

OPERATOR STUDY GUIDE

ADVANCED WATER DISTRIBUTION

For Grade III & Grade IV

MATH

1. How many 50-gallon drums of paint will be needed to paint the outside of a 90-ft. diameter storage tank that is 40 feet high if one gallon of paint covers 180 square feet?
2. How much force in tons is on a closed 8-inch valve with 75 psi on one side?
3. What is 70 degrees Fahrenheit converted to Celsius?
4. What is the gpm flow rate of a 2 feet by 3 feet open channel with a velocity of 1 fps?
5. How much will it cost in a year to chlorinate a 24-inch pipeline flowing at 15 fps if a residual of 0.4 ppm is desired with a demand of 1.2 ppm if chlorine costs \$0.81 per lb.?
6. What horsepower of a 92% efficient pump would be required to pump 5 cfs into a 40-ft. deep tank with a diameter of 90 feet at an elevation of 310 feet above the pump?
7. A pump station is located at an elevation of 4,678 feet. The pump is pumping into a 2 MG tank that is 40 feet high. The pump is located at a base elevation of 4,813 feet at a flow of 3.8 cfs, how much will it cost for electricity to run the pump for 18 hours a day for 6 months if power costs \$0.47 per kilowatt hour? Assume 100% efficiency of the pump.
8. If two 1,500 gpm pumps are pumping with a discharge pressure gauge indicating 115 psi and the elevation difference between the pumps and the water in the tank is 310 feet, what is the head loss due to friction in psi?
9. How much Calcium Hypochlorite (HTH) at 65% is needed to disinfect 3,500 feet of 12-inch pipe at 25 mg/L?
10. What is the gpm flow rate of a 16-inch pipe flowing with a velocity of 3.6 fps?
11. What would be the velocity of water in fps of an 18-inch pipe flowing at 4.2 MGD?
12. What is the percent of "unaccounted for" water in a system if the pumps deliver 450,000 gallons in a month and the combined customer meter reads 53,680 cubic feet?
13. If a pumping station produces 4,200 gpm with 520 feet of head and has efficiencies of 87% on the motor and 79% on the pump, what would be the average monthly power cost if the pump ran 10 hours per day and power costs \$0.19 per kilowatt hour?
14. What is the maximum pumping rate in cfs of a 30-HP pump with 145 feet of head?
15. What is the fps difference in velocity of a 12-inch and a 10-inch main with a flow of 4,200 gallons per minute?
16. What would be the gpm flow of an 8-inch water pipe to achieve a velocity of 2.5 fps?
17. What size of pipe would be needed to double the volume of a 10-inch pipe?
18. If a 2MG tank is dosed at 200mg/L chlorine in the bottom 1 foot of the tank and is then filled to the 38 feet overflow, what would be the resulting mg/L dosage in the full tank?
19. If the annual operating cost of a water system includes \$29,000 for salaries, \$7,450 for chemicals, \$8,620 for utilities, and \$2,350 for maintenance, and the system delivers an average of 22 MG per month, what is the annual cost per 1,000 gallons to produce water?

20. If a pump is delivering a flow of 340 gpm and using 45 kilowatts per hour with a wire-to-water efficiency of 70%, what is the total head it is pumping against?
21. If a tank has a radius of 35 feet and is 32 feet high and needs to be disinfected at 5 mg/L with 5% sodium hypochlorite, how many gallons of the hypochlorite is needed?
22. Determine the specific capacity of a well if it yields 560 gpm with a drawdown of 42 feet.
23. What additional pressure in feet of head will need to be added to water from a pipeline with 65 psi to fill a 40-ft-high tank located at an elevation of 367 feet above the pipeline?

OPERATION & MAINTENANCE

1. What is turbidity, how is it measured, and in what units is it expressed?
2. What high levels of iron affect a drinking water system and how can it be removed from the system?
3. What does TDS stand for and what does it represent in an inorganic analysis?
4. What is the C-factor and what does it indicate in a water pipe?
5. What is wire-to-water efficiency and how is it calculated?
6. What are the corrective measures a water system takes to minimize problems resulting from corrosive waters?
7. What is specific gravity and how does it relate to water and air?
8. What effect does pH adjustment have on corrosive water?
9. Water that is devoid of oxygen may produce noxious odors. What causes this?
10. What is pH saturation? What effect does it have on distribution system water quality and how is it accomplished?
11. What are chloramines, what types of problems do they cause and which one of them may be useful as a secondary disinfectant?
12. What is a cross connection, what two types of backflow can cause one and what methods of protection can be used to prevent them?
13. What is water hammer, how is it caused and how can it be prevented?
14. Define the following terms: cross connection, backsiphonage, back pressure, air gap, double check valve assembly, reduced pressure principal assembly, and pressure vacuum breaker assembly.
15. What causes friction head loss, what factors can affect it, and how does it relate to velocity in pipelines?
16. Why do electric motors normally draw more power when starting?
17. What factors should be considered when sizing a service connection and meter?
18. What is cathodic protection and why is it used on pipelines and storage tanks?
19. What types of tests are conducted to determine the corrosiveness of water on metal pipes, and what is the index called that utilizes the information derived from those tests?
20. If a three-phase electric motor is hooked up to power and the shaft turns in the wrong direction, how could the direction of rotation be corrected?
21. Why do electric motors normally draw more power when starting?
22. What would be the appropriate application for the following types of valves: gate valve, air and vacuum relief valve, altitude valve, pressure sustaining valve, butterfly valve, check valve, pressure relief and pressure regulating valve.
23. What procedures must be taken on a newly installed water main before it is put in service?
24. What relationship does head loss have with pipe size and the flow of the water?
25. What would be the purpose of installing two different sized pressure reducing valves in a parallel manifold?

26. What would be the purpose for determining the roughness coefficient of a pipe?
27. What device is used to determine flows from an open fire hydrant nozzle?
28. What is the specific capacity of a well and how is it determined?
29. What is a work order system and what is it used for?
30. What is thrust blocking, where is it used, and how does it work?
31. How is a leak survey conducted and what items are usually noted?
32. What factors would need to be considered in obtaining an easement right-of-way for constructing water lines?
33. What types of water contamination problems could result from improper installation of air vacuum and relief valves?
34. What would the head loss effects be on the following types of valves: gate, butterfly, globe, and check valves.
35. What is the easiest method of reducing water consumption?
36. What is a water audit and why and how is it performed?
37. What is the most effective way of immediately improving water quality in pipelines?
38. How long should a well that has been out of service be pumped before it is put into the drinking water system?
39. What would be the correct actions to take in the event a consumer calls and complains that the drinking water has made him sick?
40. What is the purpose of a sanitary survey?
41. What are the aesthetic concerns of drinking water and what do they indicate?
42. What effect will wear have on meter accuracy over an extended period of time?
43. What is DPD used for in the water system and how does it work?
44. What causes corrosive water and what are the indicators of its presence?
45. What instrument is used to measure resistance in an electrical circuit?
46. What is aeration and what does it remove from the water?
47. How are rectangular weirs measured?
48. What contaminant causes "Blue Baby Syndrome" and what are its effects?
49. What indicators would tell you that you had THMs throughout your system?
50. With relation to hardness in the water, define the causes and scale buildup, what titrant is used to measure it and what methods are used to control it.
51. What type of meter would best serve a fire line?
52. What hydraulic problems can occur when operating a valve?
53. What is the action level for lead and copper monitoring?
54. What device would be used to prevent surges from lightning storms?
55. What is the definition of Total Static Head?
56. What is aeration and what would it be used for in a water system?
57. What is a flush hydrant and how is it used in a water system?
58. With regards to fire hydrants, what does the term stringing mean?
59. What is the best method for controlling cross connections?
60. When a water main has been installed in a trench, what is the procedure for placing the first layer of backfill?
61. What is thermal expansion and what are the considerations with regards to backflow assemblies and devices?
62. Explain what a Hydraulic Gradeline is and the slope of the gradeline under different conditions.

PUMPS

1. What would be the effect of running a pump with the discharge valve partially closed for an extended period of time?
2. What would be the major benefit of maintaining accurate drawdown records for a well?
3. What effect could over-lubrication of grease-packed bearings have on a pump shaft?
4. What are the correct procedures to follow in packing a pump?
5. How can ball bearing failure in a pump shaft bearing generally be first detected?
6. What is the purpose of the curved diffuser vanes on the inside of a pump volute?
7. What would be the advantage of starting and stopping a centrifugal pump against a closed discharge valve?
8. What type of oil should be used for a culinary well pump?
9. What is a multistage pump and what does addition of stages do to the discharge?
10. What effect does wear on the impeller and wear rings of a pump have on efficiency?
11. Describe the following terms: head loss, friction head loss, static head, dynamic head, total dynamic head, suction head, and suction lift.
12. What is a hydraulic grade line and how can it be determined?
13. What advantages does packing have over mechanical seals and vice-versa?
14. What is the main cause of inefficiency in pumps and motors?
15. What is cavitation, how is it caused, and how can it be prevented?
16. What operational measures can be used to reduce the cost of peak demand electrical billing in an effort to save money?
17. Identify the following parts of a centrifugal pump along with the purpose of each: impeller, wear rings, shaft sleeves, seal water, lantern ring, volute, concentric reducer, and eccentric reducer.
18. What effect will water running backwards through a centrifugal pump have on the pump and how can it be prevented?
19. What is the difference between a velocity pump and a positive displacement pump, and what would be the best applications for each?
20. What would be the reason for introducing acid into a well?
21. What would be the probable cause of a severe vibration when a pump is first started?
22. What effect would the increase of head have on the volume of water pumped?
23. What is brake horsepower and how is it used in determining a pump's power cost?
24. What factors would determine the size of well casing to use on a well?
25. What is the main concern when using a coupling on a horizontal pump?
26. Why should accurate records be kept on pump operations?
27. What would happen if you lost a phase on a three-phase pump?
28. What is a hydro pneumatic tank and how does it operate?
29. What are the two most common speeds of a centrifugal pump?
30. What is a close-coupled pump and what purpose do the motor bearings serve?

CHEMICAL FEED

1. How does the alignment of the valves on a 1-ton chlorine cylinder affect the type of chlorine to be used?
2. What action could be taken immediately to help minimize a chlorine liquid leak on a 1-ton cylinder?

3. What is the purpose of a fusible plug, at what temperature does it melt, and where is it located on 150-lb. and 1-ton cylinders?
4. Where should the exhaust fan for a chlorine room be located?
5. What is the process of chlorination called as a treatment process and how does it differ from sterilization?
6. What is DPD used for in relation to chlorine and how does it work?
7. What causes the formation of trihalomethanes (THM's), how can they be prevented, how can they be removed, what is the MCL and what health risks do they present?
8. What effect do the following water quality parameters have on the disinfection process: temperature, pH, turbidity, organic matter, and hardness.
9. What is the chemical formula for hydrochloric acid and what advantages does it have as a disinfectant?
10. What do the following terms mean in relation to chlorine addition in the disinfection process: pre-chlorination, post-chlorination, and breakpoint chlorination.
11. What effect does the addition of chlorine gas to water have on the water's pH?
12. What difference does the reaction of hypochlorite with water have compared to the reaction of chlorine gas?
13. What chemical is used to detect chlorine leaks and how is it best used?
14. What type of piping should be used for chlorine?
15. How much expansion will take place if one gallon of liquid chlorine is vaporized and what is the specific gravity of chlorine gas?
16. What type of respiratory protection should be used when working with chlorine?
17. What are the two different types of chlorine residual and what are the advantages and disadvantages of each?
18. What are the three types of chlorine commonly used for disinfection and what is the effective disinfectant strength of each one?
19. How are hypochlorite solutions generally added to drinking water?
20. At what concentration in air is chlorine generally detectable?
21. What is the primary disadvantage that prevents ozone as being used as the only disinfectant for a drinking water system?
22. What item must always be replaced with a new item when changing a chlorine cylinder?
23. What are the physical properties of chlorine gas, what hazards does it present, what advantages does it have over most other disinfectants, and how does it react with bacteria?
24. What are the correct procedures to follow in collecting bacteriological samples?
25. How many turns should the valve on a chlorine cylinder be opened and where should the valve wrench be kept?
26. What is HTH and what different forms and strengths is it commonly available in?
27. What special precautions should be used when using hypochlorite compounds and why?
28. What is the approximate weight of a full 1-ton chlorine cylinder?
29. What is a rotometer and what does it do?
30. What is the proper way to remove calcium deposits from a poppet check valve?
31. What does chlorine react with when added to water?
32. What would one do to eliminate swimming pool tastes and odors from the water?
33. When ammonia and chlorine mix in water, what happens? When chlorine and hydrogen sulfide mix, what happens?
34. How would one troubleshoot a chlorinator that would feed only a portion of the setting?
35. DBP's are formed when disinfectants react with what?

RULES

1. What is Escherichia Coliform and what does it indicate in relation to drinking water?
2. How often must chlorination reports be sent in and to whom are they sent?
3. What does MCL mean, and what is the MCL for coliform bacteria, TTHMs and HAA's?
4. Where should bacteriological samples be collected from and on what frequency?
5. Who is responsible for routine bacteriological and chemical sampling of a public drinking water system?
6. What are the different types of public drinking water systems, what are their ratings, how are they assigned, and what do the ratings represent?
7. What do the following terms represent in reference to water quality: total coliform, fecal coliform, presence/absence, acute, non-acute, routine, repeat, additional, replacement, indeterminate, treatment technique and action level.
8. What would an operator need to do if the results of a routine bacteriological sample indicated the sample was "coliform positive?" What would the lab need to do?
9. What effect could an active cross connection control program have on maintaining water quality in a water system?
10. What are CEUs, why are they required, and how many are required to renew a grade 3 or 4 operator certificate?
11. What is the difference between primary and secondary drinking water standards?
12. What does the term Direct Responsible Charge operator mean in the Operator Certification Program?
13. What is the best method of protection against backflow?
14. What types of screens are required on air vent and drain lines for water storage tanks?
15. What are VOCs, Trihalomethanes, and HAA's?
16. What do the following terms mean in reference to operator certification: restricted, water specialist, water operator, and grandfather?
17. If the only certified operator of a system or plant leaves, what must the system do to maintain compliance with the Utah Public Drinking Water Rules?
18. What types of violations can occur in relation to bacteriological sampling?
19. What types of water systems must monitor for trihalomethanes?
20. What is a bacteriological sampling site plan and why is it required?
21. What is the base monitoring frequency for Pesticides for a system or source with no waivers?
22. Who must be notified in the event of a water system emergency that results in a health risk to the public water supply, and in what time frame?
23. What is a sanitary survey, who is authorized to perform one, and on what frequency?
24. What types of drinking water violations would require public notice?
25. Who is responsible for adoption and enforcement of the Utah Public Drinking Water Rules?
26. How long should records of chemical and bacteriological analyses be kept?
27. Where must chlorine room ventilation fans be located to draw air in and exhaust to the atmosphere?
28. What is a Picocurie and what water quality parameter uses it?
29. What two agency approvals must be obtained before a specific chemical can be added to drinking water?
30. What type of water system must monitor for man-made radioactivity?
31. What are the requirements regarding the design of a pump station?
32. Where should intake vents and exhaust fans be placed in a chlorine room?
33. What is the proper procedure for cleaning
34. Define: transient, non-transient, community and non-community with regards to water systems.
35. What would be required for routine maintenance of a spring collection area?

36. Where should lead and copper samples be taken and why?
37. At what level does the public need to be notified for fluoride and what is the MCL?
38. What information is contained in the Consumer Confidence Report, how often does it need to be provided and what methods are used to provide it?
39. What systems using chlorine are not required to sample with regards to the Stage 1 DBP rule?
40. How often are the Stage 1 DBP reports due?
41. Chlorine has an MRDL (Maximum Residual Disinfectant Level), what is it?
42. What are the different requirements for taking chlorine residual and bacteriological samples?
43. What are the requirements for a Distribution IV or Treatment IV operator to become unrestricted?

SAFETY & SECURITY

1. How far away from the edge of a trench should the excavated soil be kept?
2. What is the minimum safe level of oxygen content in an atmosphere?
3. What types of safety precautions should be exercised around a well site and why?
4. What is the most effective means of reducing atmospheric hazards in a confined space, what particular three atmospheric hazards are of concern, and what potential hazards do each of them represent?
5. Explain the following terms as they apply to safety issues: lock-out/tag-out, right-to-know, and MSDS.
6. What should be done with an electrical control circuit if it continues to blow fuses?
7. What should be used to soak up spilled acid solutions?
8. Who is primarily responsible for maintaining a safe work place?
9. What type of fire extinguisher should be used on an electrical fire and why?
10. What precautions should be used when working in traffic situations to repair water lines?
11. What type of equipment should operators be trained with for handling chlorine emergencies and how often should that training be conducted?
12. What precautions should be used in preparing a solution of acid and water?
13. What is the main objective of a safety program?
14. What is a "B" repair kit used for?
15. What are requirements for trench protection, what three methods can be used as protection when working in trenches, and who is responsible for inspecting the trench protection and determining hazards?
16. What precautions should be used when grinding tools on a bench grinder?
17. What precautions should be used when using acetylene torches?
18. What hazards would be present in a below-ground pump station?
19. What is a SCBA, where should it be stored in relation to the chlorine room, and what special training should be used with it and on what frequency?
20. What first aid should be given for severe cuts, first-degree burns, respiratory failure and shock?
21. Name two types of safety devices in an electrical panel.
22. How should pipe be stored safely in a storage yard?
23. What are some of the safety concerns when installing water mains?
24. Who causes the most on-the-job injuries?
25. What are the safety concerns and first aid for exposure to large amounts of fluoride?
26. What types of areas may be considered confined spaces?
27. When placing traffic warning signs, what determines the distance of placement? What are some of the safety concerns when installing water mains?

28. What are the safety concerns and first aid for exposure to large amounts of fluoride?
29. What types of areas may be considered confined spaces?
30. When placing traffic warning signs, what determines the distance of placement?
31. What is a vulnerability assessment and the steps involved?
32. What are the concerns with a water system's vulnerabilities?
33. What is a technological threat to a water system?
34. What are considered natural hazards to a water system?
35. What is an emergency response plan and what should be contained in it?
36. In an emergency, what is the Incident Command system?
37. How should sensitive documents be stored?
38. At what frequency should Emergency Response Plans be updated?
39. What is mitigation in regards to Emergency Response Planning?
40. What are the classifications of emergencies?
41. What is the threat management process and the steps involved?
42. What are the steps involved once you've determined that you have a credible threat to your system?
43. What is the Bio-terrorism Act of 2002 and the requirements that it mandated for water systems?
44. What are examples of deterrents, detection, delay, and response in relation to water security?
45. What are some of the precautions for receiving chemicals and deliveries?
46. What considerations should employers take with hiring new employees and contracting with vendors?
47. What should be taken into consideration with weeds, trees, shrubs, and other types of vegetation around sensitive sites?
48. What are some on line monitoring parameters that water systems should consider?
49. With regards to water system computers, what precautions should you take and how often should pass codes be changed?
50. What precautions should you take with having maps and sensitive documents in your water system vehicles?
51. What are some of the methods for notifying the public in a contamination event?
52. What procedures should be in place for investigating customer complaints?