



# Operator Study Aid

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## **Disclaimer**

This Study Guide was prepared as a study aid for small water treatment plant operators.

The questions and answers are based on material found on the EPA web site and in the Sacramento Manuals, field study training program.

The database of questions is intended to be helpful to you in studying for Water Treatment Plant Operator certification.

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## General Water Treatment

1. A sounding tube
  - a. Allows air to enter well during drawdown to prevent vacuum conditions.
  - b. Vents excess air during well recovery period.
  - c. Permits operator to see level of gravel and add gravel as necessary.
  - d. Permits insertion of water level measuring device. Also used to add chlorine or well cleaning agents.
  - e. Permits measurement of water level by means of air pressure measurements.
  
2. A well casing vent
  - a. Supports the weight of the pumping unit.
  - b. Provides watertight seal between the motor base and the concrete support pedestal.
  - c. Permits sampling of pumped water.
  - d. \*Permits discharge of air in column pipe during start-up and admits air during shutdown.
  - e. Used to remove first water (usually sandy) pumped at start-up.
  
3. Source waters include these two broad categories
  - a. \*Surface water and ground water
  - b. Reservoirs and wells
  - c. Reservoirs and ground water
  - d. Flowing water and stagnant water
  
4. "Uniformity coefficient" refers to:
  - a. Uniform floc formation
  - b. Running the test the same way each time
  - c. Quality of wastewater
  - d. \*Measure of uniformity of a granular material such as filter media
  
5. What conditions determine the backwash rate for a pressure filter?
  - a. \*Size and specific gravity of the media and temperature of the water
  - b. Quality of the backwash water
  - c. Settleability of solids in the secondary clarifier
  - d. Suspended solids concentrations in the water applied to the filter
  
6. If your finished water turbidity changed from 0.2 NTU to 0.8 NTU and you do not want to change the pH, what chemical would you use?
  - a. Alum
  - b. Ferric chloride
  - c. \*Polymer
  - d. Sodium aluminate

7. The precipitate formed by coagulation with alum is aluminum \_\_\_\_\_.
- Bicarbonate
  - Carbonate
  - \*Hydroxide
  - Sulfate
8. The correct amount of chemical used to remove turbidity is known as the:
- Coagulation range
  - Combination dosage
  - Efficiency range
  - \*Optimum dosage
9. Required chemical coagulation doses are commonly determined by:
- \*Jar tests
  - Measurements of zeta potential
  - Oxidation-reduction investigations
  - Stoichiometric calculations
10. The weight of a chemical compound is 1/8 of the total weight of a chemical solution. The percent by weight, of the chemical in solution is:
- 6.4
  - 8.3
  - 10.5
  - \*12.5
11. Which of the following pH readings indicates an acidic source water?
- \*3
  - 7
  - 9
  - 12
12. One mL is what fraction of a L?
- 1/10
  - 1/100
  - \*1/1000
  - 1/100000
13.  $\frac{9}{5}(\text{degrees C}) + 32 = \underline{\hspace{2cm}}$
- Celsius
  - \*Fahrenheit
  - Kelvin
14. The conductivity of the source water indicates the quantity of dissolved material present.
- \*True
  - False

15. Turbidity generally indicates the quantity of \_\_\_\_\_ material in a water, particularly at low solids concentrations.
- Dissolved
  - Dispersed
  - \*Suspended and colloidal
  - Settleable
16. \_\_\_\_\_ is the measure of how much acid can be added to a liquid to lower the pH to 4.5.
- \*Alkalinity
  - Hardness
  - pH
  - Acidity
17. The saturation level for oxygen in water \_\_\_\_\_ when temperature increases.
- Increases
  - \*Decreases
  - Stays about the same
18. The adherence of a gas, liquid, or dissolved material on the surface of another material is called:
- Absorption
  - \*Adsorption
  - Capillary action
  - Surface tension
- Note: Absorption is when things are taken inside the surface of a solid.
19. A manometer uses a column of liquid to measure:
- Liquid levels
  - \*Pressure
  - Gas volume
20. One BTU is:
- \*A unit of measure required to heat or cool 1 lb. of water by 1 degree f.
  - Equal to one joule per second
  - The amount of energy needed to cause a flow of current
  - A measure of radioactivity
21. A column of water 12" high and 1 square inch in surface area will produce a pressure of \_\_\_\_\_ lbs.
- 1.0 lb
  - 2.31 lbs
  - \*0.433 lbs
  - 62.4 lbs

22. A pound of water weighs \_\_\_\_\_ lbs.
- 7.48
  - 62.4
  - 8.34
  - \*None of the above
- Note: A pound of water weighs one pound.
23. The pressure exerted by a column of water one inch square when at rest, is the \_\_\_\_\_ pressure. It is usually measured in psi.
- \*Static
  - Dynamic
  - Theoretical
  - Practical
24. The vertical distance (in feet) equal to the pressure (in psi) at a specific point is called \_\_\_\_\_.
- Head
25. A wall or plate placed in an open channel and used to measure flow is called a:
- Baffle
  - \*Weir
  - Flume
  - Flow board
26. G27. Which of the following is not an example of a water flow measuring device?
- Magnetic meter
  - Parshall flume
  - Weirs
  - \*Manometer
  - Venturi
27. Convert 18 degrees Celsius to Fahrenheit
- 50.6
  - \*64.0
  - 68.5
  - 34.2
28. The main action of a mixed media filter is:
- \*Straining
  - Disinfecting
  - Coagulating
  - None of the above
29. A wet well probe is usually used for \_\_\_\_\_ determination(s) of level.
- Approximate
  - Dual-point

- c. Continuous
  - d. \*Single-point
30. The most critical criterion for determining when a mixed media filter should be backwashed is:
- a. \*Filter effluent quality
  - b. Flow rate
  - c. Head loss
  - d. Visual inspection of the filter surface
31. A process in which a tank or reactor is filled, the water treated, then the tank is emptied, and the process repeated is called\_\_\_\_\_.
- a. \*Batch process
  - b. Continuous process
  - c. Intermittent process
  - d. Industrial process
32. A \_\_\_\_\_ sample consists of a collection of individual samples collected at regular intervals throughout the day
- a. \*Composite
  - b. Grab
  - c. Weighted average
  - d. Final effluent
33. A long chain molecule with a high molecular weight that that is formed by either a natural or synthetic process (Can have either positive or negative charge) is called?
- a. \*Polymer
  - b. Protein
  - c. Carbohydrate
  - d. Enzyme
  - e. Deoxyribonucleic acid
34. A thin plate with a hole in the middle used to measure flow is called \_\_\_\_\_.
- a. \*An orifice plate
  - b. A parshall flume
  - c. A pinhole weir
  - d. A venturi restriction
35. The percent of oxygen in air at sea level is \_\_\_\_\_%
- a. 78
  - b. 65
  - c. \*21
  - d. 33 1/3

36. Disaster planning is:
- Having manuals ready so they can be read if a disaster occurs
  - Something that, if properly done, will not need to be revised
  - \*Useful in reducing confusion in the event of a disaster
  - None of the above
37. When purchased materials are received by the utility they should be:
- \*Counted and checked against the purchase order
  - Distributed as soon as possible
  - Placed on shelves
  - Assumed to be in working order
38. Public relations are important because we:
- Want to finish our work in a hurry
  - Don't want to be late for lunch
  - Hate listening to whiners
  - \*Must deal with the public
  - Want to keep our jobs
39. Successful communication requires mutual:
- Agreement
  - Confusion
  - Transmission
  - \*Understanding
40. When a great deal of authority is delegated on many levels, an organization may be described as:
- Authoritarian
  - Centralized
  - \*Decentralized
  - Unstructured
41. Generally, as an individual progresses upward in management, reliance on personal technical skill:
- Becomes more complex
  - \*Decreases
  - Increases
  - Remains the same
42. Control is:
- Looking backward
  - Concentrating on the present
  - \*Looking forward
  - Not connected to other managerial functions
43. There are generally more limitations on authority the farther one:



- a. Ascends
  - b. \*Descends
  - c. Moves horizontally
  - d. Remains in the same position
44. The best approach to complaints involving the operation of a water plant is to:
- a. \*Explain the problem and proposed solution and offer to conduct a tour of the plant for those complaining
  - b. Keep all persons except for operating personnel out
  - c. Never admit there is a problem or cause for the complaint
  - d. Publicize the problem as much as possible
45. List one type of common management plan.
- a. Strategic
  - b. Contingency
  - c. Single use
  - d. Program
  - e. Capital facility
  - f. Financial
46. When an employee seems to have made an error, a supervisor should first;
- a. \*Obtain all the relevant facts.
  - b. Have the employee admit the error.
  - c. Keep a written record of events.
  - d. Have a pleasant discussion with the employee.
47. When hiring a new operator, a supervisor should select;
- a. The best communicator.
  - b. The person with the lowest salary requirement.
  - c. The person with the highest level of education.
  - d. \*The person whose knowledge, skills, and abilities best match the demands of the job.
48. A \_\_\_\_ sample is a discrete sample that is collected at a particular time and place.
- a. \*Grab
  - b. Composite
  - c. Flow proportional
  - d. Temporal
49. The solubility of air into water decreases with pressure.
- a. \*False
  - b. True

50. 1 gallon = \_\_\_\_\_ liters
- 4.546
  - \*3.785
  - 2.08
  - 8.34
  - 7.48
51. 1 horsepower = .7457 \_\_\_\_\_.
- ft-lbs/min
  - watts
  - ft-lbs/sec.
  - \*kilowatts
52. 1 acre = \_\_\_\_\_ square feet.
- \*43,560
  - 62,500
  - 34,650
  - 5,280
53. What does cfs stand for?
- cubic feet per second
  - cubic feet/second
  - cubic ft/sec
  - ft<sup>3</sup>/sec
  - cuft/sec
  - \*all of the above
54. Agglomeration of colloidal and finely divided suspended matter after coagulation by gentle mixing is called what?
- \*Flocculation
  - Sedimentation
  - Polymer accretion
  - Ballasting
55. A thermocouple measures what?
- \*Temperature
  - Pressure
  - Vibration
  - Wind speed
56. A laboratory procedure for evaluating coagulation, flocculation, and sedimentation is called what?
- jar test
57. A device used for quick, uniform dispersal of a chemical throughout a liquid is called a what?

- a. Flash mixer
58. What does TDS stand for?
- a. \*Total dissolved solids
  - b. Temporarily dissolved solids
  - c. Total disaggregated solids
  - d. Total dissolved salts
59. The formation of layers of different temperature in a body of water is called what?
- a. \*Thermal stratification
  - b. Thermal justification
  - c. Limnoptic layering
  - d. Limnoptic stratification
60. Chlorine, sodium hypochlorite and ultraviolet are commonly used in what water treatment process?
- a. \*Disinfection
  - b. Manganese and iron removal
  - c. Oxidation processes
  - d. Filter backwashing
61. Floats, ultrasonic devices, and bubblers are all examples of what type of sensing equipment?
- a. \*Level
  - b. Flow
  - c. pH
  - d. Velocity
62. A bed of sand through which water is passed to remove fine suspended particles is called what?
- a. sand filter
63. In the water treatment field, mg/L and ppm are considered to be equivalent units.
- a. \*True
  - b. False
- Note: Yes, it's true. A ug/L is equal to a ppb. There are 1,000 ug/L in one ppm. There are 10,000 ppm in 1%.
64. Which one of the following statements is true in regard to the concept of pH?
- a. pH indicates the amount of total alkalinity available.
  - b. A raw water sample with a pH of 6.5 is slightly basic.
  - c. \*The range of pH is between 0 and 14
  - d. A pH meter gives the percent hydrogen ion concentration as its direct readout value.
  - e. Accurate pH measurements on raw water require that a 24-hour flow-proportional sample be collected.

65. The total solids in water would be a combination of:
- a. Fixed solids, settleable solids and volatile solids
  - b. Dissolved solids, suspended solids and volatile solids
  - c. \*Dissolved solids, settleable solids and suspended solids
  - d. Fixed solids, dissolved solids and suspended solids
66. Which of the following terms refers to the addition of chemicals to a sample in the field to prevent water quality indicators from changing before final measurements are performed?
- a. Standardization
  - b. Buffer
  - c. \*Preservation
  - d. Titration

Note: Operations Forum April 2001 -- sometimes this is also called "fixing" a sample

67. Most circuit breakers are rated at what percentage of motor amperage?
- a. 10%
  - b. 25%
  - c. 100%
  - d. 125%
  - e. \*None of these answers are correct

Note: Operations Forum July 1999 There is no fixed percentage.

68. Venturi flowmeters use differential pressure to measure flow. The high-pressure port is located on the throat of the Venturi.
- a. True
  - b. \*False

Note: Operations Forum March 1999 An increase in velocity results in a decrease in pressure at the throat.

69. Venturi flowmeters can measure flow when partially full of liquid.
- a. True
  - b. \*False

Note: Operations Forum March 1999

70. The maximum velocity a venturi flowmeter can measure is
- a. 1 ft/s
  - b. 10 in/s
  - c. \*10 ft/s
  - d. 10 m/s

Note: Operations Forum March 1999

71. The difference in pressure between high- and low-pressure taps is proportional to the square of the flow rate through the Venturi. Therefore, a differential-pressure sensor with a square root output signal can be used to indicate flow.
- \*True
  - False
- Note: Operations Forum March 1999
72. The term slaking refers to
- The addition of water to quick lime
  - The production of a lime slurry of calcium hydroxide
  - The addition of water to recalcined lime
  - \*All of these answers are correct
  - None of these answers are correct
- Note: Operations Forum November 1998
73. Which of the following is not a basic backflow prevention device?
- \*Corporation stop
  - Double check-valve assembly
  - Reduced pressure principle device
  - Air gap
- Note: Operations Forum March 1998
74. An example of a "single-use" plan is a(n)
- Regulating principle or directive
  - Indication of exactly how each step is to be carried out
  - \*Budget
  - Chronological sequence of performance acts
- Note: Operations Forum February 1998
75. Which of the following flow measuring devices is the most accurate?
- \*Venturi tube
  - Parshall flume
  - Magnetic meter
  - Weir
76. Weirs are most often used to measure flows in
- Treatment plant intakes
  - \*Open channels
  - Pipelines
  - Underground pipes
- Note: Operations Forum February 1998
77. Photosynthesis is the conversion of \_\_\_\_\_ to \_\_\_\_\_ by algae using sunlight for energy.
- Carbon dioxide to water
  - Carbon dioxide to methane

- c. \*Carbon dioxide to oxygen
- d. Carbon dioxide to ammonia

Note: Operations Forum February 1998 Plants breathe in carbon dioxide and release oxygen.

78. A caustic chemical pump has a pH controller for feed control. The controller needs to maintain a pH of 6.9. As the pH of the finished water decreases, the speed of the pump decreases.
- a. True
  - b. \*False

79. The reverse-acting actuator on a control valve is pneumatic. The valve is 50% open. As you decrease the input signal to the valve, it opens 60%. The valve is functioning normally.

- a. \*True
- b. False

Note: Operations Forum November 1997

80. What effect does temperature have on oxygen solubility?
- a. \*As temperature increases, dissolved oxygen levels decrease
  - b. As temperature decreases, dissolved oxygen levels decrease
  - c. No effect

Note: Operations Forum September 1997

81. Chlorine is primarily used to

- a. \*Disinfect
- b. Prevent corrosion
- c. Raise pH
- d. Stabilize organics

Note: Operations Forum August 1997

82. The slope of a water line is equal to the length of pipe divided by the vertical elevation difference.

- a. True
- b. \*False

Note: Operations Forum January 1997 Slope is rise over run. In other words, it is the height or elevation difference divided by the length. You can remember rise over run by always putting the two terms in alphabetical order.

83. The time it takes for a unit volume of water to pass entirely through a sedimentation basin is called

- a. \*Detention time
- b. Hydraulic loading rate
- c. Overflow time
- d. Weir loading rate

Note: WEF/ABC 2002 Guide

84. Which of the following is a typical piece of flow measuring equipment?

- a. \*Parshall flume
- b. Nephelometer
- c. Downward looking acoustic sensor
- d. Counterweighted float-level indicator

Note: WEF/ABC 2002 Guide

85. What calibrated device developed for measuring flow in an open channel consists of a contracting length, a throat with a sill, and an expanding length?

- a. \*Parshall flume
- b. V-notch weir
- c. Equalizing tank
- d. Magmeter

Note: WEF/ABC 2002 Guide

86. Magnetic flow meters work on which of the following principles of operation?

- a. The volume of water required to separate two magnets.
- b. The reduction in magnetic pull as the volume of water separates a magnet and plug.
- c. \*Magnetic induction where voltage is generated in a magnetic field and converted to a velocity.
- d. The volume of water that can be moved by an electromagnet.

Note: WEF/ABC 2002 Guide

87. What is the primary operational concern for using a float-level indicator in an open channel?

- a. Heavy flows
- b. Turbulent flows
- c. \*Solids, debris, or ice
- d. The type of counterweight used

Note: WEF/ABC 2002 Guide

88. Cross connections should never be allowed in water distribution systems because they might result in contamination.

- a. \*True
- b. False

89. A cross connection is

- a. \*Any connection between a drinking water system and an unapproved water supply
- b. Any connection between two pressure zones in a distribution system
- c. A special type of t-connection for tapping into reservoirs and water tanks
- d. A tool used for making wet-taps

90. NTU stands for
- \*Nephelometric turbidity unit
  - Nephelometric total solids utilization
  - Nepelometric turbidity utilization
  - Nominal Turbidity Unit
  - Nominal Tubidity Utilization
91. The three basic types of water rights are (check all that apply)
- \*Riparian
  - \*Appropriative
  - \*Prescriptive
  - Inherited
  - Well
  - Draft
  - Grandfathered
92. Before iron, manganese, and hydrogen sulfide can be removed by filtration they must first be converted to:
- \*Insoluble precipitates through oxidation
  - Gases through flash mixing
  - An odor free state through settling
  - Gases through adequate detention time
93. Coliform bacteria are:
- Commonly found throughout distribution systems
  - Desirable in storage tanks for iron digestion
  - Highly resistant to chlorine
  - \*Indicator organisms
  - Deadly
94. Chlorine gas is:
- Lighter than air
  - \*Heavier than air
  - The same as air
  - Completely harmless
95. Every filter plant operator's goal for effective removal of cryptosporidium and giardia should be an effluent turbidity never greater than:
- \*0.10 NTU
  - 0.20 NTU
  - 0.50 NTU
  - 0.40 NTU
  - 0.30 NTU



96. Turbidimeters must be calibrated:
- Monthly
  - \*Quarterly
  - If factory calibrated, never
  - Daily
  - Weekly
97. Free chlorine residuals throughout the distribution system must be:
- Removed
  - Measured annually
  - Greater than .50 mg/L
  - \*Measurable at all times
  - At least half the entry point residual
98. Groundwater in comparison to surface water is generally:
- \*Lower in turbidity and higher in mineral content
  - Higher in turbidity and lower in mineral content
  - More susceptible to seasonal changes
  - More susceptible to algal blooms
  - Warmer and is quite soft
99. In turbidity measurement, the abbreviation "NTU" stands for:
- Not Too Ugly
  - Norton Turbidity Unit
  - \*Nephelometric Turbidity Unit
  - Nitrification Treatment Unit
  - Nephelometric Treatment Usage
100. Over-greasing of an electric motor:
- Will cause the motor to draw less power at startup
  - Will cause the motor to run cooler
  - Cannot be done
  - \*Will cause the motor to overheat
  - Will cause the motor to run smoother
101. Adding Alum to water will cause the pH of the water to increase.
- \*False
  - True
102. A water with a pH value of 7.00 is considered to be:
- Basic
  - Acidic
  - Hot
  - \*Neutral
  - Cold

103. "Mudball" accumulation in filter media is an indication of:
- Excessive turbidity removal
  - Improper filter media
  - Desirable contaminant removal
  - Normal Operations
  - \*Ineffective backwashing
104. In water treatment, potassium permanganate is used primarily as:
- \*An oxidant
  - A disinfectant
  - A tracing Agent
  - A corrosion inhibitor
  - A coagulant

### **Conventional Treatment**

- Which is the best method to remove sand from water?
  - Add lime
  - Aerate
  - \*Provide a settling tank
  - Use zeolite softening
- The main purpose of pre-sedimentation is to:
  - Increase the oxygen content of water
  - Increase alkalinity in the water
  - Reduce the oxygen content in the water
  - \*Reduce the silt in the water
- Two fundamental treatment requirements for public water systems using surface water sources are:
  - Coagulation and sedimentation
  - Lime softening and disinfection
  - Filtration and aeration
  - \*Disinfection and filtration
- Under normal conditions, flash mixing in the coagulation process:
  - \*Occurs in seconds
  - Occurs in minutes
  - Occurs in hours
  - None of the above
- Which treatment step is not used with direct filtration?:
  - Coagulation
  - Flocculation
  - \*Sedimentation

- d. Disinfection
6. In conventional water treatment practices, the final step in the removal of suspended matter is:
    - a. Chlorination
    - b. Flocculation
    - c. Circulation
    - d. \*Filtration
  7. In order for a substance to function satisfactorily as a coagulant, it must:
    - a. Affect pH
    - b. Remove taste and odor
    - c. \*Produce a water insoluble floc
    - d. React with lime
  8. The three most commonly used coagulants in water treatment are:
    - a. Aluminum hydroxide, lime and sodium hydroxide
    - b. \*Aluminum sulfate, ferric sulfate, and ferrous sulfate
    - c. Lime, sodium hydroxide, and chlorine
    - d. Soda, lime and chlorine
  9. A chemical commonly used for coagulation in water treatment is:
    - a. Chlorine
    - b. Soda ash
    - c. \*Alum
    - d. Copper sulfate
  10. The chemical symbol for the most common coagulant used in water treatment, aluminum sulfate (alum), is:
    - a.  $Al_2(OH)_6$
    - b.  $Fe_2(SO_4)_3$
    - c.  $NH_3(OH)_7$
    - d. \* $Al_2(SO_4)_3$
  11. Alum added to turbid water containing alkalinity forms \_\_\_\_\_, which increase in size and settle out.:
    - a. \*Floc particles
    - b. Coagulants
    - c. Coagulant aids
    - d. Aluminum sulfate
  12. In order for a chemical to function satisfactorily as a coagulant, it must:
    - a. Destroy bacteria
    - b. \*Cause floc formations
    - c. React with the lime
    - d. Remove tastes and odors

13. The main purpose of coagulation/flocculation is to:
- \*Remove turbidity
  - Soften water
  - Add oxygen to water
  - Disinfect water
14. The treatment of water with chemicals to cause the non-settleable particles to form larger settleable particles is called:
- Aeration
  - Recarbonization
  - Ionization
  - \*Coagulation-flocculation
15. Clarification of water by sedimentation and filtration removes:
- [SO]
  - Dissolved solids
  - \*Suspended solids
  - Volatile solids
  - All of these are correct
16. A coagulant aid is a chemical added during coagulation to improve coagulation; to build stronger, more settleable floc; to overcome the effects of temperature drops; to reduce the amount of coagulant needed, and/or to reduce the amount of sludge produced. Which of the following is not a type of coagulant aid:
- Activated silica
  - \*Green sand
  - Polyelectrolytes or polymers
  - Weighting agents
17. Which one of the following chemicals would you most likely use as a coagulant?:
- \*Cationic polymer
  - Sulfuric acid
  - Hydrochloric acid
  - Sodium hydroxide
18. The coagulation process will most likely improve when:
- The hardness of the influent increases
  - The temperature of the influent decreases
  - \*The temperature of the influent increases
  - The alkalinity of the influent decreases

Note: All chemical reactions are affected by temperature. As temperature increases, so does the rate of chemical reaction.

19. Proper flocculation requires:
  - a. Rapid and complete mixing
  - b. Frequent filter backwashing
  - c. Low water temperature and high pH values
  - d. \*Long, gentle mixing
  
20. The lower the turbidity,:
  - a. \*The more difficult it is to form a proper floc
  - b. The lower the temperature of the water
  - c. The higher the dose of coagulant needed
  - d. The greater the zeta potential

Note: Ironically, it is easier to clean up dirty water than to make clean water cleaner. The reason is because particles must collide before they can stick together to make larger floc. More particles mean more collisions.
  
21. Sedimentation is improved by:
  - a. Short circuiting
  - b. Reducing the detention period
  - c. \*Uniform, horizontal, low-velocity flow across the basin
  - d. A sludge blanket that acts as a physical filter for incoming solids
  
22. The effluent weir of a sedimentation basin should be level in order to prevent:
  - a. Clogging of the "V notch"
  - b. Corrosion of the weir material
  - c. \*floc carryover to filters and shortened filter runs
  - d. They need not be kept level
  
23. The normal range of detention times used in sedimentation basins in conventional water treatment plants is about:
  - a. A day
  - b. 60 sec.
  - c. 10 sec.
  - d. \*3-6 hours
  
24. The liquid that stands above a sediment precipitate is referred to as the:
  - a. Slough
  - b. Effluent
  - c. Sludge blanket
  - d. \*Supernatant
  
25. Overcoming problems of cold-water floc can be corrected by operating the process at the best pH for that water temperature, increasing the coagulant dosage, or:
  - a. \*Adding weighting agents
  - b. Performing the jar test
  - c. Increasing the number and strength of floc particles
  - d. Increasing the detention time for floc formation

26. With the coming of winter, the water temperature drops. A likely operational problem at a filtration plant with coagulation is:
- \*Floc carryover from the sedimentation system
  - High chlorine residual
  - High alkalinity
  - Odor
27. Sedimentation is a process that \_\_\_\_\_ suspended matter.
- \*Settles
  - Coagulates
  - Flocculates
  - Filters
28. Sludge accumulations in settling basins over a period of time usually:
- Add hardness to the water
  - Increase the algae growth
  - \*Result in taste and odor problems
  - Result in the growth of pathogenic organisms
29. Tube settlers are used to:
- Aid coagulation
  - \*Increase settling efficiency
  - Reduce flow stability
  - Remove hardness
30. What conditions call for the use of plate or tube settlers?:
- \*Extremely turbid water
  - High iron and manganese
  - Zebra mussel infestation
  - Algal bloom
31. A test that is commonly performed to monitor the treatment process is :
- pH
  - Alkalinity
  - Turbidity
  - \*All of the above
32. When operating a surface water treatment plant, which of the following laboratory tests is of most significance for establishing chemical dosages for coagulating water?
- \*pH and alkalinity
  - Sulfates
  - Chlorides
  - Calcium and magnesium
  - Total hardness

33. Which is NOT a common method for determining optimum coagulant effectiveness?
- Jar test
  - Zeta potential detector
  - Streaming current detector
  - \*Colorimetric method
34. The purpose of the jar test is to determine:
- \*The correct amount of alum and lime to use for proper coagulation
  - The amount of chlorine to add for break-point chlorination
  - The proper amount of mixing and settling time to remove turbidity
  - Length of the flash mix
35. Optimum coagulant dosage can be established by:
- \*Performing jar tests
  - The breakpoint of chlorination
  - Performing total solids tests
  - Observing the pilot filter
36. What determines the optimum and most cost-effective amount of a coagulant to use?:
- \*Beyond that dose, it takes a very large increase in the amount of chemical to produce a small increase in turbidity removal
  - Below that dose the coagulant results in poor settling
  - The treatment plant budget
  - Divide the number of gallons of water in the coagulation tank by the nephelometric turbidity unit reading to determine the dosage in mg/L.
37. Drag and drop the following conventional unit processes into their correct order in a water treatment plant.
- [DD]
  - Coagulation
  - Flocculation
  - Settling
  - Filtration
  - Treated water storage
38. Raw water storage helps to minimize the impact of this on water treatment plant performance
- \*Storm events
  - Source water temperature
  - Source water pH
  - Upstream wastewater treatment plants
- Note: By providing a level of dilution and buffering, raw water storage helps to even out variability in source water quality and available volume.

39. Disinfection with chlorine may cause the formation of these compounds. They are a result of chlorine binding to naturally occurring organic matter.
- \*Trihalomethanes
  - Trichloramines
  - CFCs
  - Chloroalkali salts
40. Unlike most surface waters, ground waters may need to have these materials removed
- \*Iron and manganese
  - Copper and manganese
  - Iron and copper
  - Softening agents
41. Iron and manganese may be removed from source waters by oxidation. The following chemicals are often used to precipitate iron. Check all that apply
- \*Chlorine
  - \*Potassium permanganate
  - Alum
  - Sodium hydroxide

## Wells

- What percentage of the water used in the United States comes from underground sources?
  - \*45%
  - 30%
  - 60%
  - 90%
- Porosity may be defined as
  - \*The percentage of open space or voids in a particular soil
  - The ratio of filtered to reject water for a sand filter
  - The number of wells sunk per area into a particular aquifer
  - None of these is correct
- For a saturated material to qualify as an aquifer it must have:
  - Porosity area and thickness sufficient to store an adequate water supply.
  - Specific yield to allow stored water to drain into a well.
  - Hydraulic transmissivity to permit a well to drain water to meet flow requirements.
  - \*All of the above



4. Specific yield may be defined as:
  - a. \*The amount of water that a particular volume of rock or soil will produce when drained by gravity.
  - b. The amount of water that a particular well produces when drained by gravity.
  - c. The amount of water that a particular well produces when pumped forceably.
  - d. The amount of water that may be squeezed from a volume of rock or soil with a Vadose press.
  
5. This condition results when more water is removed from an aquifer than is replaced through rain and snowmelt.
  - a. \*Overdraft
  - b. Dry welling
  - c. Rising water table
  - d. Air binding
  
6. This physical property is what prevents salt and freshwater from mixing in an aquifer or underground basin.
  - a. \*Specific gravity
  - b. Temperature
  - c. pH
  - d. Van der waals forces

Note: Specific gravity is related to density. Since the seawater is more dense, it doesn't mix freely with the freshwater. It's similar to what happens with water and oil.
  
7. As groundwater moves through the soil, this type of material may be removed as the soil behaves like a natural filter.
  - a. \*Suspended material
  - b. Dissolved material
  - c. Salts
  - d. Ammonia and other nitrogen compounds
  
8. The following parameters should be recorded and tracked by water operators for each well in their system. Check all that apply.
  - a. \*Pumping amounts and dates
  - b. \*Time of pumping
  - c. \*Water quality results
  - d. Air temperature
  
9. Select the best description of the function of a well casing vent.
  - a. Allows air to enter well during drawdown to prevent vacuum conditions.  
Vents excess air during well recovery period.
  
10. Select the best description of the function of a well gravel tube.
  - a. Permits operator to see level of gravel and add gravel as necessary.

11. Select the best description of the function of a well sounding tube.
  - a. Permits insertion of water level measuring device. Also used to add chlorine or well cleaning agents.
12. Select the best description of the function of a well air line water level measuring device.
  - a. Permits measurement of water level by means of air pressure measurements.
13. Select the best description of the function of a well pump pedestal.
  - a. Supports the weight of the pumping unit.
14. Select the best description of the function of a well pump motor base seal.
  - a. Provides watertight seal between the motor base and the concrete support pedestal.
15. Select the best description of the function of a well sampling tap.
  - a. Permits sampling of pumped water.
16. Select the best description of the function of a well Air-release vacuum breaker valve.
  - a. Permits discharge of air in column pipe during start-up and admits air during shutdown.
17. Select the best description of the function of a well pump blow-off (or drain line).
  - a. Used to remove first water (usually sandy) pumped at start-up.
18. Artesian wells are defined as
  - a. \*A well drilled between two impervious layers. Water is under pressure which causes the water to rise.
  - b. Being located in an aquifer more than 200 feet deep
  - c. Any well used to pump high quality drinking water
  - d. Belonging to my brother Arty Sian
  - e. This designation is just a clever marketing ploy as it applies to all wells
19. A properly sized and constructed well-casing vent should be \_\_\_\_\_ inches in diameter.
  - a. One (1)
  - b. \*Three (3)
  - c. Six (6)
  - d. Ten (10)

Note: Dual venting is desirable on wells that are more than fourteen inches in diameter; constructed so openings are in a vertical downward position and 36 inches above finished surface; and covered with a fine mesh screen

20. Gravel tube openings should be elevated above ground level and kept tightly sealed for this reason.
- \*To prevent well contamination in the event of a flood.
  - To keep ground pigeons from nesting inside the pipe.
  - To ensure that the plant operator can see the gravel depth from a distance.
  - To prevent accidental burial of the tube.
21. Sounding tubes should generally have a minimum \_\_\_\_\_ inch diameter.
- One-half (1/2)
  - \*Two (2)
  - Six (6)
  - Ten (10)
22. Water hammer may be caused by:
- \*Quick opening or closing of a valve
  - Undersized pipes in the distribution system
  - Excessive air build-up in the distribution system
  - Filling a water storage tank too slowly
- Note: A water hammer is literally the sudden stopping of water flow. It can pack a lot of force and has been known to rip pipelines apart.
23. This may be used to control and/or eliminate water hammer in a hydropneumatic tank.
- \*Pressure relief valve
  - Rapid opening of valves
  - Air vents
  - Capacitor relays
24. 24W. For well pump installations, the pressure relief valve operating pressure is usually set at
- \*125 psi
  - 50 psi
  - 300 psi
  - 600 psi
25. If the operating pressure of a pressure relief valve is exceeding, what occurs?
- \*The valve automatically opens to relieve pressure.
  - The valve automatically closes to prevent an unsafe condition downstream.
  - The valve will be damaged.
  - Nothing, this is where it normally operates. That is why we call it the operating pressure.

26. All of these methods may be used to clean well casings and screens. Check all that apply.
- \*Surging
  - \*High-velocity jetting
  - Base treatment
  - \*Polyphosphate treatment
  - \*Explosive charges
  - Wire brushing
- Note: Please consult an expert in the field before attempting to use explosive charges! Kids, don't try this at home.
27. These two acids are typically used to remove incrustated minerals from well screens.
- \*Hydrochloric
  - \*Sulfamic
  - Nitric
  - Lime
  - Caustic
  - Phosphoric
28. Chlorine is an effective treatment for well screens. It helps to remove this material.
- \*Slime from iron-oxidizing bacteria
  - Biofilms from ammonia-oxidizing bacteria
  - Iron and manganese oxides
  - Calcium carbonate deposits
29. Chlorine treatment of wells is sometimes referred to as \_\_\_\_\_ treatment because of the high concentrations of chlorine used; between 100 and 200 mg/L.
- \*Shock
  - Slug
  - Attenuated
  - Chloro-biotic
30. When performing chlorine treatment of wells, it is important not to mix sodium and calcium hypochlorite together for this reason.
- \*Extreme heat or an explosion could occur.
  - Toxic gases may be produced.
  - Precipitation of the calcium would occur, rendering the mixture ineffective.
  - Excessive quantities of chloramines would be formed.
31. It isn't enough to just add chlorine to a well. For shock treatment to be effective, you must also do this.
- \*Agitate the chlorine solution.
  - Add hot water to speed up the reaction.
  - Draw large volumes of water out of the well during treatment.
  - Completely seal all well vents.

32. Polyphosphates are sometimes used to treat wells because they are effective at dispersing all of the following materials.
- \*Silts
  - \*Clays
  - \*Iron and manganese oxides
  - \*Iron and manganese hydroxides
  - Iron oxidizing bacteria
  - Calcium carbonate deposits
  - Chloramines
- Note: Once these materials are dispersed, they can be removed from the well by pumping.
33. What is the purpose of surging?
- \*To clean mineral deposits from well screens.
  - To remove blockages from the distribution system.
  - To backwash filters rapidly.
  - To prepare pump motors for erratic power supplies.
34. How much water is produced by a given well depends on these three factors. If the well stops producing the same amount of water as it used to, it is probably because of a change in one of these three factors.
- \*The aquifer
  - \*The pump
  - \*The well
  - The operator
35. Wells in aquifers with high mineral contents or high dissolved solids will need to be cleaned
- \*More frequently than those in low mineral aquifers
  - Less frequently than those in low mineral aquifers
  - With the same frequency as those in low mineral aquifers
  - You have to clean wells???
36. If a check valve failed on a well pump station, the most likely outcome would be
- \*Water would flow back through the well pump and into the aquifer, potentially contaminating it
  - Water would flow out of the aquifer, through the well pump, and into the distribution system
  - Water, unable to move into the distribution system, would back up into the well pump until the pressure relief valve was tripped
  - The well pump would automatically shut down

37. One consequence of pumping sand into the distribution system is
- \*Increased wear on lift station pumps and impellers
  - Decreased water volume in the distribution system
  - Clogging of fire hydrant orifices
  - Eventual collapse of the well due to wall erosion
38. This type of pump is the most common in water delivery systems because they are able to deliver large quantities of water against high or low heads. They are also very efficient.
- \*Centrifugal
  - Positive-displacement
  - Rotary lobe
  - Peristaltic
  - Screw
39. A shallow well pump takes water from the well by suction lift.
- \*True
  - False
40. Put the following steps for disinfecting a new well prior to placing it into service.
- Add enough chlorine to produce a concentration of 50 mg/L in the well casing.
  - Turn the pump on and off several times to mix the well.
  - Re-mix well several times at one-hour intervals.
  - Wait 24 hours.
  - Pump well water to waste until chlorine smell is gone.
  - Test for chlorine residual.
  - Collect a bacteriological sample.
41. A new well has been disinfected according to the standard operating procedure, but a fecal coliform sample taken after disinfection still shows colony growth. The operator should
- \*Disinfect the well again without skipping any steps.
  - Place the well into service anyway. It will be fine after a couple of hours.
  - Place the well into service, but maintain twice the normal residual chlorine concentration for a few days.
  - Abandon the well. If it isn't clean now, it never will be.
42. What concentration of residual chlorine should be maintained for 24 hours in a newly constructed well?
- \*50 mg/L
  - 50 ug/L
  - 25 mg/L
  - 25 ug/L

43. Special procedures are needed to clean and disinfect an existing well after it has been taken out of service for repairs for this reason.
- \*Dislodged bacteria may be deposited on the inside of the well casing above the water level.
  - Working on the well may have introduced bacteria from the operator's skin.
  - Airborne bacteria may be present in the well, however, a thorough air purge will remove them.
  - Disturbed sediments may contain high numbers of bacteria.
44. If an existing well becomes contaminated and the well pump is left in place, how much chlorine residual will be needed in the well casing to ensure adequate disinfection?
- 100 mg/L
  - \*200 mg/L
  - 400 mg/L
  - 1000 mg/L
45. After a routine repair to an existing well, how much chlorine residual is required in the well to ensure adequate disinfection?
- \*100 mg/L
  - 200 mg/L
  - 400 mg/L
  - 1000 mg/L
46. Two potential problems that can affect wells are
- \*Groundwater pollution
  - \*Excessive use or overdraft
  - Rising groundwater levels
  - Low mineral content
47. The mineral content and water quality of a particular well is usually pretty consistent.
- \*True
  - False
48. Unlike surface waters, well waters do not need to be disinfected prior to entering the distribution system
- \*False
  - True
49. This is the reason that pumps are primed prior to use
- \*To completely fill the pump cavity and displace any air
  - To avoid back-siphoning
  - To conserve water
  - To prevent cross connections

Note: Any air remaining in the pump cavity could potentially cause pump cavitation, which can cause severe damage to the impeller.

50. What might be the cause of of sand complaints from only one or two houses on a block?
- Customers are imagining things
  - \*Lateral is tapped into side of main near valve, creating turbulence
  - Lateral is tapped into top of main near valve, creating turbulence
  - Sand is entering the pipe near the residences through a leaky valve or break
51. Check all of the potential sources for groundwater contamination
- \*Animal wastes
  - \*Fertilizers and pesticides
  - \*Truck stops and parking lots
  - Sprinkler systems
  - \*Septic tanks
52. Gas stations may contribute these materials to the surrounding groundwater
- \*Hydrocarbons
  - Nutrients
  - \*Solvents
  - \*Waste oils
  - Pesticides
- Note: Fun fact: Gas tanks are governed by the Underground Storage Tank Act (UST) which used to be called the LEAKING Underground Storage Tank Act or LUST. EPA changed the name stating that the term LUST was redundant since ALL underground storage tanks leak.
53. What water quality test would confirm whether a well had been contaminated by a nearby septic system?
- \*Fecal coliform
  - Alkalinity
  - pH
  - Residual chlorine

## **Disinfection**

1. Chlorine demand = \_\_\_\_\_ - chlorine residual.
- [BL]
  - chlorine dosage
  - dose
  - cl2 dose
  - chlorine dose



2. The total residual chlorine is the sum of the combined available residual and the free available residual chlorine.
- \*True
  - False
3. \_\_\_\_\_ = flow, mgd x chlorine dosage, mg/L x 8.34 lb/gal.
- feed rate
  - pounds per day
  - lb/day
  - ppd
  - \*all of the above
4. 4 mg/l of chlorine is added continuously to a water flow that averages 5 MGD. How many lbs. chlorine will be used in 30 days?
- 1500 lb.
  - 3000 lb.
  - \*5000 lb.
  - 15000 lb.
5. Chlorine gas is \_\_\_\_\_ times heavier than air.
- \*2.5
  - 2.0
  - 3.5
  - 1.5
6. The \_\_\_\_\_ is the mathematical technique defined as the nth root of the product of the numbers.
- \*Geometric mean
  - Arithmetic mean
  - Mathematical expectation
  - Harmonic mean
7. Total and fecal coliform are pathogenic.
- \*False
  - True
- Note: Total and fecal coliforms are indicator organisms that are associated with fecal contamination. They are not normally pathogenic or disease causing.
8. The least potent, but longest lasting form of chlorine residual is the \_\_\_\_\_ residual.
- \*Combined
  - Free
  - Total

9. One volume of liquid chlorine will yield about \_\_\_\_ volumes of chlorine gas.
- 360
  - 500
  - 800
  - \*450
10. Proper disinfection kills all organisms.
- \*False
  - True
  - Note: Sterilization is the term for killing all organisms. Disinfection just reduces their numbers.
11. All chlorine cylinders are required to contain at least one fusible metal safety device designed to melt at between \_\_\_\_ to \_\_\_\_ degrees F.
- \*158-165
  - 100-120
  - 200-212
  - None of these
12. Coliform bacteria are:
- \*More resistant to chlorination than pathogenic bacteria
  - Less resistant to chlorination than pathogenic bacteria
  - A group of pathogens causing hepatitis
  - A group of pathogens causing cholera
13. Exhaust air from a chlorine tank room should be taken from where?
- Any location
  - \*Floor level
  - Near the entrance
  - At the ceiling
  - ?Chlorine gas is heavier than air.
14. Coliform bacteria are:
- Algae
  - Coagulant aids
  - \*Indicators
  - Sequestering agents
15. Acids should never be added to chlorine solutions because they
- \*Cause chlorine gas to be released
  - Corrode the solution tank
  - Decrease the disinfecting properties of chlorine
  - Result in the formation of chlorine precipitate

16. Which of the following would be the safest action to take in the event of a major chlorine container leak?
- \*Call the fire department
  - Notify local police or sheriff
  - Roll the container so that liquid escapes rather than gas.
  - Submerge the container in a basin or stream
17. Chlorine residual may be determined using the reagent:
- \*Diethyl-p-phenylene diamine
  - Ethylene diamine tetraacetic acid
  - Polychlorinated biphenyls
  - Sodium thiosulfate
- Note: This is the active ingredient in the Hach Company DPD Chlorine test pillows.
18. A malfunctioning gas chlorination system has normal gas pressure, no feed rate indicated on the rotometer, and no injector vacuum. What is the most likely cause of the problem?
- Air leak upstream of the rotometer
  - Gas line plugged
  - \*Injector clogged
  - Pressure reducing valve diaphragm ruptured
19. A chlorine demand test will show the:
- Safe amount of chlorine that may be fed without killing people
  - Number of lbs required to kill 100% of coliforms
  - \*Amount of chlorine required to give a desired residual after a given time
  - Amount of chlorine required to satisfy the biochemical oxygen demand
20. One ton chlorine cylinders:
- Have fusible plugs located at valves
  - Must be stored in an upright position
  - Remove liquid chlorine from the top valve
  - \*Use the bottom valve only with chlorine evaporators
21. In water disinfection, hypochlorination refers to the use of \_\_\_\_\_ hypochlorite (check all that apply)?
- \*Sodium
  - \*Calcium
  - Magnesium
  - Potassium
22. Sodium hypochlorite is manufactured by the reaction of gaseous or liquid chlorine with a solution of \_\_\_\_\_ \_\_\_\_\_ to produce a liquid containing NaOCl.
- \*Sodium hydroxide
  - Potassium hydroxide

- c. Postassium bisulfite
  - d. Sodium azide
23. What compound is first formed when chlorine is applied to water?
- a. \*Hypochlorous acid
  - b. Hydrochloric acid
  - c. Chloramines
  - d. Free chlorine ions
24. The amount of chlorine used per day from a 1 ton cylinder is normally determined by
- a. Pressure gauges
  - b. Rotometers
  - c. \*Weighings
  - d. Chlorine residuals
  - e. Ammonia equivalent
25. In the application of chlorine for disinfection, which of the following is not normally an operational consideration?
- a. [SO]
  - b. Mixing
  - c. Contact time
  - d. \*Dissolved oxygen
  - e. pH
  - f. None of these answers are correct
- Note: Operations Forum July 1999
26. If you need a chlorine residual of 1 mg/l, how many pounds of chlorine must be applied each day if the flow is 2.5 mgd and the chlorine demand is 15 mg/l?
- a. 291 lb/d
  - b. 312 lb/d
  - c. \*334 lb/d
  - d. 419 lb/d
  - e. 516 lb/d
- Note: Operations Forum July 1999
27. The destruction of the larger portion of microorganisms with the probability that all pathogens are killed is called
- a. Digestion
  - b. \*Disinfection
  - c. Dilution
  - d. Sterilization
  - e. Disposal
- Note: Operations Forum February 1999

28. Under normal conditions, the maximum amount of chlorine gas that can be drawn from a 150-lb cylinder is
- 10 lb/d
  - 20 lb/d
  - 30 lb/d
  - \*40 lb/d
  - 50 lb/d

Note: Operations Forum January 1999

29. Which of the following is a correct set of characteristics for chlorine as used in disinfection?
- Chlorine gas is colorless, flammable, and heavier than air
  - Chlorine gas is colorless, flammable, and lighter than air
  - Chlorine gas is greenish-yellow (amber) in color, flammable, and lighter than air
  - Chlorine gas is greenish-yellow (amber) in color, toxic, lighter than air, and noncorrosive
  - \*Chlorine gas is toxic, corrosive, and heavier than air

Note: Modified from Operations Forum June 1998

30. A chlorine leak can be detected by
- [SO]
  - Smell
  - Green or reddish deposits on metal
  - Waving an ammonia-soaked rag
  - \*All of these answers are correct
  - None of these answers are correct

Note: Operations Forum June 1998

31. Calculate the chlorine demand given: flow rate = 120 mgd; chlorine feed rate = 8000 lb/d; chlorine residual = 1.0 mg/l after contact time.
- 5 mg/L
  - 6 mg/L
  - \*7 mg/L
  - 8 mg/L

Note: Operations Forum June 1998

32. If a 100-mgd flow of water is dosed at a rate of 12 mg/l, what should the chlorine-feed setting be to the nearest 100 lb/d?
- 1000
  - 1200
  - \*10,000
  - 12,000

Note: Operations Forum June 1998

33. Chlorine applied minus \_\_\_\_\_ equals chlorine residual
- Chlorine dose
  - \*Chlorine demand
  - Combined chlorine
  - Free chlorine
  - Total chlorine
- Note: Operations Forum June 1998
34. Which of the following methods is not used to determine chlorine residual?
- \*Photometric
  - DPD titration
  - DPD Chlorimetric
  - Amperometric titration
35. The maximum rate for withdrawing gaseous chlorine from a 1-ton tank at room temperature is
- 2 lb/day per °F
  - 4 lb/day per °F
  - \*8 lb/day per °F
  - 10 lb/day per °F
- Note: Operations Forum June 1998
36. As water temperatures decrease, the disinfecting action of chlorine
- \*Decreases
  - Increases
  - Remains the same
- Note: Operations Forum September 1997
37. How many pounds of chlorine will be used in one day if the flow is 700,000 gal/d and a uniform dose of 1.2 mg/l is applied?
- \*7.0 lb
  - 70.1 lb
  - 698.3 lb
  - 7005 lb
- Note: Operations Forum August 1997
38. If chlorine costs \$0.21/lb, what is the daily cost to chlorinate 5 mgd of water to an initial concentration of 2.6 mg/l?
- \$108.42
  - \$56.80
  - \$516.29
  - \*\$22.77
- Note: Operations Forum August 1997

39. Name the two forms of hypochlorite (in alphabetical order) used for disinfection:
- Calcium hypochlorite and Sodium hypochlorite
  - Calcium and Sodium
  - Calcium, Sodium
  - \*All of the above

Note: Operations Forum March 1997

40. At concentrations less than \_\_\_\_\_, chlorine gas is not detectable by the human sense of smell.
- \*1 ppm
  - 2 ppm
  - 4 ppm
  - 10 ppm

Note: WEF/ABC 2002 Guide

41. Which pair of parameters is most typically used to adjust chlorine feed rates?
- Chlorine supply and temperature
  - Sulfur dioxide supply and chlorine supply
  - Sulfur dioxide supply and flow rate
  - \*Chlorine residual and water flow

Note: WEF/ABC 2002 Guide

42. A chlorine injector works by:
- \*Creating a vacuum that draws the chlorine out of the cylinder.
  - Pumping liquid chlorine from the bottom of the cylinder into the wastewater
  - Pumping gaseous chlorine from the top of the cylinder into the wastewater
  - Literally squirting chlorine into the wastewater with a little pump

43. Remote vacuum chlorine injectors use this type of injector:

- \*Venturi
- Centrifugal
- Genoa fine tip
- Cardinal

44. If your 1 ton chlorine cylinder is leaking, what type of Chlorine Institute repair kit should be used?

- A
- \*B
- C
- D

Note: WEF/ABC 2002 Guide

45. If your facility stores \_\_\_\_\_ or more of chlorine, you must develop a Risk Management Program in compliance with the USEPA's Chemical Accidental Release Prevention Regulations.
- 500 lb
  - 1000 lb
  - \*2500 lb
  - 5000 lb
- Note: WEF/ABC 2002 Guide

## **Filtration**

- Coagulation and sedimentation alone cannot remove all of the turbidity and suspended matter in raw water. The final step in the removal of suspended matter in water is?
  - Chlorination
  - Sterilization
  - Flocculation
  - \*Filtration
- What is the primary purpose of filtration?
  - to settle large particles out of the water
  - \*To remove fine suspended matter from the water
  - To reduce the velocity of water in basins
  - To bring suspended particles together to form larger, more settleable clumps
- Which of the following is not a type of filter?
  - Upflow
  - Bag
  - Pressure
  - Sand
  - \*None of the above
- What type of filter is most commonly used in surface-water treatment?
  - Diatomaceous earth filters
  - Pressure filters
  - Slow sand filters
  - \*Rapid sand filters
  - Zeolite filters
- Which of the following unit processes would diatoms most likely affect?
  - Coagulation
  - Flocculation
  - Sedimentation
  - \*Filtration
  - ?Diatoms are phytoplankton and would promote clogging of filters.



6. Slow sand filters are most useful
  - a. In large systems with poor surface water quality
  - b. In systems that have limited land area to operate
  - c. Where low construction, maintenance, and operating costs are important
  - d. \*After chemical coagulation
  
7. Dual-media and multimedia filters
  - a. Require an extremely deep bed
  - b. \*Can operate at sixty to one-hundred times faster than the rate of slow sand filters
  - c. Cannot reduce turbidity
  - d. Do not require backwashing
  
8. In a filter using gravel, anthracite, and sand, the anthracite should be?
  - a. \*The top layer of media
  - b. Beneath the gravel
  - c. Between the sand and the gravel
  - d. Mixed with the sand
  
9. When mixed media filters composed of garnet, sand, and crushed anthracite coal are used, which of the following describes their placement in the filter bed?
  - a. Anthracite coal on top, garnet in the middle, and sand on the bottom
  - b. Garnet on top, anthracite coal in the middle, and sand on the bottom
  - c. Sand on top, anthracite coal in the middle, and garnet on the bottom
  - d. \*Anthracite coal on top, sand in the middle, and garnet on the bottom
  
10. The function of the filter under-drains is best described as:
  - a. Aeration of the media to encourage bacteria growth
  - b. \*Collection of treated water and distribution of backwash
  - c. Draining off the excess oxidant
  - d. Providing access to the media
  
11. A rate-of-flow controller is commonly used in a water treatment plant:
  - a. To measure the rate of flow
  - b. \*To maintain a constant rate of flow of raw water to a rapid sand filter
  - c. On the outlet pipe of a rapid sand filter
  - d. Traffic into and out of the plant
  
12. A rate of flow controller is used to?
  - a. Check when the filter is air-bound
  - b. \*Maintain a predetermined flow through the filter
  - c. Measure the amount of water used to wash the filter
  - d. Calculate particulate removal

13. Head loss, filter-effluent turbidity, and length of filter run are each considered independently in determining
  - a. \*When a filter needs backwashing
  - b. The frequency of media replacement
  - c. The benefits of using filter aids
  - d. Filter flow rates
  
14. The most important factor in evaluating filter performance is?
  - a. Head loss
  - b. Filter loading rate
  - c. \*Effluent turbidity
  - d. Mud ball formation
  
15. A filter head loss gauge is used:
  - a. To measure the head of water on the filter sand
  - b. To control the rewash valve
  - c. \*To measure the drop in pressure through the filter bed
  - d. To indicate the rate of filtration
  - e. None of these are correct
  
16. As a general rule, gravity filters must be backwashed when a loss of head differential of \_\_\_\_ is experienced between the influent and effluent loss-of-head gauges
  - a. 1-2 ft
  - b. \*3-5 ft
  - c. 6-10 ft
  - d. 10-12 ft
  - e. 15-17 ft
  
17. A head loss gauge indicates when:
  - a. The filter should be chlorinated
  - b. Sludge should be removed from the sedimentation basin
  - c. The chlorine cylinder is empty
  - d. The elevated tank is full
  - e. \*The filter should be backwashed
  
18. The release of dissolved air in saturated cold water due to a decrease in pressure is called?
  - a. Aeration
  - b. Jet action
  - c. Air Stripping
  - d. \*Air binding

19. Air binding of a filter can be caused by?
  - a. The reduction of pressure resulting from operating under a negative head
  - b. An increase in the temperature of the water during filtration
  - c. The release of oxygen by algae collected within the filter
  - d. \*All of the above
  
20. Mud balls are?
  - a. Small balls of mud found in the distribution system
  - b. \*An aggregate of solids accumulated in sand filter beds
  - c. Bacterial residues
  - d. Not significant
  
21. One of the common problems with rapid-sand filters is the formation of mud balls in the filter bed. Since mud balls are difficult to remove after they have formed, it is best to prevent their formation by:
  - a. Strong chlorination
  - b. Using sodium hexametaphosphate
  - c. \*Proper backwashing
  - d. Using the proper grade of sand in the filter
  - e. Having a slow rate of filtration
  
22. One of the most common causes of mud balls in the filter media is?
  - a. \*Ineffective or improper filter backwashing
  - b. Excessive filtration rate
  - c. Excessive backwash rate
  - d. Broken underdrain system
  
23. When sand in a rapid sand filter becomes dirty, it can be cleaned by?
  - a. Filtering
  - b. \*Backwashing
  - c. Coagulation
  - d. Aeration
  
24. During the backwash cycle, the backwash rate must be high enough to?
  - a. Provide for proper bed stratification
  - b. Prevent media loss
  - c. \*Expand the media to cause the media grains to agitate violently
  - d. Allow the operator to observe the media
  
25. If impurities are observed in the filter bed of a rapid sand filter during backwashing procedures, the probable cause is:
  - a. No surface wash
  - b. Insufficient backwash rate
  - c. Excessive backwash rate
  - d. \*The condition is normal for such filters

26. Treated water is always used for backwashing:
- Because of its availability
  - Because the use of untreated water is more costly
  - \*To avoid contamination of the filter bed
  - Lessen sludge disposal problems
27. In a filter operating at a 2gpm/sq ft filtration rate, how much should the backwash water expand the sand bed during a backwash operation?
- 0 to 10 percent
  - 10 to 20 percent
  - \*20 to 30 percent
  - 30 to 50 percent
  - 90 to 100 percent
28. In some filtration plants, the backwash rate (in gallons per minute per square foot) required to effectively clean the filter media is greater in summer than in winter. Which of the following is the most common reason for this occurrence?
- \*Because of the lower viscosity of warm water, a higher backwash rate is needed to achieve the normal expansion of the filter media
  - Floc particles adhere less tightly to filter media particles in summer because of higher temperatures
  - Higher demands for water in summer require higher filter loadings, which in turn require higher backwash rates
  - Higher summer temperatures cause filter media particles to swell slightly, thus requiring a greater backwash rate to achieve the normal expansion of filter media
29. If a filter has been out of service and allowed to go dry, which filter control valve should be used to refill it with water?
- Effluent valve
  - \*Influent valve
  - Rewash valve
  - Wash valve
  - Solenoid valve
30. The filter rate and backwash rate of each filter shall be determined and recorded:
- \*Daily
  - Once each week
  - Once each month
  - Once every three months
  - Once every six months

31. Some idea of the amount of filter media growth can be indicated by:
- Periodic sieve analysis of the media
  - Periodic measurements of the distance from the top of the clean filter to the trough weir
  - Periodic determinations of the percent solubility of the media in hydrochloric acid
  - \*all of the above
32. The media in a rapid sand filter has an effective size of 0.2 mm. The original specification was 0.4mm. The cause could be?
- \*Abrasion over time
  - Wrong sand was delivered
  - Sand sample was taken off the surface
  - All of the above
33. When a filter wash is uneven, the spots violently over washed might result in which of the following?
- Cause the sand grains in this area to cement together
  - Cause an increase in the sand effective size
  - \*Overturn the gravel layer, allowing sand to displace it
  - Increase the free board distance in this area
34. Repeated occurrence of a sand boil on the surface of a rapid sand filter at the same location during back washing indicates which of the following?
- \*The supporting gravel bed underneath the filter sand has been disturbed
  - The filter's maximum backwash rate has been exceeded
  - The filter media is being properly fluidized during backwashing
  - A surface-wash system should be added
35. A water treatment plant produces 850,000 gal of water per day. On one day 24,526 gal was used for backwashing the filters. What was the net production for this day?
- 406,740 gal
  - 604,740 gal
  - 746,604 gal
  - \*825,474 gal
36. What is the rated capacity of a rapid-sand filter 20 ft X 17.5 ft X 10 Ft deep when operated at a filter rates of 2gpm/ft<sup>2</sup>?
- 2800 gpm
  - 7000 gpm
  - \*700 gpm
  - 1400 gpm

37. The surface of a sand bed filter measures 20 ft by 30 ft. If the flow through the filter is 1800 gpm, what is the surface loading rate in gallons per minute per square foot?
- 0.5
  - 1
  - 2
  - \*3
38. A rapid sand filter is 12 ft wide and 20 ft long. If the flow through the filter is 0.83 mgd, what is the filter-loading rate in gpm/ft<sup>2</sup>?
- \*2.4 gpm/ft<sup>2</sup>
  - 4.8 gpm/ft<sup>2</sup>
  - 24 gpm/ft<sup>2</sup>
  - 48 gpm/ft<sup>2</sup>
39. A backwash rate of 15 gpm per sq ft of area is approximately equal to a vertical water rise per minute of
- 12 in.
  - \*24 in.
  - 30 in.
  - 36 in.

## **Laboratory**

- In the membrane filter method, the number of coliforms is estimated by the:
  - \*Number of colonies grown
  - Number of negative tubes
  - Number of positive tubes
  - Sum of positive and negative tubes
- When conducting the fecal coliform membrane test, count all the colonies that are \_\_\_\_\_ in color.
  - Red
  - Yellow
  - \*Blue
  - Orange
- \_\_\_\_\_ can interfere with a turbidity meter measurement.
  - SS concentration
  - pH
  - \*Color
  - Temperature

4. Total solids can be divided into suspended solids and \_\_\_\_\_ solids.
- Ionic
  - \*Dissolved
  - Metallic
  - Molecular
5. Suspended solids, also referred to as filterable residue, represent the weight of solids remaining on a glass fiber filter following filtration and drying at \_\_\_\_ degrees C.
- 35.0
  - 44.5
  - 180
  - \*103
- Note: Total dissolved solids (TDS) refers to material that passes through a glass-fiber filter disc and remains after evaporation at 180°C.
6. \_\_\_\_\_ of \_\_\_\_\_ is a legal term for an unbroken sequence of possession from sample collection through analysis.
- chain custody
  - chain of custody
  - chain, custody
7. \_\_\_\_\_ solids remain in liquid solution and are defined as the solids that will pass through a 0.45um membrane filter.
- Suspended
  - Colloidal
  - \*Dissolved
  - Settleable
8. \_\_\_\_\_ solids, extremely fine particles, will not settle from the liquid portion, but can usually be filtered from the liquid with a 0.45-um membrane filter.
- Dissolved
  - \*Colloidal
  - Suspended
  - Settleable
9. A single sample of water taken at one time from one place is called a \_\_\_\_\_ sample.
- Grab
10. All those combinations of elements that do not include organic carbon are called what?
- \*Inorganic
  - Vitriolic
  - Sedimentary
  - Polymeric

11. What is the common name for commercial sodium carbonate?
  - a. \*Soda ash
  - b. Lime
  - c. Slaked lime
  - d. Baking soda
  
12. Both total and fecal coliforms are reported in units per 100 mL if the membrane filter technique is used, or as the \_\_\_\_\_ per 100 mL if the multiple tube method is used.
  - a. most probable number
  - b. MPN
  
13. \_\_\_\_\_ is defined as the number of equivalents of solute dissolved in one liter of solution.
  - a. \*Normality
  - b. Molarity
  - c. Alkalinity
  - d. Acidity
  
14. Another word for the average is the \_\_\_\_\_?
  - a. \*Mean
  - b. Norm
  - c. Geometric mean
  - d. Highest probability
  
15. The acronym RPD stands for what?
  - a. \*Relative Percent Difference
  - b. Ranked Percent Difference
  - c. Ranked Probable Difference
  - d. Relative Probable Difference

Note: Sometimes, the same calculation is referred to as the RSD or relative standard difference. It is calculated by dividing the difference between two numbers by their average, multiplied by 100.

  - e. 4
  - f. Positives, Negatives
  
16. Quality control samples are analyzed for all of the following reasons EXCEPT:
  - a. Check for Contamination
  - b. Verify precision
  - c. Verify accuracy
  - d. Determine if interferences are present.
  - e. \*To boost the ego of the analyst.



17. After drying, filter papers and crucibles should be stored in a \_\_\_\_\_ to prevent moisture uptake from the atmosphere.
- \*Dessicator
  - Drying oven
  - Muffle furnace
  - Tupperware container
18. If the residue remaining on a filter paper is the suspended solids, what are the solids that pass through the filter called?
- \*Dissolved (TDS)
  - Volatile
  - Non-volatile
  - Settleable
19. Control charts are used to help minimize process \_\_\_\_\_.
- Variability
20. Control charts are only effective if they are \_\_\_\_\_ and \_\_\_\_\_.
- \*Current and Available
  - Current and Colorful
  - Accurate and Contain a lot of data points
  - Pretty and Available
- Note: Control charts should be updated daily or more often if needed. Keep them out in the plant where they can be seen, not in a supervisor's drawer.
21. The two basic types of samples are \_\_\_\_\_ and \_\_\_\_\_?
- Grab and Composite
  - Composite and Grab
  - Grab, Composite
  - Composite, Grab
  - Grab Composite
  - Composite Grab
22. Samples should only be collected where the water is \_\_\_\_\_.
- \*Well mixed
  - Overflowing weirs
  - Between processes
  - Standing quietly
23. The statistical calculation done to determine the spread of a set of measurements is called the \_\_\_\_\_.
- \*Standard Deviation
  - Relative Pervasive Difference
  - Percent Deviation
  - Standard Error

24. This term refers to a false positive caused by dirty glassware or sampling equipment.
- [BL]
  - Contamination
25. This type of quality control sample is used to determine if contaminants are present.
- Blanks
  - Blank
  - Reagent Blank
  - Instrument Blank
26. Both of these quality control samples can be used to measure accuracy and precision.
- \*Standards and Duplicates
  - Blanks and Standards
  - Blanks and Duplicates
  - Duplicates and Spikes
27. Total Dissolved Solids are dried at this temperature.
- 103oC
  - 105oC
  - \*180oC
  - 550oC
28. Solids are classified by their \_\_\_\_\_ and whether they are organic or inorganic.
- [BL]
  - Size
29. Control charting consists of \_\_\_\_\_ data and then \_\_\_\_\_ it on a graph.
- \*Collecting, Plotting
  - Making up, Plotting
  - Selecting, Not Plotting
  - Making up, Not Plotting
30. Tracking data is only the first step in control charting. These need to be set next.
- \*Control Limits
  - Corrective Actions
  - Deviation Requirements
  - Deviation Limits
31. Control limits are meaningless unless these are also in place.
- Control Limits
  - \*Corrective Actions
  - Deviation Requirements
  - Standard Deviations

32. Control charts allow us to look for \_\_\_\_\_ as well as out of limits conditions.
- Trends
- Note: Sometimes trends are more important than out of limits conditions. By tracking trends, we can correct a potential problem before an out of limits condition occurs. Remember, you can only control what you measure.
33. The blank plate for a fecal coliform test should have this many colonies growing on it.
- Zero
  - 0
  - None
34. Fecal colonies take on a blue appearance from drawing up this component from the MFC media.
- \*Aniline Blue Dye
  - Lactose
  - Rosalic Acid
  - Blue dye no. 5
35. Select all of the qualities of an ideal indicator organism from the following list.
- \*Easy to analyze for.
  - \*Directly associated with target or pathogenic organism.
  - \*Present in greater numbers.
  - \*Not ubiquitous.
  - \*More difficult to kill than target organism.
  - Pathogenic
36. E. Coli results must always be higher or lower than fecal coliform results?
- \*Lower
  - Higher
  - About the same
- Note: E. coli are a subset of the fecal coliform bacteria.
37. Fecal coliforms are incubated in a water bath at this temperature for 24 hours.
- \*44.5 oC
  - 35.0 oC
  - 103 oC
  - 37.5 oC
38. This acid may be added to MFC plates to make them even more selective - a good idea for samples with high numbers of bacteria.
- \*Rosalic Acid
  - Tartaric Acid
  - Aniline Blue
  - Lactic Acid

39. Distilled water must be used for dilutions in most analyses to prevent this problem.
- Contamination
40. Calmagite turns blue in the absence of these ions.
- \*Calcium and Magnesium
  - Magnesium and Sodium
  - Sodium and Calcium
  - All carbonates
- Note: This is the indicator for the hardness titration.
41. Alkalinity is titrated to the Bromo cresol green methyl red indicator endpoint which is equivalent to this pH.
- \*4.5
  - 5.5
  - 3.0
  - 6.5
42. This is the titrant used for the Hardness analysis.
- \*EDTA - A Chelating Agent
  - 0.03 N Sulfuric acid
  - 0.125 N Hydrochloric acid
  - Sodium hydroxide
43. This is the technical term for the process of converting one unit to another is called.
- [BL]
  - Dimensional Analysis
44. The following flows are mixed together. What is the new TDS concentration?  
Flow 1 = 10 MGD @ 50 mg/L TDS    Flow 2 = 5 MGD @ 100 mg/L TDS
- 75 mg/L
  - \*67 mg/L
  - 52 mg/L
  - 80 mg/L
45. Calculate the standard percent recovery if the analytical result is 35 mg/L and the certified true value is 39.5 mg/L
- \*88.6%
  - 112.8%
  - 92.0%
  - 13.2%
46. This type of quality control sample is used to check for interferences.
- \*Spikes
  - Duplicate
  - Standards

- d. Blanks
47. Duplicates should agree with their original samples by this margin.
- a. \*Plus or Minus 20% Relative Percent Difference
  - b. Plus or Minus 10% Relative Percent Difference
  - c. Plus or Minus 20%
  - d. Plus or Minus 10%
- Note: Calculate the Relative Percent Difference by dividing the difference between two numbers by their average, multiplied by 100.
48. Fecal coliforms are a subset of this larger group of bacteria.
- a. [BL]
  - b. Total Coliforms
  - c. Enterics
49. Don't forget to adjust your dissolved oxygen meter for this important correction.
- a. \*Barometric pressure
  - b. pH
  - c. Temperature
  - d. Membrane age
50. This is the special sugar that fecal coliform bacteria can metabolize.
- a. \*Lactose
  - b. Fructose
  - c. Glucose
  - d. Rosalic acid
51. Alkalinity and hardness are both expressed analytically as this.
- a. [BL]
  - b. Calcium Carbonate - mg/L
  - c. Calcium carbonate
  - d. Calcium carbonate, mg/L
  - e. mg/L Calcium carbonate
  - f. CaCO<sub>3</sub>
52. Alkalinity and hardness are both analyzed by adding a known reagent to the sample. This process results in a \_\_\_\_\_ change.
- a. [BL]
  - b. Color
53. Alkalinity is defined as the \_\_\_\_\_ capacity of a water.
- a. Buffering
  - b. Acid Neutralizing

54. Hardness is defined principally as the sum of the \_\_\_\_\_ and \_\_\_\_\_ ions, although any divalent metal ion can contribute to hardness.
- \*Calcium and Magnesium
  - Magnesium and Sodium
  - Calcium and Sulfate
  - Struvite
55. An amperometric titrator is used to measure:
- Alkalinity
  - \*Chlorine residual
  - Conductivity
  - COD
56. The fecal coliform membrane filter test is incubated at \_\_\_\_\_ degrees C and produces blue or blue-green colonies.
- \*44.5 oC
  - 35.0 oC
  - 37.0 oC
  - 98.6 oC
57. Sample refrigerators should be set at \_\_\_\_\_ degrees C for proper preservation.
- 2
  - \*4
  - 6
  - 0
58. When reading the liquid level in a graduated cylinder, one should read from the bottom of the meniscus at eye level.
- \*True
  - False
59. The pH is a measure of the concentration of \_\_\_\_\_ \_\_\_\_\_ in a solution.
- \*Hydrogen ions
  - Hydrozide ions
  - Acid equivalents
  - Base equivalents
60. Alkalinity is reported as:
- Hardness
  - Softness
  - \*mg/l of calcium carbonate
  - Milliliters of sulfuric acid titrated
61. The amperometric titration method is used to measure residual chlorine.
- \*True
  - False

Note: Operations Forum June 2001

62. What is the most common preservation method for samples?
- \*Cooling to 4 deg. C
  - Dechlorination
  - Reduction
  - Acidification

?Operations Forum June 2001

63. Some characteristics of water, such as pH and dissolved oxygen, change so quickly that they need to be measured immediately.

- \*True
- False

Note: Operations Forum April 2001

64. pH sensors consist of
- \*A glass electrode and reference electrode
  - A pH electrode and temperature electrode
  - A junction electrode and null electrode

Note: Operations Forum March 1999

65. The range of a pH analyzer is

- 2 to 14 pH units
- 4 to 14 pH units
- \*0 to 14 pH units
- 1 to 14 pH units

Note: Operations Forum March 1999

66. pH sensors measure the activity of which ion?

- Sodium
- \*Hydrogen
- Chlorine
- Caustic

Note: Operations Forum March 1999

67. Temperature does not affect pH measurement.

- True
- \*False

Note: Operations Forum March 1999

68. Jar tests may be used to determine the optimum dosage of

- \*Polymer
- Biochemical oxygen demand
- Oil and grease
- Volatile acids

Note: Operations Forum June 1997

69. What chemical is added to a fecal coliform sample to neutralize residual chlorine?
- Sodium azide
  - \*Sodium thiosulfate
  - Sodium hydroxide
  - Potassium chloride

Note: Operations Forum March 1997

70. The recommended holding time for a fecal coliform sample prior to analysis is 8 hours or less at 10 deg. C.

- \*True
- False

Note: DEP-SOP-001/01 The maximum holding time for a total, coliform, fecal and e-coli sample is 8 hours at less than 10°.

71. What piece of laboratory glassware is used mainly to mix chemicals and measure approximate volumes?

- Buret
- Pipet
- Graduated cylinder
- \*Beaker

Note: WEF/ABC 2002 Guide

72. What is the maximum recommended holding time for a sample that is to be analyzed for pH?

- \*None; it must be analyzed immediately
- 48 hours
- 7 days
- 14 days

Note: DEP-SOP-001/01 recommends analysis within 15 minutes.

73. Coliform bacteria and the procedures used to test for them are divided into the two categories of \_\_\_\_\_.

- MF and MTF
- LTB and BGB
- \*Total and fecal coliforms
- M-Endo and M-FC

Note: WEF/ABC 2002 Guide

74. What is the minimum number of pH standards needed for calibration of a pH meter?

- 1
- \*2
- 3
- 4

Note: WEF/ABC 2002 Guide, Three standards is preferable.



75. What is the standard sample volume when measuring chlorine levels by an amperometric titration?
- 50 ml
  - 100 ml
  - 150 ml
  - \*200 ml
- Note: For residual chlorine concentrations of 2 mg/l or less, use a 200-ml sample. For greater concentrations use a 100-ml sample. It is preferable that the size of the sample be such that not more than 2 ml of titrant will be required to complete the titration.
76. Before performing a membrane electrode DO test, the equipment should be calibrated to zero by taking a reading on a sample containing an excess of \_\_\_\_\_ and a trace of cobalt chloride,  $\text{CoCl}_2$ .
- Sodium hydroxide,  $\text{NaOH}$
  - Hydrogen chloride,  $\text{HCl}$
  - \*Sodium sulfite,  $\text{Na}_2\text{SO}_3$
  - Calcium carbonate,  $\text{CaCO}_3$
- Note: WEF/ABC 2002 Guide
77. Coliforms are used as indicator bacteria to verify the effectiveness of disinfection techniques because \_\_\_\_\_.
- They are the most numerous of all wastewater pathogens
  - They cause the worst diseases of any of the wastewater pathogens
  - \*They are easier to detect and are harder to destroy than most pathogenic organisms
  - They have a symbiotic relationship with pathogens; one cannot survive without the other.
- Note: WEF/ABC 2002 Guide

### **'Maintenance, Pumps, and Safety**

- The primary causes of motor failure are: Pick the two that apply.
  - Dirt
  - \*Moisture
  - Friction
  - \*Vibration and overload
  - Overheating
- The discharge of a centrifugal pump:
  - \*Decreases with the increase of head
  - Increases with the increase of head
  - Is independent of the head
  - Increases with the head increase only at the start of pumping

3. Cavitation is the formation and collapse of a gas pocket or bubble on the blade of a pump's impeller.
  - a. \*True
  - b. False
  
4. A pump is delivering at a less than expected rate of discharge. Which of the following possible causes is incorrect?
  - a. Motor speed too low
  - b. Pump not primed
  - c. Clogged impeller
  - d. \*Discharge head too low
  
5. If packing is not maintained properly,
  - a. Cavitation damage will result
  - b. The impeller will corrode
  - c. \*There will be a loss of suction from air being allowed to enter the pipe.
  - d. The shaft or shaft sleeve will be damaged
  
6. The casing surrounding a pump impeller that collects the water discharged by the impeller is called a \_\_\_\_\_.
  - a. \*Volute
  - b. Stuffing Box
  - c. Wear Ring
  - d. Impeller casing
  
7. A straight ladder, when properly used, should have the base \_\_\_\_\_ from the supporting wall.
  - a. 1/4 of its length
  - b. \*1/4 of its working length
  - c. 3 ft
  - d. 5 ft
  
8. The main function of a lubricant is to keep moving materials separate from each other.
  - a. \*True
  - b. False
  
9. A possible cause of electric motor failure is?
  - a. Dirt
  - b. Moisture
  - c. Friction
  - d. \*All of these
  
10. A water seal on a pump serves a dual purpose. It acts as a lubricant and it also:
  - a. Acts as a coolant to keep the bearing from overheating
  - b. \*Keeps gritty material from entering the packing box

- c. Keeps the pump primed
  - d. Is a reserve water supply
11. The elevation of any pump above the source of supply should not exceed \_\_\_\_\_ ft.
- a. 2.2
  - b. \*22
  - c. 200
  - d. 224
12. Friction in a pipeline causes:
- a. Aeration
  - b. Corrosion
  - c. \*Loss of pressure
  - d. Overheating
13. Before repairing a pumps electrical circuit, which of the following actions should you take?
- a. \*Disconnect the circuit breaker, place a red tag stating "do not activate", and lock out.
  - b. Notify your supervisor
  - c. Tell all of the operators not to activate the circuit.
  - d. Turn the pump off
14. In a centrifugal pump, leakage is prevented by
- a. Impellers
  - b. Sleeves
  - c. Volutes
  - d. \*Wear rings
15. The pressure against which a pump must operate is measured in terms of:
- a. ft-lb
  - b. head
  - c. hp
  - d. \*psi
16. An air gap device is used to:
- a. Increase oxygen content in manholes
  - b. \*Prevent cross connections
  - c. Prevent excessive vibration in pipe joints
  - d. Ventilate manholes
17. Why are check valves used in conjunction with centrifugal pumps?
- a. To equalize the pressure on both sides of the impeller
  - b. \*To prevent water in the suction line from flowing back into the wetwell
  - c. To prevent water in the discharge line from flowing back into the wetwell
  - d. To regulate the rate of flow through the discharge pipe.

18. Valves should be closed slowly to prevent:
  - a. Excessive head loss
  - b. Excessive wear
  - c. Injury to operator
  - d. \*Water hammer
  
19. If a centrifugal pump loses its prime after starting, what is the most probable cause?
  - a. \*Air leaks into the pump through stuffing boxes
  - b. Air pocket in the discharge line
  - c. Foreign matter in the impeller
  - d. Speed too high
  
20. In electrical circuits a(n) \_\_\_\_\_ is used to reduce voltage where needed.
  - a. Ammeter
  - b. Thermal overload
  - c. \*Transformer
  - d. Voltmeter
  
21. Which of the following causes the greatest pipe friction loss?
  - a. Decreasing the rate of flow
  - b. Increasing the temperature of the water
  - c. \*Increasing the velocity of water
  - d. Decreasing the pressure
  
22. If the pump bearings on horizontal pumps are over lubricated, the most important effect is that the extra lubricant:
  - a. Will result in smoother and more efficient operation
  - b. Will not make any difference in the operation of the pump
  - c. Will be wasted
  - d. \*May cause overheating and possible failure of the bearings
  
23. If packing is not maintained properly:
  - a. Cavitation damage will result
  - b. Impeller will corrode
  - c. \*Loss of suction will occur due to air entering the pump
  - d. Pump efficiency will increase
  
24. Information on preventive maintenance procedures, materials, and frequencies for plant structures should be taken from:
  - a. As-built blueprints
  - b. Experience at the plant
  - c. Lab records
  - d. \*Manufacturers operation and maintenance manuals
  - e. Who needs books? We don't need no stinkin' books!

25. Instrumentation friction disks or clutch surfaces should be:
- Frequently brushed with a solution of water and soda
  - \*Kept free of oil
  - Oiled frequently
  - Roughened with emery cloth as necessary
26. An electrical system for prevention of rust, corrosion, and pitting of steel and iron surfaces in contact with water is called \_\_\_\_\_ protection.
- \*Cathodic
  - Sputterizing
  - Galvanic
  - Tempering
27. What separates the impeller from the volute and prevents backflow in a centrifugal pump?
- \*Wear rings
  - Impeller shaft
  - Stuffing box
  - Water seal
28.  $E=I \times R$  or Voltage = Amperage x Resistance is:
- Resistance formula
  - Ampere
  - \*Ohm's law
  - Theory of relativity
29. The \_\_\_ is the unit of electrical resistance; resistance to the flow of electrical current.
- \*Ohm
  - Volt
  - Ampere
  - Watt
30. The rate at which heat is produced is the \_\_\_\_\_ that the load dissipates.
- \*Power
  - Resistance
  - Capacitance
  - Work
31. \_\_\_\_\_ is the relationship in time between two waveforms of the same frequency.
- Phase
32. If bearings on a centrifugal pump are running hot, over- or under lubrication should be checked. If lubrication is satisfactory, the next preventative maintenance check would be to
- Replace the bearings

- b. Operate the pump only when needed
- c. Clean the pump
- d. Recheck the total dynamic head
- e. \*Inspect the alignment of the pump and motor

Note: Operations Forum January 1999

33. During plant rounds, an operator notices a pump is spraying water from a packing gland. The operator should

- a. \*Tighten the packing gland until the spray is reduced to a small drip
- b. Turn off the seal water and continue running the pump
- c. Loosen the packing gland
- d. Do nothing

Note: Operations Forum December 1998

34. A pump's seal water pressure should be set at

- a. 2 to 3 psi below the pump operating discharge pressure
- b. At the same level as the pump operating discharge pressure
- c. 1 to 2 psi more than the pump operating discharge pressure
- d. \*5 to 10 psi more than the pump operating discharge pressure
- e. 15 to 20 psi more than the pump operating discharge pressure

Note: Operations Forum December 1998

35. A treatment plant should have a valve exercise program in which all plant valves are exercised (opened and closed)

- a. \*Once a year
- b. Once every 2 years
- c. Once every 10 years
- d. Once every 20 years

Note: Operations Forum December 1998

36. A \_\_\_\_\_ is installed on pump discharge piping to prevent water from flowing back across a pump when it is off.

- a. Backflow preventer
- b. \*Check valve
- c. Butterfly valve
- d. Smaller diameter of piping

Note: Operations Forum January 1997

37. Centrifugal pump parts include a(n)

- a. Diaphragm
- b. \*Impeller
- c. Piston
- d. Rotor

Note: Operations Forum May 1997

38. The total dynamic head against which a pump must operate:

- a. \*Is the sum of the static head and the head due to friction loss.
  - b. Must always be above the shutoff head.
  - c. Is the static head.
  - d. Is the friction head.
39. The difference in water surface elevation between where the pump is pulling from and where it is discharging to is called the \_\_\_\_\_ head.
- a. Dynamic
  - b. Suction
  - c. Discharge
  - d. \*Static
40. A device that causes the water in a vertical riser pipe to rise to an outlet using compressed air is called an
- a. \*Air lift pump
  - b. Draft tube
  - c. Suction pump
  - d. Capillary pump
41. A centrifugal untreated raw water pump starts pumping at 25 gal/min and has a maximum pumping capacity of 100 gal/min. A Venturi flowmeter can be used to measure flow from this pump.
- a. \*True
  - b. False
- Note: Operations Forum March 1999
42. What is the vertical distance between the elevation of the free water surface at the suction and that of the free water surface at the discharge of a pump called?
- a. Discharge head
  - b. Dynamic head
  - c. Velocity head
  - d. \*Static head
- Note: WEF/ABC 2002 Guide
43. What is an air-gap device used for?
- a. \*Backflow prevention
  - b. Insulation
  - c. To prime pumps
  - d. To seal valves
- Note: WEF/ABC 2002 Guide
44. How often should inactive valves be exercised?
- a. Daily
  - b. Weekly
  - c. Monthly
  - d. \*Quarterly

Note: WEF/ABC 2002 Guide At an absolute minimum, they should be exercised annually.

45. A water-filled mechanical pump seal not only helps to prevent leaks, but also
- Cools the material being pumped
  - Keeps the pump primed
  - Acts as a reserve water supply
  - \*Acts as a lubricant for the pump shaft

Note: WEF/ABC 2002 Guide

46. If your facility cannot tolerate power loss even for short periods, then you need an emergency generator that can \_\_\_\_\_.
- Manually switch over
  - \*Automatically switch over when power goes down
  - Switch on after a specific time between power losses
  - Power the entire facility

Note: WEF/ABC 2002 Guide

47. Besides throttling the inlet valve, what type of control is used for a centrifugal pump?
- \*Variable frequency drives
  - Outlet backpressure
  - Pipe material
  - Pipe length

Note: WEF/ABC 2002 Guide

48. What type of pump is typically used to feed ferric chloride for coagulation purposes?
- \*Metering pumps
  - Rotary lobe pumps
  - Gear pumps
  - Progressing cavity pumps

Note: WEF/ABC 2002 Guide

49. The formation and collapse of gas pockets or bubbles on the blade of a centrifugal pump's impeller is known as what?
- Entrainment
  - Compression
  - Combustion
  - \*Cavitation

Note: WEF/ABC 2002 Guide

50. When planning to work on or near electrical equipment, be sure to always \_\_\_\_\_.
- Remain grounded to metallic equipment
  - \*Lock and tag out the equipment
  - Handle wires as necessary



- d. Notify your electric power provider
- Note: WEF/ABC 2002 Guide

51. What is your first course of action if you see a slow constant drip from a pump shaft packing seal?
- a. Loosen the gland nuts
  - b. \*Make no adjustment
  - c. Change/adjust packing material
  - d. Fill seal with more water as needed

Note: WEF/ABC 2002 Guide

52. Which of the following indicates that the impeller of a centrifugal pump may be worn or damaged?
- a. Pump is delivering too much flow
  - b. Pump is very cold
  - c. \*Pump is not delivering the design flow
  - d. Impeller speed is too low

Note: WEF/ABC 2002 Guide

53. A ground fault interrupter on an electrical circuit system is used to \_\_\_\_\_.
- a. Interrupt repairs if the circuit is live
  - b. \*Disconnect power from the circuit if there is a faulty ground line
  - c. Provide an extra ground line for a circuit
  - d. Divert power to a new circuit if the present circuit is damaged

Note: WEF/ABC 2002 Guide

54. Which of the following causes leaking between the segment and body of a plug valve?
- a. New seal seating itself
  - b. \*Overgreased assembly
  - c. Recently-cleaned segment
  - d. New seal ring

Note: WEF/ABC 2002 Guide

55. Which of the following is a likely benefit of a planned maintenance program?
- a. Increased emergency repair efficiency
  - b. \*Extended equipment "life"
  - c. Extended equipment downtime
  - d. Decreased health and safety violations

Note: WEF/ABC 2002 Guide

56. Why should standby generators be exercised regularly?
- a. To save money on plant electrical costs
  - b. To train new operators on generator operation
  - c. To supply extra power when needed
  - d. \*To test the system under actual conditions

Note: WEF/ABC 2002 Guide

57. What is an acceptable variation in input voltage for most electric motors?
- a. +/- 5%
  - b. \*+/- 10%
  - c. +/- 20%
  - d. +/- 50%

Note: WEF/ABC 2002 Guide

58. How often should the packing on a gate valve be replaced?
- a. Weekly
  - b. Monthly
  - c. Annually
  - d. \*As required

Note: WEF/ABC 2002 Guide

59. A well pump will not start. The circuit breaker is not tripped and no fuses are burned out. The motor is hot to the touch. The operator should
- a. \*Check the motor to see if the overload relay has tripped.
  - b. Replace a defective pressure switch.
  - c. Check and replace the motor air filter.
  - d. Replace a leaky foot valve.

Note: A hot motor frequently indicates an overload condition.

60. A well pump will not start. Upon inspection, the operator discovers that the in-line valve has been accidentally shut off. The appropriate corrective action is
- a. \*Open the closed valve and then restart the pump.
  - b. Adjust the PRV and then restart the pump.
  - c. Take an early smoke break and wait for the second shift guy to fix the problem.
  - d. Check the discharge line pressure.

61. A well pump will not shut down. Possible causes include:
- a. \*Defective pressure switch
  - b. \*Defective timer in pump stop mode
  - c. Leaking foot valve
  - d. Low line voltage
  - e. Fuses burned out

62. A well pump is starting more frequently than it should. Possible causes include:
- a. \*Leaking foot valve
  - b. \*Waterlogged tank
  - c. Defective pressure switch
  - d. Defective motor
  - e. Loose or broken wire

63. A well pump continues to trip its overload relays. The appropriate corrective action would be
- Keep resetting the relays and restarting the pump.
  - \*Verify that thermal relay components are correctly sized.
  - Blame the engineer.
  - Check the motor rotation.
64. A well pump is delivering less than the rated capacity. It does not appear to be breaking suction or rotating incorrectly. What is the next most likely cause?
- \*Worn or improperly adjusted impeller
  - Pumping against excessively low head
  - Motor overloaded
  - Well is pumping sand
65. A well pump is requiring more power than it should. The impellers are properly adjusted and the well was recently cleaned. What is the most likely cause of increased power draw?
- \*Worn bearings or bent shaft
  - Line shaft bearings not receiving oil
  - Drawdown more than anticipated
  - Impellers are worn
66. Material Safety Data Sheets (MSDS) must contain the following information:
- Chemical name, manufacturer name, purchaser name, and disposal procedures
  - \*Chemical name, emergency procedures for spills, and necessary personal protective equipment
  - Purchaser name, acute and chronic health effects, and storage requirements
  - CAS number, concentration, manufacturer name and address, and possible uses
67. Under what conditions may an operator refuse to work with a hazardous substance?
- When the scheduled work time interferes with lunch or breaks
  - When the operator believes management is using the substance as a punishment
  - \*When the operator's employer has failed to provide or attempt to provide an MSDS sheet
  - When the operator is unfamiliar with the substance
68. CAS numbers identify
- Abstract chemical reactions
  - Chemical analysis services
  - \*Specific chemical substances
  - Hazard levels of chemicals
  - Reactivity levels of chemicals

69. The Threshold Limit Value (TLV) of a substance may be expressed as a
- Ceiling (C) exposure limit
  - Lower Exposure Limit (LEL)
  - Permissible Exposure Limit (PEL)
  - Short-Term Exposure Limit (SEL)
  - Time Weighted Average (TWA)
  - \*As TWA, SEL, or Ceiling
  - As either Ceiling or TWA
70. The recommended procedure for mixing concentrated acid with water is:
- Rapidly add acid to water and mix vigorously.
  - Rapidly add water to acid and mix vigorously.
  - \*Slowly add acid to water and mix gently.
  - Slowly add water to acid and mix gently.
71. What does SCBA stand for?
- self contained breathing apparatus
  - ?And a SCUBA is a self contained underwater breathing apparatus
72. When a fire hydrant is operated, it should be:
- Opened enough to have flow
  - \*Opened fully
  - Opened halfway
  - Regulated to flow required
73. Immediate first aid for burns is to
- Bandage tightly
  - Cover liberally with a salve
  - Immerse in warm water
  - \*Flood with cold water
74. "Combustible" liquids have a flash point \_\_\_\_\_ 100 degrees F
- \*Above
  - Below
  - Approximately equal to
  - What's a flash point?
75. "Flammable" liquids have a flash point \_\_\_\_\_ 100 degrees F.
- Above
  - \*Below
  - Approximately equal to
  - What's a flash point?

76. A proper steel-toe safety shoe should be capable of resisting the impact of at least \_\_\_\_\_ ft-lb
- a. 10
  - b. 50
  - c. 100
  - d. \*300

Note: Operations Forum August 1998

77. An atmosphere should be considered dangerous when oxygen content falls below \_\_\_\_\_%
- a. 25
  - b. 21
  - c. 20
  - d. \*19

Note: Operations Forum August 1998

78. If water is added to concentrated acid instead of acid into water,
- a. Water will sink to the bottom immediately
  - b. Dilution is faster
  - c. Temperature decreases and the mixture tends to form ice
  - d. \*Heat is generated and the mixture tends to splash acid
  - e. There is no difference

Note: Operations Forum August 1998

79. An occupied trench excavation that is 4 ft or deeper must have exits (ladders) that are no more than \_\_\_\_ ft. from a workers.
- a. 5
  - b. 18
  - c. \*25
  - d. 50

Note: Operations Forum August 1998

80. In a confined space entry, the entry supervisor must ensure that all confined space entry permit provisions have been fulfilled and certify the same by signing the permit.
- a. \*True
  - b. False

Note: Operations Forum April 1998

81. Forklift accidents are particularly dangerous because of
- a. Forklift speed
  - b. Toxic emissions generated by most forklifts
  - c. \*The tremendous weight of the forklift
  - d. None of these answers are correct

Note: Operations Forum April 1998

82. If you need to raise your voice to be heard by someone less than 2 ft away, chances are you should be wearing hearing protection.

a. \*True

b. False

Note: Operations Forum April 1998

83. Loudness, length of exposure, and distance from the noise source are factors in determining if a noise is hazardous enough to damage hearing.

a. \*True

b. False

Note: Operations Forum April 1998

84. For hearing protection, workers should wear either safety plugs or safety earmuffs, but never both simultaneously.

a. True

b. \*False

Note: Operations Forum April 1998

85. Because actual conditions vary from one worksite to another, the selection of an appropriate respirator weighs heavily on all of these variables. Check all that apply.

a. \*The size of the particles to be filtered

b. \*The presence or absence of sufficient oxygen

c. The odor threshold value of the ambient air

d. Comfort of the person wearing the equipment

Note: Operations Forum April 1998

86. The Hazard Communication Standard (HazCom)

a. [SO]

b. Affects everyone using chemicals in the workplace

c. Requires employers to develop a written HazCom program

d. Requires the posting of Material Safety Data Sheets

e. Two of these answers are correct

f. \*All of these answers are correct

Note: Operations Forum April 1998

87. To prevent back injuries, follow all of these precautions

a. \*Keep fit with exercise

b. \*Warm up before lifting

c. \*Avoid being overweight

d. Practice 12 ounce curls frequently

Note: Operations Forum April 1998

88. If you arrive at an accident scene, which step should you take first?
- Call 911 or the local emergency number
  - \*Check the scene for safety
  - Care for the victim
  - Interview witnesses to determine what is wrong
- Note: Operations Forum April 1998
89. To ensure a safe working atmosphere in a confined space you need a \_\_\_\_\_?
- Canister respirator, gloves, and hard hat
  - Fan to provide ventilation
  - \*Completed confined space entry permit
  - Permission from immediate supervisor
- Note: Operations Forum April 1997
90. It is permitted to use a five-minute air escape capsule for entry or rescue in a confined space.
- True
  - \*False
- Note: Operations Forum April 1997
91. An oxygen-enriched atmosphere contains more than 21% oxygen.
- True
  - \*False
- Note: Operations Forum April 1997
92. The first step the maintenance staff should take in properly locking and tagging out a piece of equipment is to \_\_\_\_\_.
- \*Alert the operator on duty
  - Turn the equipment off at the motor control center (MCC)
  - Pull the switch on the electrical panel to "off"
  - Fill out the tags
- Note: WEF/ABC 2002 Guide
93. When working in an area with two or more floor coverings (for example, grating and checker-plate), be sure that they are always \_\_\_\_\_.
- Overlapping one another
  - \*Secured together
  - Separated from one another
  - At the entrances and exits only
- Note: WEF/ABC 2002 Guide

94. When manually lifting any object, be sure to \_\_\_\_\_.  
a. Hold it at arm's length  
b. Keep your back bent and hold it low  
c. \*Keep it close to your body and use leg strength  
d. Keep your knees locked and bend at the waist  
Note: WEF/ABC 2002 Guide
95. Oxygen deficiency becomes a concern when the oxygen level in a confined space is less than  
a. \*19.5%  
b. 22.5%  
c. 25.5%  
d. 28.5%  
Note: WEF/ABC 2002 Guide
96. Which of the following provides safety information for potentially hazardous or toxic materials?  
a. CERCLA  
b. OSHA  
c. CFR  
d. \*MSDS  
Note: WEF/ABC 2002 Guide
97. The threshold limit value concentration for chlorine vapor is  
a. ppm  
b. ppm  
c. \*0.5 ppm  
d. ppm  
Note: WEF/ABC 2002 Guide
98. In addition to the worker entering a confined space, what is the minimum number of people required to be present during a confined space entry?  
a. \*1  
b. 2  
c. 3  
d. 4  
Note: WEF/ABC 2002 Guide Use the buddy system in case you get in trouble. Someone needs to be able to go for help.
99. Hearing protection must be made available to all employees exposed to noise levels above  
a. \*85 decibels averaged over 8 working hours  
b. 850 decibels averaged over 8 working hours  
c. 85 decibels continuously for 8 working hours  
d. 85 decibels at any point in the 8-hour workday  
Note: WEF/ABC 2002 Guide



100. When using portable electric tools in damp areas or around standing water, be sure to plug them into a
- Three-prong outlet
  - Three-wire to two-wire adapter
  - \*Ground fault circuit interrupter
  - Portable power supply
- Note: WEF/ABC 2002 Guide

101. In confined space entry, LFL stands for
- \*Lower flammability limit
  - Low floor level
  - Lighting factor limitations
  - Lifeline/flotation locations
- Note: WEF/ABC 2002 Guide

102. When mixing dry sodium hydroxide and water in an enclosed vessel or area, be sure that
- The vessel or area is properly heated
  - \*The vessel or area is properly vented
  - You add the water rapidly
  - Mix the solution by agitation only
- Note: WEF/ABC 2002 Guide

103. Personnel should not work alone on energized equipment, for example, a magnetic starter, that operates at or above
- 60 V
  - 120 V
  - 240 V
  - \*480 V
- Note: WEF/ABC 2002 Guide

104. Pulmonary capacity tests are required before operators can be cleared for using respiratory equipment. These tests should be performed at a minimum of once every
- 6 months
  - year
  - \*3 years
  - 5 years
- Note: WEF/ABC 2002 Guide

105. According to Article 250 of the US National Electric Code (NEC), what color should ground wires be?
- Red
  - \*Green
  - Yellow
  - Blue
- Note: WEF/ABC 2002 Guide

## **'Regulations**

- Community water systems that detect between 5 and 10 ug/L of Arsenic in their water supply must include what information in their consumer confidence report (CCR)?
  - \*An educational statement.
  - Health effects information.
  - No information is required since it is below the MCL
  - Notice of impending violation
- Community water systems that detect between 10 and 50 ug/L of Arsenic in their water supply must include what information in their consumer confidence report (CCR)?
  - An educational statement.
  - \*Health effects information.
  - No information is required since it is less than ten times the MCL
  - Notice of impending violation
- Community water systems that detect more than 50 ug/L of Arsenic in their water supply must include what information in their consumer confidence report (CCR)?
  - An educational statement.
  - Health effects information.
  - No information is required since it is below the MCL
  - \*Notice of violation and health effects information
- All community and non-transient, non-community water systems are required to comply with the Arsenic MCL of 10 ug/L.
  - \*True
  - False
- About 90 percent all arsenic used in the United States is used for this purpose
  - \*Wood preservative
  - Fighting forest fires
  - As a colorizer for highway paint
  - Poisoning rats and other small mammals

6. The Safe Drinking Water Act (SDWA) was passed by Congress in
  - a. \*1974
  - b. 1965
  - c. 1918
  - d. 1982
  
7. What does MCL stand for?
  - a. Minimum Contaminant Level
  - b. \*Maximum Contaminant Level
  - c. Minimum Containment Level
  - d. Maximum Contact Limit
  
8. CWS and NTNCWS stand for, \_\_\_\_\_ and \_\_\_\_\_ respectively
  - a. \*Community water system and non-transient, non-community water system
  - b. City water system and national, non-city water system
  - c. Community waste system and non-transient and non-community waste system
  - d. County water system and normal, non-county water system
  
9. SDWA stands for
  - a. Sanitary Drain Waste Action
  - b. Soluble Dissolved Waste Atoms
  - c. Safe Disposal of Wastewater Act
  - d. \*Safe Drinking Water Act
  
10. Which statement best describes a Community Water System?
  - a. \*A public water system that serves at least 15 locations or 25 residents regularly, year round.
  - b. A small private water system that sells bottled water to consumers.
  - c. A public water system that serves at least 25 of the same people more than 6 months of the year.
  - d. A large public water system.
  
11. ppm and ppb stand for what, respectively?
  - a. Portions per million and portions per billion
  - b. Portions per month and portions per block
  - c. \*Parts per million and parts per billion
  - d. Parts per month and parts per block
  
12. What does PWS stand for?
  - a. Private Water System
  - b. \*Public Water System
  - c. Private Water Supplier
  - d. Public Water Supplier

13. What does CCR stand for?
  - a. \*Consumer Confidence Report
  - b. Client Care Report
  - c. Customer Client Relations
  - d. City Consumption Report
  
14. What is the MCL for arsenic?
  - a. 50 ug/L (micro grams per liter)
  - b. 25 ug/L (micro grams per liter)
  - c. \*10 ug/L (micro grams per liter)
  - d. 5 ug/L (micro grams per liter)
  - e.
  
15. What health effects are associated with exposure to arsenic? (Select all that apply)
  - a. \*Skin cancer
  - b. \*Immunological problems
  - c. \*Liver and prostate cancer
  - d. Brain cancer
  - e. Blotchy skin
  - f. Loss of fingernails
  
16. Arsenic is a naturally occurring contaminant found in rocks, soil, air, and animals.
  - a. \*True
  - b. False
  
17. Generally higher levels of arsenic tend to be found in surface waters compared to ground water.
  - a. True
  - b. \*False
  
18. The Lead and Copper Rule addresses which of the following items:
  - a. Requires water suppliers to use only lead pipes for water distribution
  - b. Establishes requirements for lead pipe replacement
  - c. Determines action levels for lead and copper in drinking water
  - d. Establishes a treatment technique including corrosion control
  - e. d only
  - f. \*b, c, d
  
19. What are the MCL and Action level for lead in drinking water?
  - a. \*15 ppb and 15 ppb
  - b. 0 and 15 ppb
  - c. 15 ppb and 50 ppb
  - d. 10 ppb and 50 ppb

20. A system will be required to replace service lines made of lead (Pb) after what series of events - check all that apply.
- \*System fails to meet the lead action level in tap samples after installing corrosion control.
  - \*System fails to meet the lead action level in tap samples after source water treatment.
  - Systems that fail to monitor for lead on a monthly basis.
  - Systems that have budgeted for service line replacement.
21. How many years must systems subject to control of lead and copper keep original records on premises?
- 4
  - 8
  - \*12
  - 16
22. What are some of the health effects of short term exposure to lead?
- Causes excessively brittle bones
  - \*Delays in physical and mental development in babies and children
  - Causes kidney disease
  - There are no short term health effects
23. What are nitrites and nitrates?
- They are two types of nitrogen used in water treatment.
  - They are non-radioactive isotopes of nitrogen with half-lives of 225 years and 128 years, respectively.
  - They are alternative chemicals used in corrosion control strategies.
  - \*They are nitrogen-oxygen chemical units that combine with various organic and inorganic compounds.
24. What are the MCLs for nitrites and nitrates?
- \*1 ppm and 10 ppm respectively
  - 1 ppb and 10 ppb respectively
  - 10 ppm and 1 ppm respectively
  - 10 ppb and 1 ppb respectively
25. Why are nitrites/nitrates considered a health hazard in drinking water?
- Nitrate and nitrite are both stored in the body and form pouches under the skin.
  - Nitrate converts to nitrite in the body and fertilizes the intestinal tract.
  - \*Nitrate converts to nitrite in the body and interferes with the oxygen-carrying capacity of blood.
  - Nitrate converts to nitrites in the body and is stored in the brain.
26. What are the EPA approved methods of treatment for the removal of nitrites/nitrates from drinking water?

- a. Coagulation, Flocculation, and Sedimentation
  - b. \*Ion Exchange, Reverse Osmosis and Electrodialysis
  - c. Slow Sand Filtration
  - d. EPA recommends source water protection methods only
27. The Radionuclide Rule applies only to CWS and not NTNWCS at this time
- a. \*True
  - b. False
28. Radionuclides include which of the following (select all that apply):
- a. \*Alpha and Beta
  - b. Lepton and Photon
  - c. Gamma and Nano
  - d. \*Radium 226 and Radium 228
29. The Public Notification Rule is designed to
- a. Increase the work load of water treatment plant operators
  - b. \*Keep the public informed of incidents that may affect drinking water quality
  - c. Increase the number of complaint calls to the water treatment plant
  - d. All of the above
30. Complete the following statement (select all that apply) “A system owner or operator must notify the public of a non-acute MCL violation...”
- a. Notification is not required.
  - b. \*By mail or hand delivery, as soon as possible, but not later than 30 days after the system learns of the violation or failure.
  - c. By mail within three months after the initial 45 day notification, for as long as the violation continues
  - d. By broadcasting on a commonly listened to radio and television station in the area ASAP but not later than 24 hours after the system learns of the violation.
31. Endrin, Lindane, Methoxychlor, and Toxaphene are examples of
- a. Inorganic chemicals
  - b. \*Organic chemicals
  - c. Metal Salts
  - d. Halogens

## **Mathematics**

1. One cubic foot of water contains
- a. \*7.48 gallons
  - b. 8.34 gallons
  - c. 3.785 gallons
  - d. 62.4 gallons

2. Five gallons of water weighs
  - a. \*41.7 pounds
  - b. 37.4 pounds
  - c. 5.0 pounds
  - d. 18.9 pounds
  
3. How many gallons of water are there in 5 cubic feet?
  - a. 41.7 gallons
  - b. \*37.4 gallons
  - c. 15.0 gallons
  - d. 100.0 gallons
  
4. If water weighs 8.34 lbs/gal, how much will 7.5 gal weigh?
  - a. 50.8 lbs
  - b. \*62.6 lbs
  - c. 75.5 lbs.
  - d. 77.3 lbs
  
5. A flow of 1.55 cubic feet per second is how many gallons per minute?
  - a. 11.6 gpm
  - b. 776 gpm
  - c. 965 gpm
  - d. \*696 gpm
  
6. Your pump ran continuously for 24 hrs and delivered 288,000 gal. The capacity of the pump is \_\_\_\_\_ gpm. Select the closest answer.
  - a. 100
  - b. \*200
  - c. 1000
  - d. 12000
  
7. A fluid with a specific gravity of 1.05 weighs \_\_\_\_\_ lb/gal.
  - a. 8.4
  - b. \*8.8
  - c. 7.2
  - d. 8.5
  
8. You have a water storage tank that is 90' tall and 45' in diameter, it currently has 56' of water in it, what is the pressure in the bottom of the tank
  - a. \*24.2 psi
  - b. 14 psi
  - c. 2 psi
  - d. 100 psi
  - e. 56 psi

Note: Each foot of water exerts 0.433 psi. The volume of the tank does not matter.

9. A flow of 2500 gal/min is equal to how many million gallons per day?
- 2.5 mgd
  - \*3.6 mgd
  - 5.0 mgd
  - 7.2 mgd

Note: Operations Forum March 2001

10. Regardless of shape, 1 ac-ft of water is equal to
- 33,000 ft<sup>3</sup>
  - \*43,560 ft<sup>3</sup>
  - 55,560 ft<sup>3</sup>
  - 77,840 ft<sup>3</sup>

Note: This assumes one foot of water depth.

11. A potable water flowmeter reads 76 gal/min. What is the total flow, in gal/d?
- 633.8 gal/d
  - 1824 gal/d
  - 14,085 gal/d
  - \*109,440 gal/d

Note: Operations Forum November 1997

12. The pressure gauge on the bottom of a water holding tank reads 15 psi. The tank is 15 ft in diameter and 40 ft high. How many feet of water are in the tank?
- 11.8 ft
  - 25.0 ft
  - \*34.6 ft
  - 38.9 ft

Note: One foot of water exerts 0.433 psi of pressure.

13. A liquid has a specific gravity of 1.16. How much would 300 gallons of this liquid weigh?
- \*2901 pounds
  - 348 pounds
  - 2603 pounds
  - 2156 pounds

14. Eight boxes of packing (for pumps) were delivered. The invoice showed \$15.93 each. What is the total cost of the packing?
- \$106.34
  - \*\$127.44
  - \$1.99
  - \$95.58



15. A water treatment plant used 647 chlorine cylinders during one year of operation. The average withdrawal from each cylinder was 138 lbs. What was the total number of pounds of chlorine used for the year?
- 50370
  - 70872
  - 69876
  - \*89286
16. A pump delivering 288,000 gallons of water in 24 hours operates at what average flow rate?
- 12000 gpm
  - \*200 gpm
  - 1000 gpm
  - 100 gpm
17. A clear well pump delivers 750 GPM to the main water storage tank, The demand for water from this tank is approximately six million gallons per week. How many hours does the pump need to run each week to meet the demand?
- 80 Hours per Week
  - 13 Hours Per Week
  - 56 Hours Per Week
  - \*133 Hours Per Week
  - 168 Hours Per Week
18. Your Water plant treats water at a rate of 700 GPM. How many MGD is this?
- \*1.008 MGD
  - 0.700 MGD
  - 0.1008 MGD
  - 1.800 MGD
  - 0.420 MGD
19. Find how many gallons of liquid are in a tank which measures 40' long, 25' wide and 12' high.
- 79872
  - 67859
  - 90272
  - \*89760
20. The diameter of a clear well is 10 ft. If filled to a depth of 10 ft. It will contain approximately:
- 2987 gal.
  - \*5872 gal.
  - 6024 gal.
  - 10,602 gal.

21. A cylindrical tank is 10 ft in diameter and 20 ft in height. What is the approximate capacity in liters?
- a. \*44,450 liters
  - b. 31,030 liters
  - c. 5,942 liters
  - d. 4,445 liters
22. Approximately how many gallons would 600 ft of 6" pipe hold?
- a. 740
  - b. \*880
  - c. 900
  - d. 930
23. The effluent weir of a clarifier is located along the rim of a 60-ft diameter tank. What is the approximate length of the weir?
- a. 2826 feet
  - b. 377 feet
  - c. \*188 feet
  - d. 540 feet
24. The entire surface of a free-standing cylindrical tank with an exposed, flat bottom must be painted. The tank does not have a top cover. The tank is 50 inches in diameter and 8 feet high. What is the total interior and exterior surface area to be painted?
- a. \*209 square feet
  - b. 105 square feet
  - c. 254 square feet
  - d. 118 square feet
25. What is the volume of water (in gallons) in an upright 25 foot diameter cylindrical tank with a water depth of 22 feet?
- a. 10,794
  - b. 13,750
  - c. \*80,737
  - d. 90,022
  - e. 102,850
26. You are going to add 6" of coal to one of the filters in your plant. The filter measures 10' x 12'. Each bag of coal contains 3 cubic feet. How many bags will you need to order?
- a. 32 bags
  - b. 60 bags
  - c. 10 bags
  - d. \*20 bags
  - e. 15 bags

27. Your system has just installed 2,000 feet of 8" pipe. How many gallons of water will it take to fill it?
- a. \*5,221
  - b. 521.4
  - c. 2,145
  - d. 6,971
  - e. 697.1
28. A plant has a 90-ft diameter storage tank with a sidewall depth of 20 ft. The tank also has a conical bottom that is 8 ft deep. The tank has a liquid level of 15 ft (sidewater depth). How many gallons of water are in the tank?
- a. 586,593
  - b. 713,424
  - c. \*840,255
  - d. 112,334
29. The flow velocity in a 6-in. diameter pipe is twice that in a 12-in diameter pipe if both are carrying 50 gal/min of wastewater.
- a. True
  - b. \*False
30. What is the average detention time in a basin given the following: diameter = 30' depth = 15' flow = 700 gpm
- a. 1hr. 34min.
  - b. \*1hr. 53min.
  - c. 1hr. 47min.
  - d. 2 hrs. 3 min.
31. What is the average detention time in a basin given the following: diameter = 80' depth = 12.2' flow = 5 MGD
- a. \*2.2 hrs.
  - b. 1.68 hrs.
  - c. 2.4 hrs.
  - d. 1.74 hrs.
32. Two 50-ft diameter, 10-ft deep sedimentation basins operating in parallel handle a flow of 2 mgd. What is the detention time in hours (assume the basins have flat floors)?
- a. \*3.5 hrs
  - b. 6.7 hrs
  - c. 7.0 hrs
  - d. hrs

Note: Operations Forum March 1998

33. Your finished water storage tank is 35 feet in diameter and 65 feet high. With no water entering it the level dropped 4' in 5 hours. How many gallons of water were used in this period?
- 7,193
  - 71,930
  - 467,542
  - \*28,772
  - 62,506
34. If two pumps will pump 120 gpm each, how long will it take to fill a tank 50' long, 20' wide, and 8' deep?
- 2 hours, 27 minutes
  - hours, 42 minutes
  - \*4 hours, 9 minutes
  - 1 hour, 49 minutes
35. Given the following information, what is the water tank detention time? Diameter = 80 ft Depth = 25 ft Flow rate = 25000 gpd
- 47.8 days
  - 25.2 days
  - \*37.6 days
  - 15.7 days
36. Compute the detention time in hours in a final sedimentation basin given: Diameter = 95' Depth = 11' Flow rate = 7.0 MGD
- \*1 hr. 59 min
  - 2 hrs 10 min
  - hrs 10 min
  - 1 hr
37. A settling basin 60' by 12' and 12' deep is used to treat a flow of 2.4 MGD. What is the detention time?
- 15 min.
  - \*39 min.
  - hrs
  - 2.3 hrs
38. What is the detention time in a reservoir if the influent flow rate is 0.785 MGD, the reservoir depth is 22 feet, and the reservoir covers 17 acres?
- 97 days
  - 56 days
  - \*155 days
  - 180 days
  - 420 days

39. Your filters fill your clearwell at a rate of 375 gpm. The clearwell measures 10' wide x 80' long x 12' deep. If it had 5' of water in it how long would it take to fill completely?
- 2.9 hours
  - \*111.7 minutes
  - 19.1 minutes
  - 11.1 hours
  - 191 minutes
40. Calculate the weir loading for a sedimentation tank that has an outlet weir 480 ft long and a flow of 5MGD.
- 9,220 gpd/ft
  - 9,600 gpd/ft
  - 9,920 gpd/ft
  - \*10,420 gpd/ft
41. Find the wier loading rate in gpd/ft for a circular tank. The tank is 40 feet in diameter and the influent flow rate is 4 mgd.
- \*31847 gpd/ft
  - 3185 gpd/ft
  - 7960 gpd/ft
  - 15794 gpd/ft
42. Find the surface overflow rate in gpd/ft<sup>2</sup> for a circular tank. The tank is 40 feet in diameter and the influent flow rate is 4 mgd.
- \*3185 gpd/ft<sup>2</sup>
  - 796 gpd/ft<sup>2</sup>
  - 1325 gpd/ft<sup>2</sup>
  - 1760 gpd/ft<sup>2</sup>
43. A circular tank receives 12.5 mgd of flow and has a Surface Overflow Rate of 100 gpm/ft. What is the diameter of the tank?
- 27.6 ft
  - \*10.5 ft
  - 75.0 ft
  - 14.7 ft
44. A water plant is equipped with six sedimentation basins that are operated in parallel. Each basin is 30 ft long by 25 ft wide. If the finished water demand is 30 mgd, how many basins need to be on-line to maintain a surface overflow rate of approximately 10 gpm/sft?
- 2
  - \*3
  - 4
  - 5
  - 6

45. A sand filter with dimensions of 12 feet by 15 feet receives 0.75 mgd. What is the hydraulic loading rate in gpm/sft?
- \*2.9 gpm/sft
  - 29.0 gpm/sft
  - 4167 gpm/sft
  - 69.4 gpm/sft
46. At what rate in gpm must wash water be delivered to a mixed media filter to attain a backwash rate of 15 gpm/sq ft if the filter is 20' wide and 30' long.
- 600
  - 2400
  - 3000
  - \*9000
47. Your filter filters at a rate of 200 GPM. On your last filter run you filtered 728,000 gallons of water before backwashing. How many hours did this filter run?
- 6.1 hours
  - \*60.7 hours
  - 3,640 hours
  - 607 hours
  - 36.4 hours
48. The optimum hydraulic loading rate for a new type of filter is 30 gpm/sft. If the flow going to the filter is 1.85 mgd, what should the area of the filter be? Round to the nearest whole foot.
- \*43 sft
  - 32 sft
  - 60 sft
  - 52 sft
49. A 42" diameter pipe is flowing at a rate of 6.5 ft/sec. What is the flow rate in cu ft/sec?
- 17.86
  - 35.71
  - \*62.53
  - 521.25
50. Given the following data, calculate the average velocity in the channel. 2.5 ft wide channel, flow depth is 1.4 ft, flow rate is 7.2 MGD
- 1 ft.sec
  - \*3.2 ft/sec
  - 11.2 ft/sec
  - 32.2 ft/sec

51. What is the approximate volume of flow (MGD) treated in a 7 ft wide, 4 ft deep chamber, if a floating stick moves 24 inches in 30 seconds.
- 1.37 MGD
  - \*1.21 MGD
  - 5.42 MGD
  - 4.52 MGD
52. What is the average flow velocity in ft/sec in a 12-in diameter force main carrying a daily flow of 2.5 mgd?
- \*4.9 ft/sec
  - 5.3 ft/s
  - 18.0 ft/sec
  - 18.85 ft/sec
- Note: Operations Forum January 1997
53. A plastic float is dropped into a water channel and is found to travel 10 feet in 4.2 seconds. The channel is 2.4 feet wide and is flowing 1.8 feet deep. Calculate the flow rate of this wastewater in cubic feet per second.
- ft<sup>3</sup>/sec
  - 2.3 ft<sup>3</sup>/sec
  - 4.2 ft<sup>3</sup>/sec
  - 5.7 ft<sup>3</sup>/sec
  - \*10.3 ft<sup>3</sup>/sec
54. You are preparing a stock solution using dry sodium bicarbonate. Your desired strength is 5,000 mg/L so that 1 ml of stock solution per 1,000 ml sample water produces 5mg/L. How many dry grams must you add to your 1 Liter of stock solution dilution water?
- 0.5
  - \*5.0
  - 500
  - 0.05
55. You have a 1000 mg/L solution of Arsenic. To calibrate the instrument, you need 250 mL of a 10 mg/L solution. How many milliliters of the stock solution should be diluted to make 250 mLs?
- \*2.5
  - 5.0
  - 15.0
  - 10.0
56. A water treatment plant adds ferric chloride as a coagulant. The raw water enters the plant at 10 mgd. Jar testing shows that the optimum ferric dose is 200 mg/L. If the ferric chloride is delivered as a 47% solution, what should the chemical delivery pump rate be? Express your answer in gpm.
- \*2.96

- b. 4255
  - c. 5.31
  - d. 25.8
57. There are two raw water lines entering a treatment plant. One line carries a flow rate of 500 gal/min with a TDS concentration of 1500 mg/l, and the other has a flow rate of 6 MGD with a 250 mg/l TDS. What is the actual combined TDS concentration entering the plant? Round off answer to nearest full unit.
- a. 700 mg/l
  - b. \*384 mg/l
  - c. 420 mg/l
  - d. 1200 mg/L
58. Two wells are used to satisfy demand during the summer months. One well produces water that contains 22 mg/L of arsenic. The other well produces water that contains 3 mg/L of arsenic. If the total demand for water is 400 gpm and the target arsenic concentration in the finished water is 8 mg/L, what is the highest pumping rate possible for the first well?
- a. 252 gpm
  - b. 105 gpm
  - c. \*295 gpm
  - d. 160 gpm
59. Liquid polymer is delivered as an 8 percent solution. How many gallons of liquid polymer should be mixed in a tank to produce 150 gallons of 0.6 percent polymer solution?
- a. 2.5 gallons
  - b. 7.5 gallons
  - c. 17.5 gallons
  - d. 22.5 gallons
  - e. \*11.3 gallons
60. The finished water chlorine demand is 12 mg/l, the target chlorine residual is 1.2 mg/l, and the plant flow is 5.6 MGD. How many lbs/day of 65% hypochlorite solution will be required?
- a. 776 lbs/day
  - b. \*948 lbs/day
  - c. 113 lbs/day
  - d. 514 lbs/day
61. If chlorine costs \$0.21/lb, what is the daily cost to chlorinate a 5 MGD flow rate at a chlorine dosage of 2.6 mg/l?
- a. \*\$22.77
  - b. \$18.95
  - c. \$31.22
  - d. \$21.34



62. If a 1-mgd plant has an chlorine demand of 4.5 mg/l and maintains a residual of 1.0 mg/l, what is the estimated required chlorine feed rate in pounds per day?
- a. 38
  - b. \*46
  - c. 51
  - d. 68

Note: Operations Forum March 1997

63. Determine the required chlorinator setting in lb/day given: Steady flow rate of 5.5 MGD, Target chlorine residual = 2.5 mg/l, Average chlorine demand = 2.5 mg/l
- a. 251 lbs/day
  - b. 195 lbs/day
  - c. 213 lbs/day
  - d. \*229 lbs/day
64. How many lbs of chlorine gas are required to treat 4,000,000 gal of water at a dosage of 2 mg/l?
- a. 61
  - b. 65
  - c. \*67
  - d. 69
65. How many pounds of calcium hypochlorite are there in 15 lbs of 65% calcium hypochlorite solution?
- a. \*9.75 pounds
  - b. 24.75 pounds
  - c. 5.25 pounds
  - d. 23.07 pounds
66. To accurately obtain a chlorine residual from your system you are sampling at a customer tap. You would like to flush twice the volume of the service line before sampling. The service line is 3/4" and approximately 200 feet from the main. How many gallons must you flush?
- a. 610
  - b. \*4.6
  - c. 61
  - d. 46
  - e. 0.61
67. How many lbs/day chlorine will be used if the flow is 7,000,000 gpd and a uniform dose of 1.2 mg/l is applied?
- a. 15 lb
  - b. 22 lb
  - c. \*70 lb
  - d. 26 lb

68. One gallon of sodium hypochlorite laundry bleach (with 5.25% available chlorine) contains:
- \*0.44 pounds of active chlorine
  - 0.053 pounds of active chlorine
  - 4.38 pounds of active chlorine
  - 0.39 pounds of active chlorine
69. How many pounds of sodium hypochlorite solution will be needed to provide 25 pounds of available chlorine if the sodium hypochlorite solution contains 8 percent available chlorine by weight?
- \*312.5 pounds
  - 27.0 pounds
  - 16.68 pounds
  - 200 pounds
70. How many pounds of 65-percent available chlorine equal 2 pounds of 100 percent chlorine.
- 1.30 pounds
  - \*3.07 pounds
  - 5.28 pounds
  - 308 pounds
71. How many pounds of 70-percent available chlorine equal 2 pounds of 100 percent chlorine?
- 1.40 pounds
  - 2.60 pounds
  - 1.35 pounds
  - \*2.86 pounds
72. If 1,000,000 bacteria are exposed to a disinfectant and 90 percent are destroyed every hour, then fewer than 5 bacteria will remain after
- 3 hours
  - \*6 hours
  - 4 hours
  - hours
  - hours
  - 24 hours
73. Determine the chlorinator setting in pounds per 24 hours if a well pump delivers 300 gpm and the desired chlorine dose is 2.0 mg/L.
- 6.5 ppd
  - 12.0 ppd
  - \*7.2 ppd
  - 4.8 ppd

74. How much sodium hypochlorite, in gallons, is required to obtain a residual of 100 mg/L in a well? The casing diameter is 18 inches and the length of water filled casing is 80 feet. Sodium hypochlorite contains 5.25% available chlorine. Assume a demand of 15 mg/L.
- 23.0 gallons
  - gallons
  - 16.8 gallons
  - \*2.3 gallons
75. A chemical feed pump has been rebuilt and must be calibrated for maximum pump rate. If it takes 1 hour and 15 minutes to fill a 10-ft X 5-ft X 10-ft rectangular tank, what is the maximum pump rate in gal/min?
- 67 gal/min
  - \*50 gal/min
  - 45 gal/min
  - 38 gal/min
- Note: Operations Forum March 1998
76. A test on a water supply showed a hardness of 232 mg/L. A certain dosage of polyphosphates will theoretically reduce this hardness by 21 percent. What should the water hardness be after treatment?
- 49 mg/L
  - 211 mg/L
  - \*183 mg/L
  - 174 mg/L
77. A water company uses an average of 600 gpm. The water contains 0.30 mg/L of manganese and 0.06 mg/L of iron. How many pounds of iron and manganese combined are pumped into the distribution system in a year?
- \*947 pounds
  - 2.52 pounds
  - 789 pounds
  - 400 pounds
78. After calibrating a chemical feed pump in your plant you have determined that its maximum feed rate is 178 mL/min. If this pump ran continuously at this rate how many gallons would it pump in 1 full day ?
- 10.7 gallons
  - 25.6 gallons
  - 256 Gal
  - \*67.7 gallons
  - 17.8 gallons

79. Your chemical supplier charges you \$1.28 / gallon of caustic soda. You have determined you will need approximately 60.1 (55 Gal) drums per year, what would be your annual budget cost for this item ?
- \$14,932.00
  - \$8,833.29
  - \$3,305.50
  - \*\$4,231.04
  - \$6,819.71
80. Your water plant feeds 25% caustic soda (containing 2.67 lbs.dry/gallon) for final pH adjustment. Historic records show your average dose is 6.5 mg/L and average flow is 310 GPM. At this rate how many 55 gallon drums will you use in 1 year?
- 24.2 drums
  - \*60.1 drums
  - 88.3 drums
  - 120 drums
  - 33.1 drums
81. An iron removal plant treats water with an average iron concentration of 3 ppm. If the process removes 90% of the iron and the daily pumpage is 1.5 million gallons, how many pounds of iron are removed per week? Assume 7 day operation.
- \*236 pounds per week
  - 3.75 pounds per week
  - 263 pounds per week
  - 27 pounds per week
82. How many pounds of copper sulfate will be needed to dose a reservoir with 0.6 mg/L copper? The reservoir volume is 30 million gallons. The copper sulfate is 25 percent copper. Select the closest answer.
- 335 pounds
  - 400 pounds
  - 500 pounds
  - \*600 pounds
  - 725 pounds
83. Determine the setting on a dry alum feeder in pounds per day when the flow is 1.2 mgd. Jar tests indicate that the best alum dose is 9 mg/L.
- 70 lbs/day
  - 75 lbs/day
  - \*90 lbs/day
  - 100 lbs/day
  - 130 lbs/day

84. The average daily flow for a water treatment plant is 0.95 mgd. Jar tests indicate that the best polymer dosage is 2.2 mg/L. How many pounds of polymer will be used in 30 days?
- 260 lbs
  - 340 lbs
  - \*523 lbs
  - 412 lbs
  - 437 lbs
85. A water treatment plant used 24 pounds of cationic polymer to treat 1.4 million gallons of water during a 24-hour period. What was the polymer dosage in mg/L?
- 5 mg/L
  - 18 mg/L
  - \*2 mg/L
  - 36 mg/L
  - 48 mg/L
86. Liquid alum delivered to a water treatment plant contains 642.3 milligrams of aluminum per milliliter of liquid solution. Jar tests indicate that the best alum dose is 9 mg/L. Determine the setting on the liquid alum feeder in milliliters per minute when the plant flow is 3.2 mgd.
- \*118 mL/min
  - 72 mL/min
  - 80 mL/min
  - 90 mL/min
  - 105 mL/min
87. A flow of 1.2 mgd will be treated with an 18-percent solution of hydrofluosilicic acid. The raw water does not contain any fluoride and the desired fluoride concentration is 1.4 mg/L. Assume that the hydrofluosilicic weighs 9.5 pounds per gallon and 79.2 percent of the solution is available fluoride. Calculate the hydrofluosilicic acid feed rate in gallons per day.
- 5.8 gpd
  - \*10.3 gpd
  - 11.6 gpd
  - 12.9 gpd
  - 14.5 gpd
88. The raw water alkalinity is 50 mg/L as calcium carbonate. The water is treated by adding 15 mg/L of alum. What is the alkalinity concentration of the finished water?
- 35.0 mg/L
  - 57.5 mg/L
  - 65.0 mg/L
  - \*42.5 mg/L
- Note: Alum consumes 0.5 mg/L of alkalinity for every 1.0 mg/L of alum added.

89. A centrifugal pump is pumping 200 gpm against a 40 ft total pumping head. The output power of the pump is approximately \_\_\_\_\_ hp.
- 0.5
  - \*2
  - 15
  - 121
90. A raw water pump with a 6" bore and a 3" stroke pumps 60 cycles/minute. What is the pumping rate in gpm?
- 18 gpm
  - 26.75 gpm
  - \*22.5 gpm
  - 14.3 gpm
91. What is the flow rate (gpm) from a pump with a discharge diameter of 6" and a velocity of 5 ft/sec?
- 198 gpm
  - \*440 gpm
  - 44 gpm
  - 338.5 gpm
92. What is the pumping rate in gpm of the following piston pump? Diameter = 10 inches, Stroke length = 6 inches, Strokes/min = 30
- 293.6 gpm
  - 86.9 gpm
  - 45.5 gpm
  - \*61.2 gpm
93. A centrifugal pump is pumping 200 gal/min against a 40-foot total pumping head. The approximate output power of is 2 HP. What will the output power be if the pumping head increased to 60 feet?
- 1 hp
  - 2 hp
  - \*3 hp
  - hp
94. A single-piston reciprocating pump has a 6" diameter piston with a 6" length of stroke. It makes 16 discharge strokes/min, the pumping rate is \_\_\_\_\_gpm.
- 6
  - \*12
  - 25
  - 47
95. A pump delivers 240,000 gallons per day at a static head of 275 feet. Calculate the pressure equivalent to this head, expressed in pounds per square inch.
- 275 psi

- b. \*119 psi
  - c. 550 psi
  - d. 635 psi
96. Determine the flow capacity of a pump in gpm if the pump lowers the water in a six-foot square clear well by 8 inches in 5 minutes.
- a. 57.6 gpm
  - b. 92.4 gpm
  - c. 179.5 gpm
  - d. \*35.9 gpm
  - e. 430 gpm
97. What horsepower must a pump deliver to water that must be lifted 90 feet? The flow is 40 gpm.
- a. HP
  - b. 50 HP
  - c. \*0.9 HP
  - d. 60 HP
  - e. 76 HP
98. If the required water horsepower of a pump is 50 HP, what must the motor horsepower be if the efficiency of the pump is 75 percent and the efficiency of the motor is 90 percent?
- a. \*74 HP
  - b. 40.5 HP
  - c. 50 HP
  - d. 89 HP
  - e. 111 HP
99. How many kilowatt-hours per day are required by a pump with a motor horsepower of 50 horsepower when the pump operates 24 hours a day?
- a. 716 kW-hr/day
  - b. 960 kW-hr/day
  - c. \*894 kW-hr/day
  - d. 1,075 kW-hr/day
  - e. 1,287 kW-hr/day
100. Through jar testing, you have determined that your best Alum dose is 5 mg/L. Your liquid alum has a specific gravity of 1.31 and its strength is 49.8%. Your plant flow is 700 GPM. How many mL/min will your chemical feed pump need to pump to produce this residual?
- a. 84.1 mL/min
  - b. 200 mL/min
  - c. 10.1 mL/min
  - d. \*20.3 mL/min
  - e. 42.0 mL/min

101. If the water rate is \$5.50 for the first 500 cu ft and all water used over the minimum is billed at a rate of \$0.25 per 100 cu ft, how much would a customer using 1200 cu ft be billed?
- \$5.25
  - \$6.25
  - \$6.75
  - \*\$7.25
102. Calculate the percent reduction in flows achieved by an industrial water conservation program if water flows are reduced from 350 gpm to 220 gpm
- 31%
  - \*37%
  - 44%
  - 59%
  - 63%
103. A wet well level transmitter says 56% on a scale of 0% to 100%. The full depth of the wet well is 35 ft. How many feet of water are in the wet well?
- 15.2 ft
  - 17.8 ft
  - \*19.6 ft
  - 20.3 ft
- Note: Operations Forum November 1997
104. Of the \$900 allotted for maintenance in the monthly budget, 15 percent was spent on pump repair. How much money was spent?
- \*\$135
  - \$765
  - \$450
  - \$13.5
105. A water treatment plant treats 36,520,000 gallons during the month of July. The total water measured in various storage tanks is 28,710,000 gallons. What percentage of treated water is unaccounted for?
- 78.6%
  - \*21.4%
  - 27.2%
  - 63.0%
106. Scientific notation is a method by which any number can be expressed as a term multiplied by a power of ten, such as  $8.75 \times 10^{-2}$ . Express this number in decimal form.
- \*0.0875
  - 0.875
  - 875.00



- d. 87.5
107. Express 7,960 in scientific notation.
- a.  $7.96 \times 10^3$
  - b.  $7.96 \times 10^{-3}$
  - c.  $7.96 \times 10^5$
  - d. None of these is correct.
108. Last month your Water System pumped 7,106,300 gallons of water into the distribution system. Your system was able to account for 5,264,800 gallons. What was your unaccounted for % of water for this month?
- a. 47.1 %
  - b. 88 %
  - c. 2.95 %
  - d. 25.9 %
  - e. 74.1 %
109. You have replaced  $\frac{3}{4}$  of the water meters in your system. You have a total of 540. How many will you need to complete the task of replacing all the meters?
- a. 195
  - b. 405
  - c. 135
  - d. 275
  - e. 54
110. Your plant's maximum capacity is 1.3 MGD. If you produced 67% of this capacity in one day how many gallons would this be?
- a. 1,100,201 gallons
  - b. 19,402 gallons
  - c. 194,020 gallons
  - d. 87,100 gallons
  - e. 871,000 gallons