

The study guide is for water treatment operators involving advanced skill and knowledge levels. The outlined topics are the general subjects which are the basis for the examination questions. The operator should be knowledgeable in the subject matter outlined and contained in the reference material list.

- PHYSICAL CHARACTERISTICS OF WATER
 - Turbidity
 - Odor and taste – rotten egg smell H₂S
 - Temperature
 - Color
- CHEMICAL CHARACTERISTICS OF WATER
 - Milligrams per liter (mg/l) or parts per million (ppm)
 - Milligrams = weight
 - Liter = volume
 - pH – acid range and base range
 - Inorganic contaminants (many are metals)
 - Primary – lead, mercury, silver, etc.
 - Secondary – sodium, calcium, etc.
 - Organic contaminants (pesticides and herbicides)
 - Iron and manganese – problem concentrations
- RADIOLOGICAL CHARACTERISTICS
 - Sampling period
 - Number of samples required to form composite sample
- WATER SOURCES AND CHARACTERISTICS
 - Define hydrological cycle
 - Define ground water
 - Aquifer – confined or unconfined
 - Movement of ground water
 - Define surface water
 - Compare quality of ground water and surface water
 - Water consumption and supply problems
- WELL CONSTRUCTION AND MAINTENANCE
 - Define static water level

- Define drawdown and freeboard (measurement of drawdown)
- Define radius of influence and cone of depression
- Basic well construction practices
 - Minimum distance from cesspool, septic tank, sources of pollution (100 feet – city well)
 - Wells may not be in a pit or basement
 - Proper grouting of well casing
 - Disinfection practices for wells
- Basic well operation – relationship of static water level, drawdown, and specific capacity
- TREATMENT (Potable water – define)
 - Sedimentation – define
 - Water velocity control
 - Calculation of detention time
 - Chemicals used as aids in sedimentation process
 - Coagulation – define
 - Flocculation – define
 - Calculation of detention time
 - Chemicals used as aids in sedimentation process
 - Softening – define carbonate hardness, noncarbonate hardness, and negative noncarbonate hardness
 - Ion exchange
 - Chemical precipitation
 - Chemical tests used to determine total hardness and calcium hardness
 - Factors influencing magnesium precipitation
 - Use of soda ash
 - Recarbonation – define (increase or decrease of carbon dioxide influences calcium carbonate)
 - Alkalinity – define
 - Define bicarbonates, carbonates, and hydroxides
 - Chemical tests used in determining P and M readings
 - Interpretation of P and M readings
 - Filtration
 - Types of filters
 - Different types of media available
 - Structure of rapid sand filter
 - Proper operation and backwash techniques
 - Formation of surface mat
 - Air binding (causes)
 - Interpretation of head loss readings
 - Disinfection – define
 - Define sterilization
 - Chlorination – reasons why chlorination is necessary

- Physical and chemical properties of chlorine
 - Breakpoint chlorination
 - Define chlorine demand, free available residual chlorine, combined available residual chlorine, total available residual chlorine
 - Factors influencing chlorination (pH, temperature, turbidity, etc.)
 - Recommended free chlorine concentration in water distribution system (1.0 mg/l)
 - Chlorinator operation, maintenance, and safety
 - Chlorine cylinders
 - Proper valve operation
 - Proper hookup techniques
 - Ventilation system
 - Fluoridation
 - Fluoride chemicals
 - Operation and maintenance of upflow fluoride saturators and fluoride equipment
 - Proper fluoride level (1.2 mg/l)
 - Aeration
 - Oxidation of iron and manganese
 - Carbon dioxide removal
 - Odor removal
- VII. CORROSION CONTROL
 - Factors influencing rate
 - Methods of control
 - Addition of metaphosphates
 - Depositing of lime (factors influencing)
 - Cathodic protection
- VIII. HYDRAULICS
 - Minimum pressure in distribution system (20 psi)
 - Application of venturi
 - $Q = VA$ Rate of flow = Velocity of water x Area of pipe
- VIX. PUMPING STATIONS, PUMPS, AND APPURTENANCES
 - Types and classification of pumps
 - Centrifugal pumps
 - Mechanical parts and function
 - Proper packing techniques
 - Pump priming
 - Shutoff head
 - Conditions causing overheating of motors

- Conditions causing loss of suction
 - Factors influencing pump output
 - Interpretation of a pump curve
 - Positive displacement pumps
 - Mechanical parts and function
 - Operation and maintenance
 - Booster pumping
 - Function
 - Control systems
 - Reservoirs
 - Protection from vandalism
 - Manhole for entry – overlapping and locked
 - Vents and overflows screened
 - Basic cross-connection control
 - Air gap
 - Vacuum breakers
 - Reduced pressure zone backflow preventor
 - Types of valves and function
 - Diaphragm, globe, rotary, slide, check, relief, altitude, pressure reducing
 - Proper repair
 - Proper opening and closing of valves
- X. SAFETY
 - Housekeeping techniques
 - Handling hazardous materials
 - Construction safety
 - Ventilation of all underground areas – pits, vaults, manholes
 - No smoking in manholes, vaults, and pits
 - First aid
- STATE AND FEDERAL SAFE DRINKING WATER ACT (SDWA) REGULATIONS
 - Responsibility (lawsuits and fines)
 - Sampling responsibility lies with provider
 - Requirements for submission of plans and specifications (required for new facilities, but also for changes in existing systems)
 - Sampling frequencies – physical, chemical, microbiological, radiological
 - Microbiological – number of monthly samples from distribution system based on population
 - Radiological sampling – four samples collected during the year and combined to form one composite sample – once every four years
 - Organic chemicals – sampled once every three years, applies to surface water only
 - Inorganic chemicals

- Ground water sampled once every three years
- Surface water sampled yearly
- Proper written reports
- Public notification responsibilities
- RECORDKEEPING
 - Need for records – some required by state and federal law
 - Types of records
 - Treatment
 - Operation
 - Maintenance
 - Repair work
 - Operation and maintenance manuals

REFERENCES

1. “Basic Level Water Treatment Operator’s Practices”
American Water Works Association Manual No. M18
2. “Manual of Instruction for Water Treatment Plant Operators”
New York State Department of Health
3. “Environmental Data Sheets for Municipal Utilities”
North Dakota Water and Pollution Control Conference
4. North Dakota Administrative Code Title 33 – Department of Health, Chapter 33-17 Public Water Supply Systems (Safe Drinking Water Regulations)

TYPICAL EXAMINATION QUESTIONS
Class III and IV Water Treatment

1. Hydrogen sulfide is a source of odor in water. Aeration is one method to remove it. Another method is:
 - a. Coagulation
 - a. Titration
 - b. Filtration
 - c. Super chlorination
 - d. Fluoridation

2. In the softening process by precipitation, noncarbonate hardness is removed by:
 - a. Lime
 - b. Phosphates
 - c. Carbon dioxide
 - d. Soda ash
 - e. Sodium aluminate

3. After a pump is shut off but continues to run backwards indicates:
 - a. The bearings are failing
 - b. The packing needs tightening
 - c. The main lock nut needs to be tightened
 - d. The check valve is leaking
 - e. A valve on the discharge side of the pump is shut

4. Name the type of valve that is sometimes found on the suction side of a centrifugal pump and is located where the water enters the casing.
 - a. Check valve
 - b. Gate valve
 - c. Altitude valve
 - d. Pressure relief valve
 - e. Foot valve

PROBLEMS:

5. An iron removal plant processes water with an average iron concentration of 2.5 mg/l. If the iron concentration is 0.01 mg/l after treatment and the total daily pumpage is one million gallons, how many pounds of iron will be removed per day?
- 10.77 pounds
 - 20.77 pounds
 - 25.77 pounds
 - 30.77 pounds
 - 35.77 pounds

ANSWERS TO TYPICAL EXAMINATION QUESTIONS
Class III and IV Water Treatment

1. d. 2. d. 3. d. 4. e.

5. PROBLEM ANSWER:

$$\begin{array}{r} 2.5 \text{ mg/l Influent} \\ -0.01 \text{ mg/l Effluent} \\ \hline 2.49 \text{ mg/l Iron Removed} \end{array}$$

$$2.49 \text{ mg/l} \quad \times \quad \frac{8.34 \text{ lbs.}}{1,000,000 \text{ gal.}} \times 1,000,000 \text{ gal.} = 20.77 \text{ lbs.}$$

mg/l