OPERATOR STUDY GUIDE

BASIC WATER TREATMENT

For Grade I through Grade IV

MATH

1. What is the detention time in hours of a 120-ft. diameter tank that holds 40 feet of water with a flow of 1.4 MGD?
2. If a tank has 32 feet of water in it and is 100 feet in diameter, what is the pressure at the bottom of the tank?
3. What is the filter loading rate in gpm/ft^2 of a 30 ft. by 15 ft. filter with a flow of 1 MGD?
4. What is the gpm flow rate of a 15 ft. by 20 ft. filter flowing at 5 gpm/ft^2?
5. What is the gpm flow rate of a 2 ft. by 3 ft. open channel with a velocity of 1 fps?
6. What is the surface overflow rate of a 100 ft. by 25 ft. tank that is 10 feet deep with a flow of 2.5 MGD?
7. How many pounds of Alum will be needed per day to dose 1.5 MGD to 21 mg/L?
8. How much force in tons is on a closed 8-inch valve with 75 psi on one side?
9. How many gallons will a 40-ft-high tank with a circumference of 283 feet hold full?
10. How many gallons of water will it take to backwash a 12 ft. by 20 ft. filter with a backwash rate of 18 gpm/ft^2 for two 12-minute cycles?
11. How long will it take to fill a tank that is 16 feet wide, 20 feet long and 8 feet deep with a flow of 30 gpm?
12. What is the gpm/ft^2 backwash rate of a 420-ft^2 filter with a flow of 4,200 gpm?
13. What is the maximum gpm pumping rate of a 400-HP pump with 450 feet of total head?
14. If a pump pumps 250 gpm against 50 feet of head, what is the horsepower of the pump?
15. How many vertical feet of water would be needed to create 92 psi?
16. If chlorine gas cost $0.21 per pound, how much would it cost to chlorinate 4 MGD at 1.9 ppm?
17. How many pounds of 65% HTH chlorine will be needed to dose a 100 ft. diameter tank that is 38 feet high with a residual dose of 10 mg/L if the demand is 2.5 mg/L?
18. What is the gpm flow into a 60 ft. diameter tank if it gains 1.5 feet an hour of water?
19. If a tank is 70 feet long, 30 feet wide and 12 feet deep and is supplied by a well pumping 550 gpm, how many hours will it take the well to fill the tank?
20. If a pump station is located at an elevation of 4,354 feet, has 6 feet of suction lift and discharges to a tank with a full water surface of 4,679 feet, and the pressure gauge on the pump discharge indicates 162 psi, what is the total dynamic head?
21. If a chlorine residual at a disinfection facility is 1.2 mg/L and the residual in the distribution system is 0.5 mg/L, what is the chlorine demand?
22. Given the following six turbidity readings throughout the day, determine the average daily turbidity: **0.10**, **0.13**, **0.11**, **0.09**, **0.08**, **0.09**.

23. If the specific gravity of liquid alum is 1.33, how much would a full 5 gallons of it weigh?
24. If a chemical feed pump doses 12 mg/L at 30 strokes per minute, how many strokes per minute will it need to be set at to dose 21 mg/L?
25. How many cubic feet per second of water would be used to produce 2.5 MGD?

OPERATION AND MAINTENANCE

1. What are the major differences between conventional and non-conventional treatment plants?
2. What are the different types of intake structures, and what are the advantages and disadvantages of each one?
3. What do the following abbreviations stand for and what do they mean: gpm, MGD, TTHMs, psi, NTU, and mg/L?
4. What are the different treatment processes in sequence in a conventional treatment plant?
5. What is turbidity, how is it measured, what units are used to measure it, and how does it affect water quality?
6. How would fluctuations in the volume of plant influent affect the settling basins?
7. What is pH, how does it affect water treatment, and what chemicals are added in order to adjust it?
8. What are coagulants, what are they used for, and what are the different primary coagulants?
9. What is the flocculation process and how does it work?
10. What effect does algae have on a treatment plant filter and what is this effect called? What other effects can algae have on water treatment?
11. What is the purpose of a sanitary survey and how often should it be conducted?
12. What is a colorimetric method and where is it used?
13. What would be the correct actions to take in the event a consumer calls and complains that the drinking water has made him sick?
14. What effect does pH have on distribution system piping?
15. What benefits does a surface wash add to a filter backwash?
16. What do the following terms mean in relation to drinking water: pathogenic, toxic, palatable, culinary, aesthetic, and potable?
17. What is water hammer, how is it caused, and how can it be prevented?
18. What test is most often used to determine chemical dosage in the treatment process?
19. What effect does water temperature have on the coagulation and flocculation process?
20. What are chloramines, what problems do they cause, and which one of them may be useful as a secondary disinfectant?
21. What factors determine when a filter should be backwashed, and what variables determine the effectiveness of the backwash cycle?
22. What storage tank operating procedure would keep water from freezing in cold weather?
23. What is a cross connection, what two types of backflow can cause one, and what methods of protection can be used to prevent them?
24. What effect will wear have on meter accuracy over an extended period of time?
25. What water quality parameters should be monitored on treatment plant effluent on a fairly constant basis?
26. What conditions could cause air binding in the filters?
27. What is a filter loading rate and how is it determined?

28. What minerals commonly cause hardness and how does hardness affect the drinking water?
29. What is the C-factor, and what does it indicate in a water pipe?
30. What causes friction head loss, what factors can affect it, and how does it relate to velocity in pipe lines?
31. Define the following terms: mud balling, filter head loss, percolation, and aeration.
32. What water quality problems would be associated with operating a fire hydrant?
33. What is the purpose of a finished water reservoir?
34. What types of filter media are used in water treatment?
35. What effect does iron have on drinking water?
36. Describe and give applications for the following valves: plug, ball, gate, sleeve, diaphragm, and check valve.
37. What chemicals would be used for taste and odor problems?
38. What is potassium permanganate used for and where is it fed at the treatment plant?
39. How do you determine the slope or grade of a pipeline?
40. Define and know the formulas for brake, water, and motor horsepower.
41. Explain the correct order of the treatment process in a conventional treatment plant.

PUMPS

1. What effect could over-lubrication of grease-packed bearings have on a pump shaft?
2. What is packing, and what does it do? What is a packing gland, and what are the correct procedures for adjusting and replacing the packing in a centrifugal pump?
3. Describe the following terms used in pumping: psi, head, head loss, friction head loss, static head, dynamic head, total dynamic head, drawdown, suction head and suction lift.
4. Identify the major parts of a typical centrifugal pump stuffing box.
5. What type of seal or packing is recommended for pumps with high suction head?
6. What would be the advantage of starting and stopping a centrifugal pump against a closed discharge valve?
7. What specific type of valve can be installed immediately downstream of a pump to prevent a reverse flow when the pump is shut off?
8. What are the three different designs of impellers in relation to shrouds that are used on centrifugal pumps?
9. What functions do pump and motor couplings serve?
10. What is the main cause of inefficiency in pumps and motors?
11. How does the impeller of a centrifugal pump move water?
12. What would determine the frequency for lubrication for the bearings of a pump?
13. What are the differences in starting and stopping procedures between a centrifugal pump and a positive displacement pump?
14. What would happen to a three-phase pump if one of the phases went out?
15. What effect would the increase of head have on the volume of water pumped?
16. What is the purpose of "priming" a centrifugal pump?
17. What type of pump would be best suited to providing precise chemical dosages?
18. If a pump shaft is spinning after the pump had been shut down, what is happening and how could this be prevented?

19. What would be the probable cause of a severe vibration when a pump is first started?
20. What effect does wear on the impeller and wear rings of a pump have on efficiency?
21. What type of oil and drip rate (drops per minute)is recommended for a deep well pump?
22. How does a pump control the level in a hydro pneumatic tank?
23. What tools would be needed to align a flex coupling?

CHEMICAL FEED

1. Explain the following terms and their relationship to each other: free chlorine, total chlorine, demand, and residual.
2. What is the process of chlorination called as a treatment process, and how does it differ from sterilization?
3. How, when and where should residuals be taken, and what information do they provide?
4. What effect do the following water quality parameters have on the disinfection process: temperature, pH, turbidity, organic matter, and hardness.
5. 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?
6. What is the recommended maximum feed rate for a 150-lb. chlorine cylinder?
7. What is a rotameter and what does it do?
8. 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?
9. 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?
10. What do the following terms mean in relation to chlorine addition in the disinfection process: prechlorination, post chlorination, and breakpoint chlorination.
11. What is the purpose of the vent line on a chlorinator?
12. What effect does the addition of chlorine gas to water have on the water's pH?
13. What difference does the reaction of hypochlorite with water have compared to the reaction of chlorine gas?
14. What chemical is used to detect chlorine leaks and how is it best used?
15. What type of piping should be used for chlorine?
16. How much expansion will take place if one gallon of liquid chlorine is vaporized, and what is the specific gravity of chlorine gas?
17. What type of respiratory protection should be used when working with chlorine?
18. What is HTH, and what different forms and strengths is it commonly available in?
19. What are the three types of chlorine commonly used for disinfection and what is the effective disinfectant strength of each one?
20. How are hypochlorite solutions generally added to drinking water?
21. Where should the exhaust fan for a chlorine room be located?
22. What is DPD used for in relation to chlorine and how does it work?
23. How many turns should the valve on a chlorine cylinder be opened and where should the valve wrench be kept?
24. What is a chlorinator that works off of the pressure of a chlorine cylinder called?
25. How would you minimize a liquid chlorine leak from a 1-ton cylinder?

26. What factors are used in determining CT values?
27. What is an auxiliary chlorine valve and what is it used for?
28. DBP's are formed when disinfectants react with what?

RULES

1. 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 levels?
2. 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?
3. Who has the primary responsibility for taking routine bacteriological samples of the drinking water system?
4. What determines how many bacteriological samples must be collected by a system?
5. What does MCL mean, and what are the MCLs for turbidity, TTHM's, HAA's, coliform bacteria, and fluoride?
6. Where should bacteriological samples be collected from and on what frequency?
7. What type of respiratory protection should be used when working with chlorine, where should it be stored, and what routine maintenance should be performed on it?
8. What is turbidity, what unit is it measured in, and where should it be monitored for in a water treatment plant?
9. What are the different types of public drinking water systems, what are their ratings, how are they assigned, and what do the ratings represent?
10. What are CEUs, why are they required, and how many are required to renew a grade 1 or 2 operator certificate?
11. What is the difference between primary and secondary drinking water standards?
12. What is the main objective of the Utah Water 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. Where and when should water treatment plant reports and chlorination facilities reports be sent?
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 water 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 is the action level for lead and copper monitoring and how is it determined?
20. What is a bacteriological sampling site plan and why is it required?
21. What is the base monitoring frequency for Pesticides/PCBs/SOCs for a system or source with no waivers?
22. What is the highest acceptable filter loading rate for dual-media and mixed-media filters according to the Utah Drinking Water Rules?
23. What effect could an active cross connection control program have on maintaining water quality in a water system?
24. What types of violations would require a system to issue a "public notice?

25. What two agency approvals must be obtained before a specific chemical can be used for the water treatment process?
26. What would be considered an emergency situation (health risk), what agencies must be notified, and in what time frame?
27. Where should intake vents and exhaust fans be placed in a chlorine room?
28. What is the proper procedure for cleaning then putting a finished water reservoir back in service.
29. How often do surface and ground water sources need to be tested for radioactivity?
30. What level of certification is required of a DRC operator?
31. What is contained in the health effects language for a coliform violation and when is it used?
32. At what level does the public need to be notified for fluoride and what is the MCL?
33. 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?
34. Where should TTHM and HAA samples be taken if you are required to take only one sample?
35. What systems are required to sample under the Stage 1 DBP rule and when are the reports due?
36. What causes DBP's?
37. Under the DBP rule which treatment types must sample for Raw, finish TOC and Raw alkality?
38. What are the different requirements for taking chlorine residual and bacteriological samples?
39. Chlorine has an MRDL (Maximum Residual Disinfectant Level), what is it?

SAFETY & SECURITY

1. What testing and ventilating procedures should be taken before entering a confined space and what are the specific atmospheric hazards associated with a confined space?
2. 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?
3. What chemical reaction takes place when chlorine gas comes into contact with body moisture, and what are the effects?
4. Who is primarily responsible for maintaining a safe work place?
5. What hazards would be present in a below-ground pump station?
6. What are the two types of electrical control safety devices found in electrical panels or control boxes?
7. What should an operator do if acid or other toxic chemicals are spilled on the skin?
8. What procedures should be followed by an operator who is lifting heavy objects?
9. What procedures should be followed to safely enter a confined space?
10. What precautions should be used in preparing a solution of acid and water?
11. What is the main objective of a safety program?
12. What is a "B" repair kit used for?
13. What is the purpose of putting guards on moving parts of machines and equipment?
14. What is the minimum safe level of oxygen in a confined space?
15. What should be used to soak up spilled acid solutions?
16. What should an operator do if acid or other toxic chemicals are splashed in the eyes?
17. What precautions should be used in handling activated carbon and why? Where should it be stored?
18. When using a hand truck to move 150-lb. chlorine cylinders, at what height on the cylinder should the safety chain be attached?
19. Where do most chlorine leaks occur and what action is usually taken first to stop a leak?

20. What type of fire extinguisher should be used on an electrical fire and why?
21. What might be the first indication of a chlorine leak on chlorine piping and equipment?
22. What should be the first concern when an employee has inhaled chlorine gas?
23. What should be done with an electrical control circuit if it continues to blow fuses?
24. Explain the following terms as they apply to safety issues: lock-out tag-out, right-to-know, and MSDS.
25. What is the first aid for severe bleeding, shock, first degree burns, and respiratory failure?
26. What are the hazards associated with using saw dust, powder activated carbon, ferric chloride and caustic soda?
27. How far away from the edge of a trench should the excavated soil be kept?
28. What are some of the safety concerns when installing water mains?
29. Who causes the most on-the-job injuries?
30. What are the safety concerns and first aid for exposure to large amounts of fluoride?
31. What types of areas may be considered confined spaces?
32. When placing traffic warning signs, what determines the distance of placement?
33. What is a vulnerability assessment and the steps involved?
34. What are the concerns with a water system's vulnerabilities?
35. What is a technological threat to a water system?
36. What are considered natural hazards to a water system?
37. What is an emergency response plan and what should be contained in it?
38. In an emergency, what is the Incident Command system?
39. How should sensitive documents be stored?
40. At what frequency should Emergency Response Plans be updated?
41. What is mitigation in regards to Emergency Response Planning?
42. What are the classifications of emergencies?
43. What is the threat management process and the steps involved?
44. What are the steps involved once you've determined that you have a credible threat to your system?
45. What is the Bio-terrorism Act of 2002 and the requirements that it mandated for water systems?
46. What are examples of deterrents, detection, delay, and response in relation to water security?
47. What are some of the precautions for receiving chemicals and deliveries?
48. What considerations should employers take with hiring new employees and contracting with vendors?
49. What should be taken into consideration with weeds, trees, shrubs, and other types of vegetation around sensitive sites?
50. What are some on line monitoring parameters that water systems should consider?
51. With regards to water system computers, what precautions should you take and how often should pass codes be changed?
52. What precautions should you take with having maps and sensitive documents in your water system vehicles?
53. What are some of the methods for notifying the public in a contamination event?
54. What procedures should be in place for investigating customer complaints?