to
 - equal to or slightly larger than
110. Conductors usually fail because of
- excessive heat.
 - mechanical failure.
 - lightening.
 - simple aging.
111. Inspection of the shaft and coupling alignment should be performed every or immediately, if problem signs develop.
- month
 - quarter
 - 6 months
 - year
112. Bearings should not be lubricated with this type of oil because this oil forms acids as it begins to break down.
- Non-detergent mineral oil
 - Animal oil
 - SAE 10
 - SAE 20
113. How much resistance should motor-winding insulation exhibit?
- At least 0.5 megohm of resistance
 - At least 1.0 megohm of resistance
 - At least 2.0 megohm of resistance
 - At least 5.0 megohm of resistance
145. Which is the pneumatic standard range?
- 0 to 10 psig
 - 3 to 15 psig
 - 4 to 20 psig
 - 0 to 100%
114. Which of the following methods for preventing external corrosion is only a shortterm remedy?
- Extra thickness for pipe walls
 - Wrapping pipe in polyethylene plastic sleeves
 - Applying a coating of bitumastic or coal tar
 - Installing cathodic protection on the pipe
115. The D'Arsonval meter is
- an amperometric meter.
 - a type of pH meter.

- c. an analog (uses a needle) meter.
 - d. a digital (number displays on unit) meter.
116. How does H_2S gas kill a person?
- a. Asphyxiation
 - b. Paralyzes the respiratory system
 - c. Paralyzes the nervous system
 - d. Stops the heart
117. If sodium hypochlorite comes into contact with the skin, it should be immediately flushed with water for at least
- a. 10 minutes
 - b. 15 minutes
 - c. 20 minutes
 - d. 30 minutes
118. Which is the Secondary Maximum Contaminant Level for pH ?
- a. 7.0pH units
 - b. 6.5 to 7.5pH units
 - c. 6.5 to 8.5pH units
 - d. 6.0 to 8.5pH units
119. If an excavation on a road requires that one of the lanes be closed and the speed limit is 25mph, how many cones are required to divert the traffic?
- a. 6
 - b. 9
 - c. 13
 - d. 15
120. If an excavation on a road requires that one of the lanes be closed and the speed limit is 45mph, how many cones are required to divert the traffic?
- a. 9
 - b. 13
 - c. 15
 - d. 18
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- a. 6
 - b. 9
 - c. 13
 - d. 15
134. If an excavation on a road requires that one of the lanes be closed and the speed limit is 45mph, how many cones are required to divert the traffic?
- a. 9
 - b. 13
 - c. 15
 - d. 18
135. Which chemical may cause leaching of lead in stagnant waters?
- a. Sodium zinc phosphate
 - b. Lime
 - c. Sodium carbonate
 - d. Sodium hydroxide
136. During simulated distribution testing, a borate buffer solution maintains a constant pH of

- a. 10.
 - b. 8 .
 - c. 7 .
 - d. 5.
136. In permit-entry confined space, who is responsible for terminating entries?
- a. Authorized entrant
 - b. Standby attendant
 - c. Entry supervisor
 - d. Entry supervisor and the standby attendant
137. In permit-entry confined space, who is responsible for summoning rescuers?
- a. Standby attendant and authorized attendant
 - b. Entry supervisor and authorized attendant
 - c. Authorized attendant
 - d. Authorized entrant
138. Extremely small chlorine leaks that go for weeks will most likely be found
- a. by using a very strong ammonia solution.
 - b. by using soap and looking for bubbles.
 - c. by using your nose.
 - d. by seeing the discoloration and moisture at the leak point.
139. Which is the Action Level for lead?
- a. 0.015mg/L
 - b. 0.020mg/L
 - c. 0.025mg/L
 - d. 0.040mg/L
140. Most regulated contaminants
- a. are thought to cause liver or kidney damage.
 - b. can cause heart or cardiovascular diseases.
 - c. cause health effects only after long exposure.
 - d. cause acute effects.
141. High levels of cadmium at the customer's tap would most likely be due to
- a. copper pipe.
 - b. galvanized pipe.
 - c. iron pipe.
 - d. household fixtures.
161. Which is the Secondary Maximum Contaminant Level for zinc?
- a. 1mg/L
 - b. 2mg/L
 - c. 5mg/L
 - d. 10mg/L
142. The prevention of trench cave-ins using the sloping method requires which slope ratio? (Note: horizontal to vertical distance, respectively)

- a. 1.0 : 1.0
 - b. 1.5 : 1.0
 - c. 2.0 : 1.0
 - d. The angle will vary with type of soil, moisture content, and surrounding conditions
143. What is the Maximum Contaminant Level for asbestos fibers greater than 10 micrometers?
- a. 1 million fibers per liter (MFL)
 - b. 2.5MFL
 - c. 5.0MFL
 - d. 7.0MFL
144. Which is the Locational Running Annual Average (LRAA) for trihalomethanes (THM) and haloacetic acid 5 (HAA5) under the Stage 2 Disinfectants/Disinfection By-Products Rule?
- a. 80/60 μ g/L
 - b. 100/75 μ g/L
 - c. 100/80 μ g/L
 - d. 120/100 μ g/L
145. Under the Surface Water Treatment Rule, undetected disinfection residuals must not exceed what percentage of samples each month for any two consecutive months that water is served to the public?
- a. Zero tolerance
 - b. 1%
 - c. 2%
 - d. 5%
146. Which would be the most probable solution if Actinomyces were causing taste and odor problems in the distribution system?
- a. Use copper sulfate and flush the system
 - b. Start using chloramines as a disinfectant since it has a longer lasting residual compared to chlorine
 - c. Use activated carbon and flush the system
 - d. Control nutrients
147. Where is scale most likely to form in a hypochlorinator?
- a. Push rod
 - b. Plunger
 - c. Pump head
 - d. Spring
168. Which type of chlorine gas feeding equipment would be most appropriate for distribution systems where rechlorination is required?
- a. Compound-loop control gas feeder
 - b. Automatic proportioning control gas feeder
 - c. Automatic residual control gas feeder
 - d. Semiautomatic control gas feeder

148. When a sample is collected, its quality begins to change because of
 - a. dissolved gases.
 - b. chemical activity.
 - c. pH.
 - d. alkalinity.
149. Chemolithotrophic nitrifying bacteria are
 - a. gram-negative and anaerobic.
 - b. gram-positive and strictly aerobic.
 - c. gram-negative and facultative or aerobic.
 - d. gram-negative and strictly aerobic.
150. Which index will indicate scale-forming water with values less than 6 and corrosive water with values greater than 7 ?
 - a. Baylis curve
 - b. Langelier saturation index
 - c. Marble test
 - d. Ryzner index
151. The radiation term corresponding to an energy absorption of 100 ergs per gram of any medium is called a(n)
 - a. rad.
 - b. rem.
 - c. curie.
 - d. erg.
152. Community and nontransient community water systems must test for if they use ozone for disinfection or oxidation.
 - a. chlorate
 - b. bromate
 - c. haloacetic acids (five)
 - d. total trihalomethanes
153. According to AWWA Standard C652 Method 3, disinfection of water tanks requires exposure to free chlorine at a concentration of chlorine residual ending at a concentration of at least for 24-hours with the free
 - a. 10mg/L; 2mg/L
 - b. 25mg/L; 10mg/L
 - c. 50mg/L; 10mg/L
 - d. 100mg/L; 25mg/L
175. If a main cannot be installed at an adequate depth in a cold weather climate, Styrofoam insulation board can be used to protect the water in the pipe from freezing. How far above the pipe should this insulation be installed?
 - a. 2 to 4 inches
 - b. 5 to 7 inches
 - c. 8 to 10 inches
 - d. 1 foot

154. How much deeper below the grade line of a pipe bottom should a trench be excavated if it is being dug in a rock formation?
 - a. 3 to 6 inches
 - b. 6 to 9 inches
 - c. 9 to 12 inches
 - d. 12 to 18 inches
155. Pressure-relief valves are most similar to
 - a. globe valves.
 - b. vacuum relief valves.
 - c. needle valves.
 - d. check valves.
156. Current meters are primarily used for measuring flow in lines that are
 - a. 5/8 to 1 inch.
 - b. 1 to 3 inches.
 - c. 3 inches or greater.
 - d. 12 inches or greater.
157. Which does beam breakage resemble?
 - a. Shear breakage
 - b. Stress breakage
 - c. Flexural breakage
 - d. Tensile breakage
158. Which type of valve should be installed for pressure control and flow control in large pipes?
 - a. Butterfly valve
 - b. Globe valve
 - c. Gate valve
 - d. Ball valve
159. Which can be developed by measuring the pressure along a pipeline?
 - a. The C factor
 - b. The total dynamic head
 - c. The pipeline's grade
 - d. The hydraulic grade
160. A thrust block would not be required on pipes that are
 - a. made of steel.
 - b. made of reinforced concrete.
 - c. welded at the joints.
 - d. of the bell and socket type.
183. Which is the recommended water pressure in commercial districts?
 - a. 50 to less than 65 psi
 - b. 55 to less than 75 psi
 - c. 75 to less than 100 psi
 - d. 90 to less than 120 psi

161. Which can be used to avoid excessively high water pressures in distribution mains?
- a. Pressure-reducing valves
 - b. Plug valves
 - c. Installation of a pneumatic tank
 - d. Blowoff valves
162. Which is the commonly accepted water velocity in water mains at maximum flows?
- a. 1 to 3ft/sec
 - b. 2 to 4ft/sec
 - c. 4 to 5ft/sec
 - d. 5 to 6ft/sec
163. It is recommended that dead-end water mains more than 1,000 feet in length should be constructed of pipe that is at least in diameter.
- a. 6 inches
 - b. 8 inches
 - c. 10 inches
 - d. 12 inches
164. Water mains that are 12 inches or less in diameter should have isolation valves that are located not more than between each other.
- a. 500 feet
 - b. 750 feet
 - c. 1,000 feet
 - d. 1,200 feet
165. The size and capacity of a water distribution system is based largely on
- a. peak hour customer demands.
 - b. fire demand.
 - c. agricultural demand.
 - d. industrial demand.
166. A water storage tank located far from the source of demand would most likely have which type of problem during peak demand, if the area between storage and use is relatively flat?
- a. Low flow due to friction losses
 - b. Poor water quality due to transmission pipe being too long
 - c. High pumping costs during peak hourly flow
 - d. Low pressure
167. Which type of pipe material is prestressed?
- a. Steel cylinder
 - b. Ductile iron
 - c. Asbestos-cement
 - d. C-900 PVC
191. Which type of service pipe material is no longer acceptable for drinking water?

- a. Brass
 - b. Lead
 - c. Galvanized wrought iron
 - d. Copper
168. Which type of joint for connecting water pipes has the advantage of moderate deflection and the gaskets used absorb vibration and pipe movement?
- a. Flanged joint
 - b. Victaulic joint
 - c. Dressler coupling
 - d. Restrained joint
169. Which type of joint for connecting water pipes has the disadvantage of having a groove that weakens the pipe wall?
- a. Flanged joint
 - b. Victaulic joint
 - c. Dressler coupling
 - d. Restrained joint
170. Which type of joint for connecting water pipes is used where the available space to lock a joint in place is lacking and where the soil behind the fitting may be disturbed?
- a. Flanged joint
 - b. Victaulic joint
 - c. Dressler coupling
 - d. Restrained joint
171. Which is normally used on the outside joint space of steel cylinder concrete in order to protect the joint rings from external corrosion?
- a. Bituminous material
 - b. Epoxy material
 - c. Mastic coating
 - d. Cement mortar
172. How much deflection is allowed for asbestos-cement couplings that are 3 to 12 inches in diameter?
- a. 5 degrees
 - b. 7 degrees
 - c. 10 degrees
 - d. 12 degrees
173. Which is the best or first choice corrosion control method(s) to protect pipe?
- a. Use of noncorrosive metals and/or mechanical coatings
 - b. Chemical protective coatings
 - c. Electrical control by using cathodic protection
 - d. Use of metallic coatings such as zinc or aluminum
198. What is an

- effective way for a distribution system agency to measure financial stability?
- Measuring the debt
 - Calculating the operating and coverage ratios
 - By dividing the paying customers by the total customers, then multiplying by 100%; anything over 95% is excellent
 - Simply by how much money in the black that they have each fiscal year
174. Where do good public relations start for a water utility?
- With well-maintained fire hydrants
 - With meaningful advertising
 - Via public relations campaigns
 - Through dedicated service-oriented employees
175. One of the most important functions and the major part of the work day for a manager of a water utility or distribution system is involved in
- organizing.
 - planning.
 - directing.
 - controlling.
176. Which term defines lead free, when used with respect to solders and flux?
- Containing not more than 0.01% lead
 - Containing not more than 0.02% lead
 - Containing not more than 0.04% lead
 - Containing not more than 0.05% lead
177. Which defines lead free when used with respect to pipes and pipe fittings?
- Containing not more than 3% lead
 - Containing not more than 6% lead
 - Containing not more than 8% lead
 - Containing not more than 9% lead
178. If a water system collects less than 40 samples per month for the analyses of total coliforms, how many samples can be total coliform positive and the system still remain in compliance with the maximum contaminant level for total coliforms?
- Zero
 - 1
 - 2
 - 3
179. Which is the maximum holding time for fecal coliforms using the Fecal Coliform Procedure?
- 8 hours
 - 12 hours
 - 24 hours
 - 36 hours
205. The peak historical month for a ground water system

- is the month with the high total trihalomethanes or haloacetic acids (five) levels or the month with the
- warmest water temperature.
 - lowest pH.
 - lowest alkalinity.
 - highest alkalinity.
180. A water system doing a system specific study plan may use the results of samples collected and analyzed for total trihalomethanes and haloacetic acids (five), if the samples were collected within before the study plan submission date.
- 1 year
 - 2 years
 - 3 years
 - 5 years
181. A water system is eligible to be certified 40/30, if it had no samples that exceeded 0.040mg/L for total trihalomethanes and no samples that exceeded 0.030mg/L for haloacetic acids (five). How many consecutive quarters must a water system be below these numbers to be 40/30 certified?
- 6 quarters
 - 8 quarters
 - 10 quarters
 - 12 quarters
182. If a water system is required to conduct quarterly monitoring less frequently than the quarterly under the Stage 2 Disinfection By-products Requirements they must begin monitoring in the calendar month
- beginning in January 2012.
 - recommended in the Initial Distribution System Evaluation (IDSE) report.
 - that includes the compliance date.
 - that follows the quarter that includes the compliance date.
183. A water system that is required to sample quarterly must make compliance calculations at the end of the
- first quarter.
 - fourth quarter.
 - sixth quarter.
 - eighth quarter.
184. All water systems under the Stage 2 Disinfection By-products Requirements must monitor during the month with the highest
- disinfection by-products.
 - total organic carbon.
 - organic acids.
 - temperature and lowest pH.
211. A water system monitoring total trihalomethanes and haloacetic acids (five) quarterly must report the

number of samples collected, date, and results of each sample during the last quarter. When must this report be submitted to the state?

- a. Within 5 days after quarter ends
 - b. Within 10 days after quarter ends
 - c. Within 14 days after quarter ends
 - d. Within 30 days after quarter ends
185. How are samples for lead and copper analyses collected from services that have a lead service line?
- a. First draw samples that have remained motionless for at least 2 hours
 - b. First draw samples that have remained motionless for at least 4 hours
 - c. First flush the volume of water between tap and lead service line, then collect the sample
 - d. Flush two volumes calculated between tap to end of lead service line, then collect the sample
186. When can a water system that meets the lead and copper action levels for two consecutive six-month periods, reduce the number of samples and reduce the frequency of sampling at the same time such that they only sample every 3 years?
- a. When the 90 th percentiles for lead and copper are 0.003mg/L and 0.50mg/L, respectively
 - b. When the 90 th percentiles for lead and copper are 0.004mg/L and 0.60mg/L, respectively
 - c. When the 90 th percentiles for lead and copper are 0.005mg/L and 0.65mg/L, respectively
 - d. When the 90 th percentiles for lead and copper are 0.007mg/L and 0.70mg/L, respectively
187. Water systems that are sampling for lead and copper and qualify for a reduction in the number and frequency of sampling, unless the State has approved a different sampling period, shall conduct lead and copper sampling
- a. during October, November, December, and January.
 - b. during June, July, August, and September.
 - c. in the months January, April, July, and October.
 - d. alternate months, collecting 6 sets of samples.
188. A small water system has met certain criteria and has been granted a waiver and thus a reduced frequency for monitoring lead and copper. How often with this waiver does it have to monitor?
- a. Once every 5 years
 - b. Once every 9 years
 - c. Once every 10 years
 - d. Once every 12 years
216. When a water system is required to monitor water quality parameters because it exceeded the lead and copper action level, which parameter must be measured every two weeks at each entry

- point to the distribution system?
 - a. Alkalinity
 - b. Disinfectant residual
 - c. pH
 - d. Orthophosphate
- 189. Each day following a routine sample monitoring result that exceeds the maximum residual disinfectant level for chlorine dioxide, the water system must collect from the distribution system samples for analyses of chlorine dioxide.
 - a. 2
 - b. 3
 - c. 4
 - d. 5
- 190. If a water system monitors for total trihalomethanes (TTHM) and the sum of five haloacetic acids (HAA5), then on a quarterly basis the system must report
 - a. the mean of both TTHM and HAA5 results each quarter.
 - b. the highest value for both TTHM and HAA5 for each quarter.
 - c. the arithmetic average of all samples for TTHM and HAA5.
 - d. a running annual average for TTHM and HAA5 once four quarters of data have been collected.
- 191. How should a distribution operator preserve a sample to be analyzed for asbestos?
 - a. Preserve with HNO_3
 - b. Preserve with NaOH
 - c. Preserve with H_2SO_4
 - d. Preserve by keeping it at 4°C
- 192. How should a distribution operator preserve a sample to be analyzed for nitratennitrite?
 - a. Preserve with HNO_3
 - b. Preserve with NaOH
 - c. Preserve with H_2SO_4
 - d. Preserve by keeping it at 4°C
- 193. Which is the sample size for lead and copper analyses?
 - a. 100 mL
 - b. 250 mL
 - c. 500 mL
 - d. 1,000 mL
- 194. Which method can be used to control scaling but is never used to control corrosion?
 - a. Controlled CaCO_3 scaling
 - b. Polyphosphate addition

- c. pH and alkalinity adjustment with lime
 - d. Sequestering 223. Samples collected for lead and copper analyses by customers need to avoid problems of residents handling an acid that would otherwise be contained in sample bottles. Thus the samples must be later acidified to
 - a. preserve the sample.
 - b. resolubilize the metals.
 - c. free the lead and copper from possible reactions with other metals in the sample bottles.
 - d. free the lead and copper from sodium that may be in the water.
195. Water systems are required to monitor for certain water quality parameters when they exceed the lead and copper action levels. If these systems maintain the range of values for the water quality parameters that reflect optimal corrosion control treatment during each of two consecutive six-month monitoring periods, then although they must still monitor at the entry point(s) to the distribution system, they are allowed to
- a. reduce the number of sites sampled.
 - b. reduce the frequency of sampling from 6-month periods to annually.
 - c. eliminate all water quality parameters monitored, except pH and alkalinity.
 - d. eliminate all water quality parameters monitored, except pH and they must record in mg/L the dosage for any chemical alkalinity adjustment.
196. If the continuous monitoring of the residual disinfectant concentration for water entering the distribution system fails, how often must grab samples be collected in lieu of continuous monitoring until the problem is repaired?
- a. Every hour
 - b. Every 4 hours
 - c. Every 8 hours
 - d. Every 12 hours

95 Math for Water Distribution Operators Levels I & II

96 Sample Questions

97 Answers on Page 371

1. A well yields 2,840 gallons in exactly 20 minutes. What is the well yield in gpm?
 - a. 140gpm
 - b. 142 gpm
 - c. 145gpm
 - d. 150gpm

2. Convert 37.4 degrees Fahrenheit to degrees Celsius.
 - a. 3.0°C
 - b. 5.3°C
 - c. 7.9°C
 - d. 9.7°C

3. What is the area of a circular tank pad in ft², if it has a diameter of 102ft ?
 - a. 6,160ft²
 - b. 6,167ft²
 - c. 8,170ft²
 - d. 8,200ft²

4. What is the pressure 1.85 feet from the bottom of a water storage tank if the water level is 28.7 feet?
 - a. 11.6psi
 - b. 12.4psi
 - c. 62.0psi
 - d. 66.3 psi

5. Calculate the well yield in gpm, given a drawdown of 14.1ft and a specific yield of 31 gpm/ft.
 - a. 2.2gpm
 - b. 7.3gpm
 - c. 45.1gpm
 - d. 440gpm

6. How many gallons are in a pipe that is 18.0 in. in diameter and 1,165ft long?
 - a. 2,060 gal
 - b. 10,300 gal
 - c. 15,400gal
 - d. 17,200 gal

7. A water tank with a capacity of 5.75 million gallons (mil gal) is being filled at a rate of 2,105 gpm. How many hours will it take to fill the tank?
 - a. 31.6hr
 - b. 37.8hr
 - c. 42.9hr
 - d. 45.5hr

7. Determine the detention time in hours for the following water treatment system:
 - Distribution pipe from water plant to storage tank is 549ft in length and 14 in. in diameter
 - Storage tank averages 2,310,000 gal of water at any given time

- Flow through system is 6.72mgd
 - a. 7.2hr
 - b. 7.4hr
 - c. 8.0hr
 - d. 8.3hr
9. Convert 28.7 cubic feet per second (cfs) to gallons per minute (gpm).
 - a. 12,477gpm
 - b. 12,700gpm
 - c. 12,880gpm
 - d. 12,900gpm
 10. Convert 16,912,000 liters to acre-feet.
 - a. 13.7 acre-ft
 - b. 41.5 acre-ft
 - c. 51.9 acre-ft
 - d. 767 acre-ft
 11. Convert -22.6°C to degrees Fahrenheit.
 - a. -4.6°F
 - b. -8.7°F
 - c. -11.8°F
 - d. -12.8°F
 12. A sodium hypochlorite solution contains 11.3% hypochlorite. Calculate the mg/L hypochlorite in the solution.
 - a. 11.3mg/L sodium hypochlorite
 - b. 1,130mg/L sodium hypochlorite
 - c. 11,300mg/L sodium hypochlorite
 - d. 113,000mg/L sodium hypochlorite
 13. Records for a pump show that on June 1st at exactly 9:00 a.m. the number of pumped gallons was 71,576,344 and on July 1st at exactly 9:00 a.m. it was 72,487,008 gallons. Determine the average gallons pumped per day (gal/day) for this month to the nearest gallon.
 - a. 18,605gal/day
 - b. 25,875gal/day
 - c. 30,355gal/day
 - d. 34,325gal/ day 14. If chlorine is being fed at a rate of 260lb/ day for a flow rate of 23cfs, which should be the adjustment on the chlorinator when the flow rate is decreased to 16cfs, if all other water parameters remain the same?
 - a. 160lb/ day
 - b. 180lb/day
 - c. 310lb/ day
 - d. 370lb/day

14. Calculate the diameter of a clarifier with a circumference of 215ft.
 - a. 34.8ft
 - b. 56.7ft
 - c. 68.5ft
 - d. 76.2ft
15. Determine the depth of water in a reservoir, if the psi is 31.9.
 - a. 13.8ft deep
 - b. 24.9ft deep
 - c. 45.6ft deep
 - d. 73.7ft deep
16. Calculate the area of a tank, if the tank's radius is 39.8ft.
 - a. 4,970ft²
 - b. 5,670ft²
 - c. 7,820ft²
 - d. 9,940ft²
17. Determine the specific gravity (SG) of an unknown liquid, if the density of the liquid is 70.9lb/ft³.
 - a. 1.05 SG
 - b. 1.14 SG
 - c. 1.18SG
 - d. 1.21 SG
18. A water treatment plant is feeding an average of 295lb/ day of chlorine. If the dosage is 2.25mg/L, which is the number of millions of gallons per day (mgd) being treated?
 - a. 15.7mgd
 - b. 35.1mgd
 - c. 58.3mgd
 - d. 79.6mgd
19. How many gallons of a sodium hypochlorite solution that contains 12.1% available chlorine are needed to disinfect a 1.5-ft diameter pipeline that is 283ft long, if the dosage required is 50.0mg/L ? Assume the sodium hypochlorite is 9.92lb/gal.
 - a. 0.87 gal sodium hypochlorite
 - b. 1.0 gal sodium hypochlorite
 - c. 1.3 gal sodium hypochlorite
 - d. 1.5 gal sodium hypochlorite
20. A water treatment plant is treating 16.4 million gallons per day (mgd). If the chlorine feed rate is 415lb/ day, which is the chlorine dosage in mg/L ?
 - a. 3.03mg/L
 - b. 3.38mg/L
 - c. 3.43mg/L
 - d. 3.67mg/L

20. A 1.65-million gallon (mil gal) storage tank needs to be disinfected with a sodium hypochlorite solution that has 11.8% available chlorine. The tank is to be filled at 10% capacity, and the initial chlorine dosage required is 50.0mg/L. How many gallons of sodium hypochlorite will be needed, if it weighs 9.84lb/gal ?
- 50 gal sodium hypochlorite
 - 53 gal sodium hypochlorite
 - 59 gal sodium hypochlorite
 - 63 gal sodium hypochlorite
21. How many pounds of a calcium hypochlorite that contains 64.3% available chlorine are needed to disinfect a water main that is 24 in. in diameter, if the pipeline is 781ft long and the dosage required is 50.0mg/L ?
- 5.95lb calcium hypochlorite
 - 8.25lb calcium hypochlorite
 - 11.9lb calcium hypochlorite
 - 13.8 lb calcium hypochlorite
22. A well is pumping water at a rate of 428gpm. Which should be the setting on a chlorinator in pounds per day, if the dosage desired is 1.20mg/L and the chlorine demand is 3.85mg/L ?
- 19.8lb/ day of chlorine
 - 20.6lb/ day of chlorine
 - 23.7lb/ day of chlorine
 - 26.0lb/ day of chlorine
23. Convert 48.1 million gallons a day (mgd) to cubic feet per second (cfs).
- 68.7cfs
 - 74.4cfs
 - 79.1cfs
 - 82.0cfs
24. Convert 184gpm to liters per second (L/s).
- 10.3 L/s
 - 11.1 L/s
 - 11.6 L/s
 - 12.3 L/s
27. Which is the average turbidity in ntu at the end of a sedimentation basin given the following data?

1	2	3	4	5	6	7
1.08ntu	0.98ntu	0.94ntu	0.88ntu	0.96ntu	1.03ntu	1.25ntu

- 1.00ntu
 - 1.01ntu
 - 1.02ntu
 - 1.03ntu
28. If 288 is 70.3%, how much is 100% ?
- 410

- b. 412
 - c. 415
 - d. 418
29. The iron (Fe) content of a water source averages 0.81mg/L iron. Which is the percent removal, if the treated water averages 0.01mg/L iron?
- a. 96% Fe removal efficiency
 - b. 97% Fe removal efficiency
 - c. 98% Fe removal efficiency
 - d. 99% Fe removal efficiency
30. Which will be the percent of soda ash in the resulting slurry, if 28.2 pounds of soda ash are mixed with exactly 100.0 gallons of water?
- a. 3.27% soda ash slurry
 - b. 3.38% soda ash slurry
 - c. 3.45% soda ash slurry
 - d. 3.54% soda ash slurry
31. Which is the exposed exterior surface area of a ground-level storage tank that is 24.0 ft high and has a diameter of 80.1ft ? Assume top is flat.
- a. 10,800ft²
 - b. 10,900ft²
 - c. 11,000ft²
 - d. 11,100ft²
32. A pipe is 1.43 miles long and has an inner diameter of 18.0 inches. How many gallons are in the pipeline if it is full?
- a. 66,500gal
 - b. 79,200 gal
 - c. 99,800gal
 - d. 104,000gal
33. A storage tank has a 60.0 – ft radius and averages 25.5ft in water depth. Calculate the average detention time in hours for this storage tank, if flow through the tank averages 2.91mgd during a particular month in question.
- a. 17.5hr
 - b. 17.8hr
 - c. 18.6hr
 - d. 19.8hr
34. If the pressure head on a fire hydrant is 134ft, which is the pressure in psi?
- a. 50psi
 - b. 52 psi
 - c. 54psi
 - d. 58psi
34. A meter indicates the water flow from a fire hydrant is 5.5ft³/min. How many gallons will flow from the hydrant in 20 minutes?
- a. 820gal

- b. 850gal
 - c. 880gal
 - d. 920 gal
35. A polymer weighs 8.25lb and occupies 3.150 liters. Which is the density of the polymer in g/cm^3 ?
- a. 1.18 g/cm^3
 - b. 1.19 g/cm^3
 - c. 1.20 g/cm^3
 - d. 1.21 g/cm^3
36. Determine the percent accuracy for a meter being tested, if it reads 245.7 cubic feet and the volumetric tank used to measure the water that flowed through the meter indicates the actual volume as 1,863 gallons.
- a. 97.8% meter efficiency
 - b. 98.6% meter efficiency
 - c. 99.0% meter efficiency
 - d. 99.3% meter efficiency
37. Which is the chlorine dosage at a water treatment plant, if the chlorinator is set on 320lb/ day and the plant is treating 11.6mgd ?
- a. 2.8mg/L
 - b. 3.0mg/L
 - c. 3.3mg/L
 - d. 3.7mg/L
38. A 1.75-mil gal storage tank needs to be disinfected with a sodium hypochlorite solution that contains 12.0% available chlorine and weighs 8.97lb/ gal. If the chlorine dosage is to be 50.0mg/L, how many gallons of sodium hypochlorite are required?
- a. 678 gal
 - b. 729gal
 - c. 750gal
 - d. 791gal
39. A 24.0-in. pipeline, 427ft long, was disinfected with calcium hypochlorite tablets with 65.0% available chlorine. Determine the chlorine dosage in mg/L, if 7.0lb of calcium hypochlorite was used. Assume that the hypochlorite is so diluted that it weighs 8.34 lb/gal.
- a. 25mg/L chlorine
 - b. 39mg/L chlorine
 - c. 43mg/L chlorine
 - d. 54mg/L chlorine
41. Water from a well is treated with a sodium hypochlorite solution that contains 10.3% available chlorine and weighs 8.95lb/gal. The well is pumping water at 260gpm. Calculate the chlorine dosage, if the chlorinator is pumping at a rate of 95 liters/day.
- a. 5.6mg/L sodium hypochlorite
 - b. 6.3mg/L sodium hypochlorite

- c. 7.4mg/L sodium hypochlorite
 - d. 8.8mg/L sodium hypochlorite
40. Which should be the setting on a chlorinator in pounds per day, if the dosage desired is 1.75mg/L, the chlorine demand averages 2.45mg/L, and the pumping rate from the well is 208gpm ?
- a. 10.5lb/ day chlorine
 - b. 11.2lb/ day chlorine
 - c. 12.0lb/ day chlorine
 - d. 13.1lb/ day chlorine
41. What is the maximum pumping rate (in gpm) of a pump that is producing 15 water horsepower against a head of 65ft ?
- a. 115gpm
 - b. 910gpm
 - c. 17,000gpm
 - d. 63,000gpm
42. A water plant serves 23,210 people. If it treats a yearly average of 2.98mgd, what are the gallons per capita per day (gpcd)? Note: A capita = 1 person.
- a. 115gpcd
 - b. 120 gpcd
 - c. 122 gpcd
 - d. 128 gpcd

98 Math for Water Distribution Operators Levels III & IV

99 Answers on Page 381

1. What is the velocity of flow in feet per second for a 6.0-in. diameter pipe, if it delivers 122gpm ? Assume pipe is full.
 - a. 1.3ft/sec
 - b. 1.35ft/sec
 - c. 1.38ft/sec
 - d. 1.4ft/sec
2. A small cylinder on a hydraulic jack is 10in. in diameter. A force of 130lb is applied to the small cylinder. If the diameter of the large cylinder is 2.5ft, what is the total lifting force?
 - a. 1,170lb
 - b. 1,200lb
 - c. 1,250lb
 - d. 1,300lb

3. A 2.0-ft diameter pipe that is 2.45 miles long was disinfected with chlorine. If 126.9lb of chlorine were used, what was the initial dosage in mg/L ?
 - a. 25mg/L
 - b. 40mg/L
 - c. 50mg/L
 - d. 60mg/L
4. What is the motor horsepower (mhp), if 200 horsepower (hp) is required to run a pump with a motor efficiency (Effic.) of 88% and a pump efficiency of 74% ? Note: The 200hp in this problem is called the water horsepower (whp). The whp is the actual energy (horsepower) available to pump water. Give results to two significant figures.
 - a. 130mhp
 - b. 180mhp
 - c. 200mhp
 - d. 310mhp
5. What is the bowl horsepower (bhp) for a vertical turbine pump given the following parameters?
 - Pumping rate = 385gpm
 - Bowl head = 215 feet
 - Bowl efficiency = 81%
 - a. 17bhp
 - b. 20bhp
 - c. 26bhp
 - d. 33bhp
6. Water is flowing at a velocity of 1.3ft/sec in a 4.0-in. diameter pipe. If the pipe changes from the 4.0-inch to a 3.0-in. pipe, what will the velocity be in the 3.0-in. pipe?
 - a. 0.73ft/sec
 - b. 1.28ft/sec
 - c. 2.3ft/sec
 - d. 2.6ft/sec
7. The level in a storage tank drops 2.3ft in exactly 18hr. If the tank has a diameter of 120ft and the plant is producing 4.75mgd, what is the average discharge rate of the three treated water discharge pumps in gpm?
 - a. 3,479gpm
 - b. 3,500gpm
 - c. 4,578gpm
 - d. 4,600gpm
8. How many gallons of a 12.5% sodium hypochlorite solution (9.34 lb/gal) are required to make exactly 1,000 gal of a 50mg/L solution?
 - a. 0.3 gal
 - b. 0.4gal

- c. 0.43 gal
 - d. 0.63gal
9. What percent hypochlorite solution would result, if 350 gal of an 11% solution were mixed with 225 gal of a 5.8% solution? Assume both solutions have the same density.
 - a. 8.9% final solution
 - b. 9.0% final solution
 - c. 9.1% final solution
 - d. 9.12% final solution
 10. What water horsepower (whp) is required for a pump that delivers 650 gpm to a total head of 195 feet?
 - a. 25whp
 - b. 30whp
 - c. 32whp
 - d. 40 whp
 11. Determine the percentage strength of a solution mixture, if 875lb of a 49.5% strength solution is mixed with 293lb of a 17.2% strength solution.
 - a. 41.4%
 - b. 42.4%
 - c. 43.0%
 - d. 43.1%
 12. How many fluid ounces (oz) of sodium hypochlorite (10.5% available chlorine and 9.10lb/gal) are required to disinfect a well with the following parameters?
 - Depth of well is 287ft
 - 12-in. diameter well casing extends down to 100.0ft
 - The remainder is a 10.0-in. diameter casing
 - The residual desired dose is 50.0mg/L
 - The depth to water is 168.4ft
 - The chlorine demand is 4.7mg/L
 - a. 21oz
 - b. 25oz
 - c. 27oz
 - d. 30oz
 13. Determine the cost to the nearest cent to operate a 300Hp motor for one month (assume 30 days), if it runs an average of 4.2hr/ day, is 82% efficient, and the electrical costs are \$0.041 per kW.
 - a. \$948.04
 - b. \$970.92
 - c. \$1,156.15
 - d. \$1,184.05

14. A storage tank has a level capacity of 24.50ft. Currently the water level is 16.55ft in the tank. Calculate the SCADA reading on the board in mA for a 4 mA to 20 mA signal.
 - a. 13.5 mA
 - b. 13.51 mA
 - c. 14.8 mA
 - d. 14.81 mA
15. A pipe that is 3,270ft long has a diameter of 14.0 in. for two-thirds of its length and 10.0 in. for the remaining one-third. How many gallons will it take to completely fill this pipe?
 - a. 17,598gal
 - b. 21,900gal
 - c. 52,670gal
 - d. 87,500gal
16. How many pounds of lime must be added to exactly 200 gal of water to produce a lime slurry of 15% ?
 - a. 220lb
 - b. 290lb
 - c. 340lb
 - d. 420lb
17. Determine the volume in gallons of a trapezoid-shaped canal that has the following dimensions:
 - Length = 6,091ft
 - Height = 4.10ft
 - Bottom width = 5.85ft (b_1)
 - Top width = 10.6ft (b_2)
 - a. 1,270,000 gal
 - b. 1,330,000gal
 - c. 1,480,000 gal
 - d. 1,540,000gal
18. Calculate the detention time to the nearest 100hr for the following system:
 - The clear well is 308ft long, 118ft wide, and has an average water depth of 12.85ft
 - Distribution pipe from clear well to storage tank is 1.34 miles long and has a diameter of 2.00ft
 - The storage tank has a diameter of 99.8ft and averages a height of 26.48ft of water
 - The water production for the year averaged 30.02mgd
 - a. 4.02hr

- b. 4.16hr
 - c. 4.22hr
 - d. 4.29hr
19. A well has a depth of 276.5ft. If the depth to water is 153.8ft, which is the pressure in psi 5.0ft above the bottom? Disregard the additional atmospheric pressure in the well.
- a. 42psi
 - b. 46 psi
 - c. 48psi
 - d. 51psi
20. How many gallons per minute should a flowmeter register, if a 10.0-in. diameter main is to be flushed at 5.10ft/sec ?
- a. 1,050gpm
 - b. 1,100gpm
 - c. 1,250gpm
 - d. 1,350gpm
21. Water is flowing at a velocity of 2.0ft/sec in an 8.0-in. diameter pipe. If the pipe changes from the 8.0-in. to a 10.0-in. pipe, the velocity in the 10.0-in. pipe will be
- a. 1.3ft/sec
 - b. 1.5ft/sec
 - c. 1.7ft/sec
 - d. 1.8ft/sec
22. An 18-in. diameter distribution pipe delivers 988,000 gallons in 24hr. Which is the average flow during the 24hr in ft/sec ?
- a. 0.60ft/sec
 - b. 0.73ft/sec
 - c. 0.87ft/sec
 - d. 0.94ft/sec
22. A 64.5% calcium hypochlorite solution was used to treat 10.6mil gal. The tank containing the hypochlorite solution is 6.0ft in diameter. If the tank dropped 8.03 in. during the time the 10.6mil gal were treated, which must have been the chlorine dosage in mg/L ?
- a. 5.78mg/L
 - b. 6.33mg/L
 - c. 7.25mg/L
 - d. 8.61mg/L
23. A well that is 227ft deep and 12 in. in diameter requires disinfection. Depth to water from the casing top is 143ft. If the desired dose is 50.0mg/L, how many gallons of sodium hypochlorite (12.5% available chlorine) are required? Note: The specific gravity of the sodium hypochlorite is 1.15 or 9.59lb/gal.
- a. 0.17 gal

- b. 0.19 gal
 - c. 0.21gal
 - d. 0.25 gal
24. A pipe that is 2.50ft in diameter and 1,058ft long is to be disinfected with 64.5% calcium hypochlorite tablets. If the desired dose is 25.0mg/L, how many pounds of calcium hypochlorite are required?
- a. 10.1lb
 - b. 11.7lb
 - c. 12.6lb
 - d. 13.2lb
25. A tank 84.0ft in diameter and 24.25ft high at the overflow requires disinfection. How much 12.5% sodium hypochlorite that is 9.59lb/gal will be required for a dosage of 50.0mg/L ?
- a. 310 gal
 - b. 350gal
 - c. 380 gal
 - d. 410gal
26. How many calcium hypochlorite tablets, each weighing 0.45lb, are needed to disinfect a water main, given the following information:
- Length of pipe = 513ft
 - Pipe diameter = 2.50ft
 - Calcium hypochlorite = 64.0% available chlorine
 - Dosage required = 25.0mg/L
 - a. 10 tablets
 - b. 12 tablets
 - c. 14 tablets
 - d. 16 tablets
28. A well that is 210ft in depth and 14.0in. in diameter requires disinfection. The depth to water from top of casing is 91ft. If the desired dose is 50.0mg/L, which is the number of pounds and ounces of sodium hypochlorite (12.5% available chlorine) required? Assume the sodium hypochlorite solution is 9.59lb/gal.
- a. 43oz of NaOCl
 - b. 45oz of NaOCl
 - c. 49 oz of NaOCl
 - d. 54 oz of NaOCl
29. Soda ash slurry is being added to water being released from a clear well to the distribution system to raise the pH. If the amount of soda ash being added averages 124.5 grams per minute for that day and the water leaving the distribution system averages 3,075 gpm for that day, which must have been the soda ash dosage in mg/L ?

- a. 8.18mg/L
 - b. 9.70mg/L
 - c. 10.69mg/L
 - d. 12.47mg/L
30. The level in a clearwell tank drops 7.08ft in exactly 12.0hr. If the tank has a diameter of 149.8ft and the plant is producing 4.75mgd, calculate the average discharge rate for each pump of the four same capacity treated water discharge pumps in gallons per minute.
- a. 1,150gpm
 - b. 1200gpm
 - c. 1,250gpm
 - d. 1,680gpm
31. Determine the horsepower (hp) required for a clear well water pump that needs to pump water to a storage tank given the following parameters:
- Elevation of clear well water pump = 170.84ft
 - Elevation of water storage tank = 478.16ft
 - Length of pipeline from clear well water pump to storage tank = 2,107ft
 - Pump above clear well (suction lift) = 2.5ft
 - Friction loss in pipeline = 1.57ft per 1,000ft
 - Assume velocity head = 2.38ft
 - Required flow per day (maximum) = 4,000gpm
 - Pump efficiency = 85%
 - Motor efficiency = 89%
 - a. 375hp
 - b. 400hp
 - c. 420hp
 - d. 450hp
32. Which is the net positive suction head available (NPSHA) given the following data? Will the pump cavitate, if the net positive suction head required (NPSHR) is 18.4ft ? Note: There are 1.11ft/in. of Hg.
- Atmospheric pressure (AP) = 29.8 in. Hg
 - Static suction lift (SSL) = 15.1ft
 - Friction headloss (Hf) = 0.61ft

- Vapor pressure at 12°F(VP) = 0.50ft
 - a. 14ft, therefore NPSHA < NPSHR so cavitation should occur
 - b. 17ft, therefore NPSHA < NPSHR so cavitation should occur
 - c. 20ft, therefore NPSHA > NPSHR so cavitation should not occur
 - d. 22ft, therefore NPSHA > NPSHR so cavitation should not occur
33. Determine the approximate C factor for a pipe that is 1.0ft in diameter and has a flow of 1,225gpm given the following data:
- Upstream pressure gauge = 120ft
 - Downstream pressure gauge = 105ft
 - Distance between gauges = 2,274ft
 - a. 95
 - b. 100
 - c. 110
 - d. 120
34. A storage tank has a capacity of 34.0ft. Currently there are 22.89ft of water in the tank. Which would the SCADA reading be on the board in milliamps (mA) for a 4-mA to 20 – mA signal?
- a. 13.9 mA
 - b. 14.1 mA
 - c. 14.3 mA
 - d. 14.8 mA