

OPERATOR STUDY GUIDE

ADVANCED WATER TREATMENT

For Grade III & Grade IV

MATH

1. If an empty tank is 90 feet in diameter with an overflow at 30 feet and it is filled in 12 hours, what is the pump's gpm flow rate that is filling the tank?
2. What is the detention time (in seconds) of a flash mixer that is 8 feet deep and 6 feet wide with a flow of 2.5 MGD?
3. How much 65% HTH chlorine would be needed to dose a 90-ft. diameter clearwell that is 15 feet deep with a dose of 75 ppm?
4. If the flow through a filter is 2 cfs and the filter is 20 feet by 10 feet, what is the filter loading rate in gpm/ft²?
5. If a treatment plant has 4 filters that are each 50 feet long and 20 feet wide and the total flow of the plant is 5 MGD, what is the gpm/ft² flow rate of the filters?
6. What HP of 92% efficient pump would be required to pump 5 cfs into a 40-feet-deep tank with a diameter of 90 feet at an elevation of 310 feet above the pump?
7. If a treatment plant receives 7.2 cfs of water from a river with an alkalinity of 157 mg/L as CaCO₃ and 1,400 gpm from a reservoir with an alkalinity of 229 mg/L of CaCO₃, what would be the alkalinity of the resulting mixture?
8. If a 200-ml sample contains 0.43 mg of magnesium, what would be the mg/L concentration?
9. A 100-foot diameter tank with a 38-foot overflow is located at an elevation of 5,414 feet. The pumps that supply water to the tank are at 5,137 feet of elevation and together pump 1,400 gpm. What is the pump head in psi and how long will it take the tank to fill?
10. 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?
11. If a 90-foot diameter tank has 40 feet of water in it, what would be the psi at the bottom?
12. What is the per capita production in gpd of a plant that produces 5.75 csf to a system with a population of 2,450?
13. What would be the resultant dosage in mg/L of putting 100 lbs. of 65% HTH chlorine in a tank with a circumference of 283 feet with 32 feet of water in it with no chlorine demand?
14. What would be the velocity of water in fps of an 18-inch pipe flowing at 4.2 MGD?
15. What would be the chlorine dosage in mg/L of a plant that treats 5.2 cfs per day and uses 150 lbs. of chlorine each day?
16. What would be the gpm flow of an 8-inch water pipe to achieve a velocity of 2.5 fps?
17. What is the detention time in a sedimentation basin with a volume of 80,000 gallons and a flow of 1.1 MGD?

18. If a 2-MG tank is dosed at 200 mg/L chlorine in the bottom 1 foot of the tank, and is then filled to the 38-foot overflow, what would be the resulting mg/L dosage in the full tank?
19. What is the surface overflow rate of a circular sedimentation basin with a radius of 45 feet with a flow that is 4.2 MGD?
20. What is the percentage of mudballs in a filter if a 2000-ml sample of sand has 135 ml of mud balls?
21. A water treatment plant is changing over from using dry alum to liquid alum. If the specific gravity of dry alum is 0.98 and the specific gravity of liquid alum is 1.33, how much more weight will be in the 2,000-gallon alum tank?
22. What gpm flow would you need to have a backwash rate of 20 gpm/ft² on a filter that is 30 feet long and 18 feet wide?
23. Define interpolation.

OPERATION AND MAINTENANCE

1. What would be considered a typical filter backwash rate for a multi-media filter?
2. What effects might the use of fertilizers near surface water reservoirs have on water quality?
3. What are the different forms of activated carbon and under what specific conditions would they be used?
4. What unit of measurement is used in determining degree of odors in water?
5. What is the main purpose of a finished water storage reservoir?
6. What effect does pH adjustment have on corrosive water?
7. Water that is devoid of oxygen may produce noxious odors. What causes this?
8. Which contaminant is associated with "blue baby" syndrome?
9. What are chloramines, what problems do they cause, and which one of them may be useful as a secondary disinfectant?
10. What do the following abbreviations mean in relation to drinking water: TDS, TTHMs, NTU, pH, mg/L, ug/L, gpm, and psi?
11. What are TTHMs, how are they formed, and how can they be prevented and eliminated?
12. What is hardness in water and what chemicals cause it?
13. What is a cross connection, what two types of backflow can cause one, what methods of protection can be used to prevent them and what should you do with all newly installed devices?
14. What is pH, how does it affect water treatment, and what chemicals are added in order to adjust it?
15. What would be the correct actions to take in the event a consumer calls and complains that the drinking water has made them sick?
16. What water quality parameters should be monitored on treatment plant effluent on a fairly constant basis?
17. What test is most often used to determine chemical dosage in the treatment process?
18. How does the temperature of the water affect the coagulation and flocculation process?
19. What conditions could cause air binding in the filters?
20. What is a filter-loading rate and how is it determined?
21. What minerals commonly cause hardness, in what terms is hardness usually expressed, how does its presence or the absence of it, affect the drinking water, what titrant is used to test for it and what level would be considered soft water?
22. What is the C-factor and what does it indicate in a water pipe?
23. What is wire-to-water efficiency and how is it calculated?

24. What is specific gravity and how does it relate to water and air?
25. 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?
26. What is the Langlier index used for in drinking water?
27. Why do electric motors normally draw more power when starting?
28. What are electrical transformers used for?
29. What would the head loss effects be on the following types of valves: gate, butterfly, globe, and check valves.
30. What factors determine when a filter should be backwashed, and what variables determine the effectiveness of the backwash cycle?
31. What are the major elements and objectives of a preventive maintenance program?
32. What is the easiest method of reducing water consumption?
33. How does the pH of water affect the chlorination process?
34. What is aeration and what is its purpose in water treatment?
35. What causes friction head loss, what factors can affect it, and how does it relate to velocity in pipelines?
36. What is pH saturation, what effect does it have on distribution system water quality, and how is it accomplished?
37. What do the following terms relate to in raw water storage: thermocline, turnover, nutrients, and algae.
38. What is cathodic protection and why is it used on pipelines and storage tanks?
39. What type of corrosion would result from the combination of two different types of metals?
40. What would be the purpose of conducting roughness coefficient tests on pipes?
41. What are the effects and customer complaints associated with iron and manganese in water?
42. How are the following chemicals used in water treatment: alum, copper sulfate, anionic polymer, cationic polymer, potassium permanganate, caustic soda, lime, ferric chloride, and PAC.
43. What instrument would you use to measure resistance in an electrical circuit?
44. How is a rectangular weir measured?
45. What are the most effective oxidants used in taste and odor control?
46. How does alkalinity affect the coagulation process?
47. What is the correct order of the combined processes in a conventional water treatment plant?
48. Describe the components of a double-check valve assembly.

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 is packing, what types are used and what does it do. What is a packing gland, what are the correct procedures to follow in replacing and adjusting the packing in a centrifugal pump?
3. What would be the probable cause of a severe vibration when a pump is first started?
4. What effect does wear on the impeller and wear rings of a pump have on efficiency?
5. What is the purpose of the curved diffuser vanes on the inside of a pump volute?
6. 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.

7. What effect will water running backwards through a centrifugal pump have on the pump, and how can it be prevented?
8. What is cavitation, how is it caused, and how can it be prevented?
9. What is a multi-stage pump and what does addition of stages do to the discharge?
10. What is the difference between a velocity pump and a positive displacement pump, and what would be the best applications for each?
11. What should the operating pressure of seal water be in relation to the suction pressure of a pump?
12. How can ball bearing failure in a pump shaft bearing generally be first detected?
13. If one phase of a three-phase pump went out, what would the pump most likely do?
14. What are the three different designs of impellers in relation to shrouds that are used on centrifugal pumps?
15. Describe the following terms: head loss, friction head loss, static head, dynamic head, total dynamic head, suction head, and suction lift.
16. What is a hydraulic grade line and how can it be determined?
17. What advantages do mechanical seals have over packing and vice-versa?
18. Identify the major parts of a typical centrifugal pump stuffing box.
19. What type of seal or packing is recommended for pumps with high suction head?
20. What would be the advantage of starting and stopping a centrifugal pump against a closed discharge valve?
21. What effect would the increase of head have on the volume of water pumped?
22. What are the two most common speeds of a centrifugal pump?
23. Define: brake horsepower, electric horsepower, and water horsepower.

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 is the correct procedure to follow in changing a chlorine cylinder, and what item should always be replaced with a new one in doing so?
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 are the three types of chlorine commonly used for disinfection and what is the effective disinfectant strength of each one?
6. What is DPD used for in relation to chlorine, and how does it work?
7. What causes the formation of trihalomethanes and how can they be prevented. How can TTHMs be removed and what health risk 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. 9. What is the chemical formula for hydrochloric acid and what advantages does it have as a disinfectant?
10. 10. What do the following terms mean in relation to chlorine addition in the disinfection process: prechlorination, post chlorination, and breakpoint chlorination.
11. 11. What effect does the addition of chlorine gas to water have on the water's pH?

12. 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. 16. What type of respiratory protection should be used when working with chlorine?
17. 17. What are the two different types of chlorine residual and what are the advantages and disadvantages of each?
18. 18. What are chloramines, how are they formed, what problems can result from their presence in a water system, and what advantages does monochloramine have over a free residual?
19. 19. How are hypochlorite solutions generally added to drinking water?
20. 20. At what concentration in air is chlorine generally detectable?
21. 21. What are the advantages and disadvantages of using UV or ozone for disinfection?
22. 22. What is a rotameter and what does it do?
23. What are the physical properties of chlorine, what hazards does it present, what advantages does it have over most other disinfectants, and how does it react with bacteria?
24. What action could be taken immediately to help minimize a chlorine liquid leak on a 1-ton cylinder?
25. How many turns should the valve on a chlorine cylinder be opened and where should the valve wrench be kept?
26. What is the process of chlorination called as a treatment process and how does it differ from sterilization?
27. What is the approximate weight of a full 1-ton chlorine cylinder?
28. What is HTH and how do you clean its deposits off of equipment?
29. If a customer complains of swimming pool tastes and odors in the water, what is the problem and how do you correct it?
30. What problems are associated with Hydrogen Sulfide in the water?
31. Why is it important to know what the turbidity of the water is when using chlorine?
32. What are some problems that might cause a chlorinator to not feed chlorine at the desired rates?
33. What factors are used to determine CT values?
34. DBP's are formed by reacting with what?

RULES

1. What does MCL mean, and what are the MCLs for turbidity, coliform bacteria, HAA's and TTHMs?
2. What is Escherichia Coliform and what does it indicate in relation to drinking water?
3. How often must chlorination reports be sent in, and to whom are they sent?
4. How often must treatment plant reports be sent in, and to whom are they sent?
5. Where should bacteriological samples be collected from and on what frequency?
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 techniques, and action level?

8. What would an operator need to do if the results of a routine bacteriological sample indicated "coliform positive"? What would the lab need to do?
9. What is the highest acceptable filter loading rate for dual-media and mixed-media filters according to the Utah Drinking Water Rules?
10. What effect could an active cross connection control program have on maintaining water quality in a water system?
11. What are CEUs, why are they required, and how many are required to renew a grade 3 or 4 operator certificate?
12. What are the requirements for a facility that works 24-hour shifts in relation to DRC operators on duty?
13. What does the term Direct Responsible Charge operator mean in the Operator Certification Program?
14. Where must the ventilation fan in a chlorine room be located to draw air from?
15. What types of screens are required on air vent and drain lines for water storage tanks?
16. What are VOCs, THM's and HAA's?
17. What do the following terms mean in reference to operator certification: restricted, water specialist, water operator, and grandfather?
18. 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?
19. What types of violations can occur in relation to bacteriological sampling?
20. What type of systems must or don't need to monitor for trihalomethanes /HAA's and where should the samples be pulled from?
21. What is a bacteriological sampling site plan and why is it required?
22. What is the base monitoring frequency for Pesticides for a system or source with no waivers?
23. Who must be notified in the event of a water system emergency that results in a health risk to the public water supply?
24. What is a sanitary survey, and who is authorized to perform one and on what frequency?
25. What types of drinking water violations would require public notice?
26. What approvals must be obtained before a chemical can be added to drinking water?
27. Who is responsible for adoption and enforcement of the Utah Public Drinking Water Rules?
28. How long should records of chemical and bacteriological analyses be kept?
29. What type of water system must monitor for man-made radioactivity?
30. What is turbidity, what unit is it measured in, and where should it be monitored for in a water treatment plant?
31. Who is responsible for routine bacteriological and chemical sampling of a public drinking water system?
32. 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?
33. At what level does the public need to be notified for fluoride and what is the MCL?
34. What is the log removal for Cryptosporidium?
35. What are the turbidity requirements for Direct and Conventional filtration plants?
36. What are the requirements for surface water systems to submit reports to the Division of Drinking Water?
37. What are the requirements for a Distribution IV or Treatment IV operator to become unrestricted?
38. What are the requirements if a water system pulls multiple samples per month and has a total-coliform positive sample?

39. When are the reports due for the Stage 1 DBP rule?
40. What type of system needs to monitor for Raw, Finish TOC, and Raw alkalinity?
41. What is the maximum residual level for Chlorine?
42. What is the minimum amount of chlorine residual samples that need to be taken from a distribution system each week?
43. What sample must be taken at the same time and place as the chlorine residual sample?

SAFETY & SECURITY

1. What precautions should be used when grinding tools on a bench grinder?
2. What actions should be taken if a fuse or circuit breaker continues to fail?
3. What might be the first indication of a chlorine leak on chlorine piping and equipment?
4. 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?
5. 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?
6. Explain the following terms as they apply to safety issues: lock-out tag-out, right-to-know, and MSDS.
7. What should be done with an electrical control circuit if it continues to blow fuses?
8. What should be used to soak up spilled acid solutions?
9. Who is primarily responsible for maintaining a safe workplace?
10. What type of fire extinguisher should be used on an electrical fire and why?
11. What precautions should be used in handling activated carbon and why? Where should it be stored?
12. What is the safest procedure to use in a lab to transfer small amounts of acid or toxic chemicals?
13. What precautions should be used in preparing a solution of acid and water?
14. What is the main objective of a safety program?
15. What is a "B" repair kit used for?
16. What hazards could be present in a below ground pump station?
17. Whose responsibility is it to provide a safe workplace for employees?
18. What is the minimum safe level of oxygen content in an atmosphere?
19. How often should chlorine supply line valves be replaced?
20. Who is primarily responsible for creating and maintaining a working safety program?
21. In what area of gas chlorination systems are leaks most likely to occur?
22. What are the hazards and rules associated with trench safety?
23. What level and time of exposure is dangerous for airborne alum dust and what precautions should be taken?
24. What are some of the safety concerns while handling polymers?
25. What is the first aid for severe bleeding, shock, first-degree burns, and respiratory failure? What are some of the safety concerns when installing water mains?
26. Who causes the most on-the-job injuries?
27. What are the safety concerns and first aid for exposure to large amounts of fluoride?
28. What types of areas may be considered confined spaces?
29. When placing traffic warning signs, what determines the distance of placement?
30. What is a vulnerability assessment and the steps involved?
31. What are the concerns with a water system's vulnerabilities?
32. What is a technological threat to a water system?
33. What are considered natural hazards to a water system?

34. What is an emergency response plan and what should be contained in it?
35. In an emergency, what is the Incident Command system?
36. How should sensitive documents be stored?
37. At what frequency should Emergency Response Plans be updated?
38. What is mitigation in regards to Emergency Response Planning?
39. What are the classifications of emergencies?
40. What is the threat management process and the steps involved?
41. What are the steps involved once you've determined that you have a credible threat to your system?
42. What is the Bio-terrorism Act of 2002 and the requirements that it mandated for water systems?
43. What are examples of deterrents, detection, delay, and response in relation to water security?
44. What are some of the precautions for receiving chemicals and deliveries?
45. What considerations should employers take with hiring new employees and contracting with vendors?
46. What should be taken into consideration with weeds, trees, shrubs, and other types of vegetation around sensitive sites?
47. What are some on line monitoring parameters that water systems should consider?
48. With regards to water system computers, what precautions should you take and how often should pass codes be changed?
49. What precautions should you take with having maps and sensitive documents in your water system vehicles?
50. What are some of the methods for notifying the public in a contamination event?
51. What procedures should be in place for investigating customer complaints?