

**Registration form**

**WATER TREATMENT SYSTEM SURVEY \$300.00  
48 HOUR RUSH ORDER PROCESSING FEE ADDITIONAL \$50.00**

**Start and Finish Dates:** \_\_\_\_\_

*You will have 90 days from this date in order to complete this course*

List number of hours worked on assignment must match State Requirement. \_\_\_\_\_

**Name** \_\_\_\_\_ **Signature** \_\_\_\_\_

*I have read and understood the disclaimer notice on page 2. Digitally sign XXX*

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**Phone:**

**Home ( \_\_\_\_\_ )** \_\_\_\_\_ **Work ( \_\_\_\_\_ )** \_\_\_\_\_

**Operator ID #** \_\_\_\_\_ **Exp. Date** \_\_\_\_\_

**Class/Grade** \_\_\_\_\_

**Please circle/check which certification you are applying the course CEU's.**

Water Treatment  Water Distribution  Other \_\_\_\_\_

**Technical Learning College TLC PO Box 3060, Chino Valley, AZ 86323  
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## **DISCLAIMER NOTICE**

I understand that it is my responsibility to ensure that this CEU course is either approved or accepted in my State for CEU credit. I understand State laws and rules change on a frequent basis and I believe this course is currently accepted in my State for CEU or contact hour credit, if it is not, I will not hold Technical Learning College responsible. I also understand that this type of study program deals with dangerous conditions and that I will not hold Technical Learning College, Technical Learning Consultants, Inc. (TLC) liable for any errors or omissions or advice contained in this CEU education training course or for any violation or injury or neglect or damage caused by this CEU education training or course material suggestion or error. I will call or contact TLC if I need help or assistance and double-check to ensure my registration page and assignment has been received and graded.

**State Approval Listing Link**, check to see if your State accepts or has pre-approved this course. Not all States are listed. Not all courses are listed. If the course is not accepted for CEU credit, we will give you the course free if you ask your State to accept it for credit.

**Professional Engineers**; Most states will accept our courses for credit but we do not officially list the States or Agencies. Please check your State for approval.

## **State Approval Listing URL...**

<http://www.abctlc.com/downloads/PDF/CEU%20State%20Approvals.pdf>

*You can obtain a printed version of the course manual from TLC for an additional \$89.95 plus shipping charges.*

## **AFFIDAVIT OF EXAM COMPLETION**

I affirm that I personally completed the entire text of the course. I also affirm that I completed the exam without assistance from any outside source. I understand that it is my responsibility to file or maintain my certificate of completion as required by the state or by the designation organization.

## **Grading Information**

In order to maintain the integrity of our courses we do not distribute test scores, percentages or questions missed. Our exams are based upon pass/fail criteria with the benchmark for successful completion set at 70%. Once you pass the exam, your record will reflect a successful completion and a certificate will be issued to you.

## **Rush Grading Service**

If you need this assignment graded and the results mailed to you within a 48-hour period, prepare to pay an additional rush service handling fee of \$50.00. This fee may not cover postage costs. If you need this service, simply write RUSH on the top of your Registration Form. We will place you in the front of the grading and processing line.

For security purposes, please fax or e-mail a copy of your driver's license and always call us to confirm we've received your assignment and to confirm your identity.

# WT SYSTEM SURVEY - Answer Key

Name \_\_\_\_\_

Phone \_\_\_\_\_

Did you check with your State agency to ensure this course is accepted for credit?

You are responsible to ensure this course is accepted for credit.  
Method of Course acceptance confirmation. Please fill this section

Website \_\_\_ Telephone Call \_\_\_ Email \_\_\_ Spoke to \_\_\_\_\_

Did you receive the approval number, if applicable? \_\_\_\_\_

What is the course approval number, if applicable? \_\_\_\_\_

*You can electronically complete this assignment in Adobe Acrobat DC.*

Please Circle, Bold, Underline or X, one answer per question. A **felt tipped pen** works best.

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***Please write down any questions you could not find the answers or that have errors.***

**Please fax the answer key to TLC Western Campus  
Fax (928) 272-0747**

Always call us after faxing the paperwork to ensure that we've received it.

**Rush Grading Service**

If you need this assignment graded and the results mailed to you within a 48-hour period, prepare to pay an additional rush service handling fee of \$50.00.

*This course contains general EPA's SDWA federal rule requirements. Please be aware that each state implements water / sampling procedures/ safety / environmental / SDWA regulations that may be more stringent than EPA's regulations. Check with your state environmental/health agency for more information. These rules change frequently and are often difficult to interpret and follow. Be careful to be in compliance with your regulatory agencies and do not follow this course for any compliance concerns.*



*Please e-mail or fax this survey along with your final exam*

**WATER TREATMENT SYSTEM SURVEY CEU COURSE  
CUSTOMER SERVICE RESPONSE CARD**

NAME: \_\_\_\_\_

E-MAIL \_\_\_\_\_ PHONE \_\_\_\_\_

**PLEASE COMPLETE THIS FORM BY CIRCLING THE NUMBER OF THE APPROPRIATE ANSWER IN THE AREA BELOW.**

Please rate the difficulty of your course.  
Very Easy    0    1    2    3    4    5    Very Difficult

Please rate the difficulty of the testing process.  
Very Easy    0    1    2    3    4    5    Very Difficult

Please rate the subject matter on the exam to your actual field or work.  
Very Similar    0    1    2    3    4    5    Very Different

How did you hear about this Course? \_\_\_\_\_

What would you do to improve the Course?  
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Any other concerns or comments.  
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## Water Treatment System Survey CEU Training Course Assignment

The Water Treatment System Survey CEU course assignment is available in Word on the Internet for your convenience, please visit [www.abctlc.com](http://www.abctlc.com) and download the assignment and e-mail it back to TLC.

You will have 90 days from receipt of this manual to complete it in order to receive your Professional Development Hours (PDHs) or Continuing Education Unit (CEU). A score of 70 % or better is necessary to pass this course. If you should need any assistance, please email or fax all concerns and the completed ANSWER KEY to [info@tlch2o.com](mailto:info@tlch2o.com).

Select one answer per question. Please utilize the answer key. (s) on the answer will indicate either plural and singular tenses.

### Hyperlink to the Glossary and Appendix

<http://www.abctlc.com/downloads/PDF/WTGlossary.pdf>

### Water Distribution Section

#### System Elements

1. Distribution mains function is to carry water from the water source or treatment works to users, these are the pipelines that make up the?

- A. Arterial system
- C. Distribution system
- B. Distribution tree
- D. None of the above

2. Storage reservoirs are structures used to store water and \_\_\_\_\_ the supply or pressure in the distribution system.

- A. Increase water pressure
- C. Provide a reserve pressure for
- B. Equalize
- D. None of the above

3. Booster stations are used to \_\_\_\_\_ from storage tanks for low-pressure mains.

- A. Increase water pressure
- C. Provide a reserve pressure
- B. Equalize
- D. None of the above

4. According to the text, globe valves should only be used in the Arterial system for main line isolation.

- A. True
- B. False

#### Butterfly Valve

5. Butterfly valves are rotary type of valves usually found on large transmission lines, and may also have an additional valve beside it known as a \_\_\_\_\_ to prevent water hammer.

- A. Regulator
- C. PRV
- B. Bypass
- D. None of the above

#### Water Distribution Valves

6. According to the text, at intersections of distribution mains, the number of valves required is normally one less than the number of?

- A. Ties
- C. Depends on customers
- B. Radiating mains
- D. None of the above

7. All buried small- and medium-sized valves shall be installed in the sidewalk for safety.

- A. True
- B. False

8. For large shutoff valves, it may be necessary to surround the valve operator or entire valve within a vault or manhole to allow?

- A. Bluestakes
- B. Dependability
- C. Repair or replacement
- D. None of the above

### Gate Valves

9. In the distribution system, gate valves are used when a straight-line flow of fluid and because of easy repair or replacement.

- A. True
- B. False

10. If the valve is wide open, the gate is \_\_\_\_\_ into the valve bonnet.

- A. Fully drawn up
- B. Fully down
- C. Fully closed
- D. None of the above

11. There is little pressure drop or flow restriction through the gate valves; however, the valves are not suitable for?

- A. Pressure drops
- B. Isolation
- C. Throttling purposes
- D. None of the above

12. The valve's control of flow is easy because of the valve's design, and the flow of fluid

- A. True
- B. False

### Ball Valves

13. Ball valves should be either fully-on or fully-off, some ball valves also contain a swing check located within the ball to give the valve a check valve feature.

- A. True
- B. False

### Valve Exercising

14. Valve exercising should be done to locate inoperable due to freezing or build-up of rust or corrosion and done once per year to detect minimum flow restriction and to prevent valves from becoming

- A. True
- B. False

15. A valve inspection should include drawing valve location maps to show distances to the valve from specific reference.

- A. True
- B. False

16. Over-pressurization is when a valve can \_\_\_\_\_ when high pressure enters the cavity and has no way to escape.

- A. Positive pressure differential
- B. Lock in the open position
- C. Lock in the closed position
- D. None of the above

17. Tuberculation corrosion is caused by chemical changes produced by?

- A. Hard water
- B. Chemical changes
- C. Electricity or electrolysis
- D. None of the above

18. Corrosion will increase the C-Factor and the carrying capacity in a pipe.

- A. True
- B. False

### Common Rotary Valves

19. Globe valve, a rotary valve is rare to find in most distribution systems, but can be found at treatment plants.

- A. True
- B. False

20. Most Globes have compact OS & Y type, bolted bonnet, rising stems, with renewable seat rings.  
A. True                      B. False

### Water Quality Section

#### Three Types of Public Water Systems

21. Provides water to the same population year-round (for example: homes, apartment buildings)  
A. TNCWS    C. NTNCWSs  
B. CWSs      D. None of the above
22. Approximately 85,000 systems  
A. TNCWS    C. NTNCWSs  
B. CWSs      D. None of the above
23. Approximately 18,000 water systems  
A. TNCWS    C. NTNCWSs  
B. CWSs      D. None of the above

### Water Quality Key Words

24. Which of the following is manufactured from aluminum hydroxide by dehydroxylating it in a way that produces a highly porous material?  
A. Activated alumina              C. Aluminum salts  
B. Fluoride                          D. None of the above

### Water Quality Section

#### Surface (Raw) Water Introduction

25. Operators need to appropriately treat surface water is never pure of \_\_\_\_\_, it. Most of the earth's water sources obtain their water supplies through precipitation.  
A. Excess nutrients              C. Pollution  
B. Biological actions            D. None of the above
26. Water passes runoffs and infiltrates the ground during precipitation; this runoff acquires a wide variety of \_\_\_\_\_ that intensely alters its usefulness.  
A. Excess nutrients              C. Dissolved or suspended impurities  
B. Biological actions            D. None of the above

### Surface Water Properties

27. Water is accepted as the \_\_\_\_\_ because will dissolve most substances that comes in contact.  
A. Universal solvent              C. Surface water  
B. Water quality                  D. None of the above
28. Depending on the region, some lakes and rivers receive \_\_\_\_\_ from sewer facilities or defective septic tanks.  
A. Excess nutrients              C. Discharge  
B. Biological actions            D. None of the above
29. Runoff could produce mud, leaves, decayed vegetation, and human and animal refuse. The discharge from industry could increase \_\_\_\_\_. Some lakes and reservoirs may experience seasonal turnover.  
A. Volatile organic compounds    C. Excess nutrients  
B. Water quality                  D. None of the above

30. Adjustments in the dissolved oxygen, algae, temperature, suspended solids, turbidity, and carbon dioxide will change because of \_\_\_\_\_.
- A. Excess nutrients
  - B. Biological actions
  - C. Discharge
  - D. None of the above

### Managing Water Quality at the Source

31. Contingent upon the region, source water may have several restrictions of use as part of a Water Shed Management Plan. In some areas, it may be restricted from recreational use, discharge or runoff from agriculture, or \_\_\_\_\_.
- A. Excess nutrients
  - B. Biological actions
  - C. Industrial and wastewater discharge
  - D. None of the above

32. Another characteristic of quality control is aquatic plants. The ecological equilibrium in lakes and reservoirs plays a natural part in purifying and sustaining the life of the lake. Certain vegetation removes the excess nutrients that would promote the growth of algae. Too much algae will imbalance the lake and kill fish.
- A. True
  - B. False

33. Algae growth is supplied by the energy of the sun. As algae absorbs this energy, it converts carbon dioxide to oxygen. Algae and rooted aquatic plants are essential in the food chain of fish and birds. Algae growth is the result of photosynthesis.
- A. True
  - B. False

34. The absence of dissolved oxygen in water is known as aerobic conditions.
- A. True
  - B. False

35. Most treatment plant upsets are such as taste and odor, color, and filter clogging is due to algae. The type of algae determines the problem it will cause, for instance slime, corrosion, color, and toxicity.
- A. True
  - B. False

### Physical Characteristics of Water

36. Physical characteristics are the elements found that are considered alkali, metals, and non-metals such as carbonates, fluoride, \_\_\_\_\_. The consumer relates it to scaling of faucets or staining.
- A. pH and alkalinity
  - B. Sulfides or acids
  - C. Powdered activated carbon and chlorine
  - D. None of the above

37. Total Dissolved Solids (TDS) is not a primary pollutant; it is a gauge of appealing water characteristics such as hardness and an indication of an assortment of chemical contaminants that might be present, such as?
- A. Turbidity
  - B. Colloids
  - C. Arsenic
  - D. None of the above

38. pH is the negative logarithm of the hydrogen ion concentration,  $[H^+]$ , a measure of the degree to which a solution is \_\_\_\_\_.
- A. Alkalinity
  - B. Acidic or alkaline
  - C. Hydrogen ion ( $H^+$ )
  - D. None of the above

(S) Means the answer can be plural or singular in nature

39. \_\_\_\_\_ is a substance that can give up a hydrogen ion ( $H^+$ ); a base is a substance that can accept  $H^+$ .

- A. Acid
- B. Base
- C. Acidic or alkaline
- D. None of the above

40. The more acidic a solution the greater the hydrogen ion concentration and the lower the pH; a pH of 7.0 indicates neutrality, a pH of less than 7 indicates acidity, and a pH of more than 7 indicates \_\_\_\_\_.

- A. Acid
- B. Base
- C. Alkalinity
- D. None of the above

### Alkalinity

41. Alkalinity is substantial in many uses and treatments of natural waters and wastewaters. Because the alkalinity of many surface waters is primarily a function of carbonate, bicarbonate, and hydroxide content, it is taken as an indication of the concentration of these constituents. The measured values also may include contributions from borates, phosphates, silicates or other bases if these are present.

- A. True
- B. False

42. \_\_\_\_\_ with an overabundance of alkaline earth metal concentrations is significant in determining the suitability of water for irrigation.

- A. Alkalinity
- B. Acid
- C. Hydrogen ion ( $H^+$ )
- D. None of the above

43. Alkalinity measurements are used in the interpretation and control of water and wastewater treatment processes

- A. True
- B. False

44. Alkalinity is a measure of \_\_\_\_\_ and can be interpreted in terms of specific substances only when the chemical composition of the sample is known.

- A. Hydrogen ion ( $H^+$ )
- B. Alkaline earth metal
- C. An aggregate property of water
- D. None of the above

### Turbidity Introduction

45. One physical feature of water is turbidity. A measure of the cloudiness of water caused by \_\_\_\_\_. The cloudy appearance of water caused by the presence of tiny particles.

- A. Suspended particles
- B. Variations
- C. Temperature fluctuation
- D. None of the above

46. High levels of turbidity may inhibit with proper water treatment and monitoring. If high quality raw water is low in turbidity, there will be a reduction in water treatment costs. Turbidity is unwanted because it causes health hazards.

- A. True
- B. False

47. The turbidity in natural surface waters is composed of a large number of sizes of particles. The sizes of particles can be changing constantly, depending on precipitation and \_\_\_\_\_ factors.

- A. MCL
- B. Manmade
- C. Temperature
- D. None of the above

48. Low \_\_\_\_\_ waters can be very difficult to coagulate due to the difficulty in inducing collision between the colloids.

- A. Turbidity
- B. Colloids
- C. Total Dissolved Solids (TDS)
- D. None of the above

49. \_\_\_\_\_ may be existing in a water supply due to pollution, and these colloids can be difficult to remove in the coagulation process. In this situation, higher coagulant dosages are generally required.

- A. Turbidity
- B. Organic colloids
- C. Total Dissolved Solids (TDS)
- D. None of the above

### **Turbidity MCL**

50. An MCL for turbidity established by the EPA because \_\_\_\_\_ interferes with disinfection. This characteristic of water changes the most rapidly after a heavy rainfall.

- A. Conductivity
- B. Turbidity
- C. Temperature
- D. None of the above

### **Dissolved Oxygen**

51. The level of dissolved oxygen in natural waters is often a direct indication of quality, since aquatic plants produce oxygen, while microorganisms generally consume it as they feed on \_\_\_\_\_.

- A. Pollutants
- B. Organic matter
- C. E. coli bacteria
- D. None of the above

52. At low temperatures, the \_\_\_\_\_ is increased, so that in winter, concentrations as high as 20 ppm may be found in natural waters; during summer, saturation levels can be as low as 4 or 5 ppm.

- A. Dissolved oxygen
- B. Thermal stratification
- C. Solubility of oxygen
- D. None of the above

53. \_\_\_\_\_ is essential for the support of fish and other aquatic life and aids in the natural decomposition of organic matter.

- A. Dissolved oxygen
- B. Thermal stratification
- C. Solubility of oxygen
- D. None of the above

54. Thermal stratification is possible as water becomes less dense when heated; meaning water weighs less per unit volume. Therefore, warmer water will be lighter and colder water will be heavier. Due to this, there will always be a level of "self-induced" \_\_\_\_\_ in a water storage.

- A. Saturation level(s)
- B. Thermal stratification
- C. Permanent hardness
- D. None of the above

### **Objections to Hard Water**

#### **Scale Formation**

55. Hard water forms scale, usually \_\_\_\_\_, which causes a variety of problems. Left to dry on the surface of glassware and plumbing fixtures, including showers doors, faucets, and sink tops; hard water leaves unsightly white scale known as water spots.

- A. Magnesium carbonate
- B. Calcium carbonate
- C. Calcite
- D. None of the above



### Secondary Standard

56. TDS is most often measured in parts per million (ppm) or milligrams per liter of water (mg/L). The normal TDS level ranges from \_\_\_\_\_

- A. 50 ppm to 1,000 ppm
- B. 5 ppm to 10 ppm
- C. 50 ppm to 100 ppm
- D. None of the above

57. The Environmental Protection Agency (EPA), which is responsible for drinking water regulations in the United States, has identified TDS as a secondary standard, meaning that it is a voluntary guideline. While the United States set legal standards for many harmful substances, TDS, along with other contaminants that cause aesthetic, cosmetic, and technical effects, has only a guideline.

- A. True
- B. False

### Langelier Saturation Index

58. The Langelier Saturation index (LSI) is an evenness scale derived from the theoretical concept of saturation and provides an indicator of the degree of saturation of water with respect to calcium carbonate. It can be shown that the Langelier saturation index (LSI) approximates the base 10 logarithm of the \_\_\_\_\_ saturation level.

- A. Magnesium carbonate
- B. Calcium carbonate
- C. Calcite
- D. None of the above

59. The Langelier saturation level approaches the concept of saturation using pH as a main variable. The LSI can be interpreted as the pH change required to bring water to \_\_\_\_\_.

- A. Saturation level(s)
- B. Stratification
- C. Equilibrium
- D. None of the above

### More on the Stage 2 DBP Rule

60. Which of the following rules focuses on public health protection by limiting exposure to DBPs, specifically total trihalomethanes and five haloacetic acids, which can form in water through disinfectants used to control microbial pathogens?

- A. Stage 2 DBP rule
- B. Stage 1 DBPR
- C. Long Term 2 Enhanced Surface Water Treatment Rule
- D. None of the above

61. Safe Drinking Water Act (SDWA) has been highly effective in protecting public health and has evolved to respond to new and emerging threats to safe drinking water.

- A. True
- B. False

62. There are specific microbial pathogens, such as \_\_\_\_\_, which can cause illness, and are highly resistant to traditional disinfection practices.

- A. Cryptosporidium
- B. E. coli host culture
- C. Protozoa
- D. None of the above

63. The Stage 1 Disinfectants and Disinfection Byproducts Rule and \_\_\_\_\_, promulgated in December 1998.

- A. Stage 1 DBPR
- B. Stage 2 DBPR
- C. Interim Enhanced Surface Water Treatment Rule
- D. None of the above

64. Which of the following rules will reduce potential cancer and reproductive and developmental health risks from disinfection byproducts?

- A. Stage 1 DBPR
- B. Stage 2 DBPR
- C. Long Term 2 Enhanced Surface Water Rule
- D. None of the above

### What are Disinfection Byproducts (DBPs)?

65. Which of the following form when disinfectants used to treat drinking water react with naturally occurring materials in the water?

- A. Chloramines
- B. Humic and fulvic acids
- C. Disinfection byproducts (DBPs)
- D. None of the above

66. Total trihalomethanes and haloacetic acids are widely occurring \_\_\_\_\_ formed during disinfection with chlorine and chloramine.

- A. Gases
- B. Substances
- C. Classes of DBPs
- D. None of the above

### Are THMs and HAAs the only disinfection byproducts?

67. The presence of TTHM and HAA5 is representative of the occurrence of many other chlorination DBPs; thus, an increase of TTHM and HAA5 generally indicates an increase of DBPs from chlorination.

- A. True
- B. False

### All disinfectants form DBPs in one of two reactions:

68. Chlorine and chlorine-based compounds (halogens) react with organics in water causing the hydrogen atom to substitute other atoms, resulting in halogenated by-products.

- A. True
- B. False

69. Secondary by-products are also formed when multiple disinfectants are used.

- A. True
- B. False

70. The EPA Surface Water Treatment Rule (SWTR) requires systems using public water supplies from either surface water or groundwater under the direct influence of surface water to disinfect.

- A. True
- B. False

### Public Health Concerns

71. Results from toxicology studies have shown several DBPs (e.g., bromodichloromethane, bromoform, chloroform, dichloroacetic acid, and bromate) to be inert to laboratory animals.

- A. True
- B. False

72. Other DBPs (e.g., chlorite, bromodichloromethane, and certain haloacetic acids) have also been shown to cause adverse mutations (extra chromosomes) in laboratory animals.

- A. True
- B. False

### Disinfection Byproduct Research and Regulations Summary

#### The IPCS (IPCS 2000, p. 375) reached similar conclusions:

73. \_\_\_\_\_ is unquestionably the most important step in the treatment of water for drinking water supplies.

- A. DBP(s)
- B. Turbidity (particle)
- C. Disinfection
- D. None of the above

74. The \_\_\_\_\_ should not be compromised because of concern over the potential long-term effects of disinfectants and DBPs.

- A. DBP(s)
- B. Turbidity (particle)
- C. Microbial quality of drinking water
- D. None of the above

75. The risk of illness and death resulting from exposure to pathogens in drinking water is very much greater than the risks from \_\_\_\_\_.

- A. Disinfectants and DBPs
- B. Turbidity (particle)
- C. Natural organic matter precursors
- D. None of the above

### Controlling Disinfection Byproducts

76. Treatment techniques are available that provide water suppliers the opportunity to maximize potable water safety and quality while minimizing the risk of \_\_\_\_\_.

- A. DBP risks
- B. Turbidity (particle)
- C. Disinfectants and DBPs
- D. None of the above

77. Generally, the best approach to reduce \_\_\_\_\_ is to remove natural organic matter precursors prior to disinfection.

- A. DBP(s)
- B. Turbidity (particle)
- C. DBP formation
- D. None of the above

### The EPA guidance discusses three processes to effectively remove natural organic matter prior to disinfection:

#### Coagulation and Clarification

78. Most treatment plants optimize their coagulation process for \_\_\_\_\_ removal.

- A. Inorganic coagulants
- B. Most contaminants
- C. Turbidity (particle)
- D. None of the above

79. Coagulation processes can also be optimized for natural organic matter removal with higher doses of \_\_\_\_\_ (such as alum or iron salts), and optimization of pH.

- A. THMs and HAAs
- B. Inorganic coagulants
- C. Natural organic matter
- D. None of the above

#### Absorption

80. Activated carbon can be used to absorb \_\_\_\_\_ that react with disinfectants to form byproducts.

- A. Inorganic coagulants
- B. Most contaminants
- C. Soluble organics
- D. None of the above

#### Membrane Technology

81. Membranes, used historically to desalinate brackish waters, have also demonstrated excellent removal of \_\_\_\_\_.

- A. THMs and HAAs
- B. Optimization of pH
- C. Natural organic matter
- D. None of the above

82. Membrane processes use hydraulic pressure to force water through a semi-permeable membrane that rejects most \_\_\_\_\_. Variations of this technology include reverse osmosis (RO), nanofiltration (low pressure RO), and microfiltration (comparable to conventional sand filtration).

- A. Inorganic coagulants
- B. Contaminants
- C. Insoluble organics
- D. None of the above

83. Other conventional methods of reducing DBP formation include changing the point of chlorination and using \_\_\_\_\_ for residual disinfection.

- A. Free residual disinfection
- B. Chloramines
- C. Total residual disinfection
- D. None of the above

84. EPA predicted that most water systems will be able to achieve compliance with new DBP regulations through the use of one or more of these relatively low cost methods (EPA, 1998). Water system managers may also consider switching from chlorine to alternative disinfectants to reduce formation of \_\_\_\_\_.

- A. THMs and HAAs
- B. Optimization of pH
- C. Natural organic matter
- D. None of the above

### Organisms Descriptors and Meanings

85. Litho means...

- A. Rock
- B. Organic
- C. Light
- D. None of the above

86. Organo means...

- A. Rock
- B. Organic
- C. Light
- D. None of the above

87. Photo means...

- A. Feed or nourish
- B. Other (Organic carbon)
- C. Light
- D. None of the above

88. Troph means...

- A. Feed or nourish
- B. Other (Organic carbon)
- C. Light
- D. None of the above

89. Auto means...

- A. Without air
- B. With air
- C. Self (Inorganic carbon)
- D. None of the above

90. Facultative means...

- A. Without air
- B. With air or without air
- C. Self (Inorganic carbon)
- D. None of the above

91. Aerobic means...

- A. Without air
- B. With air
- C. Self (Inorganic carbon)
- D. None of the above

92. Chemo means...

- A. Rock
- B. Organic
- C. Chemical
- D. None of the above

93. Hetero means...

- A. Feed or nourish
- B. Other (Organic carbon)
- C. Light
- D. None of the above

94. Anaerobic means...

- A. Without air
- B. With air
- C. Self (Inorganic carbon)
- D. None of the above

**Contaminants that may be present in sources of drinking water include:**

95. Which of the following like salts and metals, which can be naturally occurring or result from urban stormwater runoff, industrial or domestic wastewater discharges, oil and gas production, mining or farming?

- A. Radioactive contaminants
- B. Pesticides and herbicides
- C. Inorganic contaminants
- D. Microbial contaminants

96. Which of the following may come from a variety of sources such as agriculture, urban stormwater run-off, and residential uses?

- A. Radioactive contaminants
- B. Pesticides and herbicides
- C. Inorganic contaminants
- D. Microbial contaminants

97. Which of the following, such as viruses and bacteria may come from sewage treatment plants, septic systems, agricultural livestock operations and wildlife?

- A. Microbial contaminants
- B. Pesticides and herbicides
- C. Inorganic contaminants
- D. All of the above

98. Which of the following can be synthetic and volatile organic chemicals, which are by-products of industrial processes and petroleum production, and can come from gas stations, urban stormwater run-off, and septic systems?

- A. Organic chemical contaminants
- B. Pesticides and herbicides
- C. Inorganic contaminants
- D. Microbial contaminants

99. Which of the following can be naturally occurring or be the result of oil and gas production and mining activities?

- A. Radioactive contaminants
- B. Pesticides and herbicides
- C. Inorganic contaminants
- D. Microbial contaminants

**Background**

100. Coliform bacteria and chlorine residual are the only routine sampling and monitoring requirements for small ground water systems with chlorination. The coliform bacteriological sampling is governed by the Coliform Reduction amendment of the SDWA.

- A. True
- B. False

**TCR**

101. The TCR recommends most of the Public Water Systems (PWS) to monitor their distribution system for bacteria according to the written sample sitting plan for that system.

- A. True
- B. False

102. The sample sitting plan identifies sampling frequency and locations throughout the distribution system that are selected to be representative of conditions in the entire system.

- A. True
- B. False

103. Coliform contamination may occur anywhere in the system, possibly due to problems such as; high-pressure conditions, line fluctuations, or wells, and therefore routine monitoring is required.

- A. True
- B. False

### **Routine Sampling Requirements**

104. Total coliform samples must be collected by PWSs at sites that are representative of water quality throughout the distribution system according to a written sample siting plan subject to state review and revision.

- A. True      B. False

105. For PWSs collecting more than one sample per month, collect total coliform samples at regular intervals throughout the month, except that ground water systems serving 4,900 or fewer people may collect all required samples on a single day if the samples are taken from different sites.

- A. True      B. False

106. Each total coliform-positive (TC+) routine sample must be tested for the presence of heterotrophic bacteria.

- A. True      B. False

107. If any TC+ sample is also E. coli-positive (EC+), then the EC+ sample result must be reported to the state by the end of the month that the PWS is notified.

- A. True      B. False

108. If any routine sample is TC+, repeat samples are required. – PWSs on quarterly or annual monitoring must take a minimum of one additional routine samples (known as additional routine monitoring) the quarter following a TC+ routine or repeat sample.

- A. True      B. False

109. Reduced monitoring is general available for PWSs using only surface water and serving 1,000 or fewer persons that meet certain additional PWS criteria.

- A. True      B. False

### **Dangerous Waterborne Microbes**

110. Which of the following is a parasite that enters lakes and rivers through sewage and animal waste. It causes cryptosporidiosis, a mild gastrointestinal disease. The disease can be severe or fatal for people with severely weakened immune systems.

- A. Coliform Bacteria    C. Giardia lamblia  
B. Cryptosporidium    D. None of the above

111. Which of the following are not necessarily agents of disease may indicate the presence of disease-carrying organisms?

- A. Fecal coliform bacteria    C. Shigella dysenteriae  
B. Cryptosporidium            D. None of the above

112. Which of the following is a parasite that enters lakes and rivers through sewage and animal waste. It causes gastrointestinal illness?

- A. Coliform Bacteria    C. Protozoa  
B. Cryptosporidium    D. None of the above

113. Which of the following is a species of the rod-shaped bacterial genus Shigella?

- A. Fecal coliform bacteria    C. Shigella dysenteriae  
B. Cryptosporidium            D. None of the above

114. Which of the following can cause bacillary dysentery?

- A. Fecal coliform bacteria
- B. Cryptosporidium
- C. Shigella
- D. None of the above

115. Which of the following are Gram-negative, non-spore-forming, facultatively anaerobic, non-motile bacteria.

- A. Fecal coliform bacteria
- B. Cryptosporidium
- C. Shigellae
- D. None of the above

116. Which of the following are microscopic organisms that live in the intestines of warm-blooded animals? They also live in the waste material, or feces, excreted from the intestinal tract. When fecal coliform bacteria are present in high numbers in a water sample, it means that the water has received fecal matter from one source or another.

- A. Fecal coliform bacteria
- B. Cryptosporidium
- C. Shigella dysenteriae
- D. None of the above

117. Which of the following are common in the environment and are generally not harmful? However, the presence of these bacteria in drinking water are usually a result of a problem with the treatment system or the pipes which distribute water, and indicates that the water may be contaminated with germs that can cause disease.

- A. Coliform Bacteria
- B. Cryptosporidium
- C. Giardia lamblia
- D. None of the above

118. Which of the following are bacteria whose presence indicates that the water may be contaminated with human or animal wastes? Microbes in these wastes can cause short-term effects, such as diarrhea, cramps, nausea, headaches, or other symptoms.

- A. Fecal Coliform and E. coli
- B. Cryptosporidium
- C. Shigella dysenteriae
- D. None of the above

### **Bacteriological Monitoring Introduction**

119. According to the text, the routine microbiological analysis of your water is for?

- A. Contamination
- B. Colloids
- C. Coliform bacteria
- D. None of the above

### **Bacteria Sampling**

120. Water samples for \_\_\_\_\_ must always be collected in a sterile container.

- A. Amoebas
- B. Bacteria tests
- C. Viruses
- D. None of the above

### **Methods**

121. The MMO-MUG test, a product marketed as \_\_\_\_\_, is the most common. The sample results will be reported by the laboratories as simply coliforms present or absent.

- A. Colilert
- B. Coliform
- C. Total coliform analysis
- D. None of the above

### **Microbial Regulations**

122. One of the key regulations developed and implemented by the United States Environmental Protection Agency (USEPA) to counter pathogens in drinking water is the Surface Water Treatment Rule.

- A. True
- B. False

(S) Means the answer can be plural or singular in nature

123. Among Surface Water Treatment Rule provisions, the rule requires that a public water system, using surface water (or ground water under the direct influence of surface water) as its source, have sufficient treatment to reduce the source water concentration of protozoa and coliform bacteria by at least 99.9% and 99.99%, respectively.

- A. True                      B. False

124. The Surface Water Treatment Rule suggests treatment criteria to assure that these performance recommendations are met; they may include turbidity limits, disinfectant residual and disinfectant contact time conditions.

- A. True                      B. False

### **Basic Types of Water Samples**

125. It is important to properly identify the type of sample you are collecting.

- A. True                      B. False

### **The three (3) types of samples are:**

126. Samples collected following a coliform present routine sample. The number of repeat samples to be collected is based on the number of \_\_\_\_\_ samples you normally collect.

- A. Repeat      C. Routine  
B. Special      D. None of the above

127. A PWS fails to take every required repeat sample after any single TC+ sample

- A. Trigger: Level 1 Assessment      C. All of the above  
B. Trigger: Level 2 Assessment      D. None of the above

128. A PWS on state-approved annual monitoring has a Level 1 Assessment trigger in 2 consecutive years.

- A. Trigger: Level 1 Assessment      C. All of the above  
B. Trigger: Level 2 Assessment      D. None of the above

129. A PWS collecting fewer than 40 samples per month has 2 or more TC+ routine/ repeat samples in the same month.

- A. Trigger: Level 1 Assessment      C. All of the above  
B. Trigger: Level 2 Assessment      D. None of the above

### **Maximum Contaminant Levels (MCLs)**

130. State and federal laws establish standards for drinking water quality. Under normal circumstances when these standards are being met, the water is safe to drink with no threat to human health. These standards are known as maximum contaminant levels (MCL).

- A. True                      B. False

131. When a particular contaminant exceeds its MCL no potential health threats will occur.

- A. True                      B. False

132. The MCLs are based on extensive research on toxicological properties of the contaminants, risk assessments and factors, short-term (acute) exposure, and long-term (chronic) exposure. You conduct the monitoring to make sure your water is in compliance with the MCL.

- A. True                      B. False



133. There are two types of MCL violations for coliform bacteria. The first is for total coliform; the second is an acute risk to health violation characterized by the confirmed presence of fecal coliform or E. coli.

- A. True                      B. False

**Positive or Coliform Present Results**

134. If you are notified of a positive coliform test result you need to contact either the Drinking Water Program or your local county health department within 72 hours, or by the next business day after the MCL compliance violation

- A. True                      B. False

135. With a positive total coliform sample, after you have contacted an agency for assistance, you will be instructed as to the proper repeat sampling procedures and possible corrective measures for solving the problem. It is very important to initiate the \_\_\_\_\_ as the corrective measures will be based on those results.

- A. Perform routine procedures              C. Corrective measures  
B. Repeat sampling immediately              D. None of the above

**Heterotrophic Plate Count HPC**

136. Heterotrophic Plate Count (HPC) --- formerly known as the Bac-T plate, is a procedure for estimating the number of live heterotrophic bacteria and measuring changes during water treatment and distribution in water or in swimming pools.

- A. True                      B. False

**Heterotrophic Plate Count (Spread Plate Method)**

137. Which of the following provides a technique to quantify the bacteriological activity of a sample?

- A. Colonies              C. Heterotrophic Plate Count  
B. Agar                      D. None of the above

**Total Coliforms**

138. This MCL is based on the presence of total coliforms, and compliance is on a daily or weekly basis, depending on your water system type and state rule.

- A. True                      B. False

139. For systems which collect fewer than \_\_\_\_\_ samples per month, no more than one sample per month may be positive. In other words, the second positive result (repeat or routine) in a month or quarter results in a MCL violation.

- A. 40                      C. 200  
B. 100                      D. None of the above

**The following are acute violations:**

140. Which determines a violation of nitrate?

- A. Presence              C. MCLG  
B. MCL                      D. None of the above

**Revised Total Coliform Rule (RTCR) Summary**

141. EPA published the Revised Total Coliform Rule (RTCR) in the Federal Register (FR) on February 13, 2013 (78 FR 10269). It is the revision to the 1989 Total Coliform Rule (TCR).

- A. True                      B. False

142. The RTCR upholds the purpose of the 1989 TCR to protect public health by ensuring the duplicity of the drinking water distribution system and monitoring for the absence of microbial contamination.

- A. True      B. False

143. The RTCR establishes criteria for systems to qualify for and stay on for special increased monitoring, which could reduce water system problems for better system operation.

- A. True      B. False

144. The water provider shall develop and follow a sample-siting plan that designates the PWS's collection schedule. This includes location of \_\_\_\_\_.

- A. Routine and repeat water samples      C. Microbial contamination  
B. Reduced monitoring      D. Repeat water samples

145. The water provider shall collect \_\_\_\_\_ on a regular basis (monthly, quarterly, annually). Have samples tested for the presence of total coliforms by a state certified laboratory.

- A. Routine water samples      C. Microbial contamination  
B. Reduced monitoring      D. Repeat water samples

146. PN is required for violations incurred. Within required timeframes, the PWS must use the required health effects language and notify the public if they did not comply with certain requirements of the RTCR. The type of \_\_\_\_\_ depends on the severity of the violation.

- A. CCR(s)      C. MCL violation  
B. PN      D. TC+ routine or repeat sample

147. The RTCR requires public water systems that are vulnerable to microbial contamination to identify and fix problems.

- A. True      B. False

148. The water provider shall collect repeat samples (at least 3) for each TC+ positive routine sample.

- A. True      B. False

149. For PWSs on quarterly or annual routine sampling, collect additional routine samples (at least 3) in the month after a \_\_\_\_\_.

- A. CCR(s)      C. Total coliform positive samples  
B. PN      D. TC+ routine or repeat sample

150. PWSs incur violations if they do not comply with the requirements of the RTCR. The violation types are essentially the same as under the TCR with few changes. The biggest change is no acute or monthly MCL violation for \_\_\_\_\_ only.

- A. CCR(s)      C. Total coliform positive samples  
B. PN      D. TC+ routine or repeat sample

151. Community water systems (CWSs) must use specific language in their CCRs when they must conduct an assessment or if they incur \_\_\_\_\_.

- A. CCR(s)      C. An E. coli MCL violation  
B. PN      D. TC+ routine or repeat sample

152. The water provider shall analyze all \_\_\_\_\_ that are total coliform positive (TC+) for E. coli.

- A. Routine or repeat water samples
- B. Reduced monitoring
- C. Microbial contamination
- D. Repeat water samples

153. The RTCR requires public water systems (PWSs) to meet a legal limit for E. coli, as demonstrated by required monitoring.

- A. True
- B. False

154. The RTCR suggests the frequency and timing of required microbial testing based on, public water type and source water type.

- A. True
- B. False

### Disinfection Key

155. The RTCR requires 99.99% or 4 log inactivation of \_\_\_\_\_ .

- A. Enteric viruses
- B. Crypto
- C. Giardia lamblia cysts
- D. None of the above

156. The RTCR requires 99% or 2 log inactivation of \_\_\_\_\_ .

- A. Enteric viruses
- B. Crypto
- C. Giardia lamblia cysts
- D. None of the above

157. The RTCR requires 99.9% or 3 log inactivation of \_\_\_\_\_ .

- A. Enteric viruses
- B. Crypto
- C. Giardia lamblia cysts
- D. None of the above

158. The RTCR requires the chlorine residual leaving the plant must be = or \_\_\_\_\_ mg/L and measurable throughout the system.

- A. > 0.2
- B. 2.0
- C. 0.2
- D. None of the above

### Waterborne Pathogen Section - Introduction

#### Pathogen Section

159. Most pathogens are generally associated with diseases that \_\_\_\_\_ and affect people in a relatively short amount of time, generally a few days to two weeks.

- A. Cause intestinal illness
- B. Are mild in nature
- C. Will cause fatalities
- D. None of the above

#### How Diseases are Transmitted.

160. Waterborne pathogens are primarily spread by the?

- A. Fecal-oral, or feces-to-mouth route
- B. Dermal to fecal route
- C. Oral to fecal route
- D. None of the above

#### Protozoan Caused Diseases

161. Which of the following bugs is larger than bacteria and viruses but still microscopic; they invade and inhabit the gastrointestinal tract?

- A. Hepatitis A
- B. E.coli
- C. Protozoan pathogens
- D. None of the above

162. Some of the parasites enter the environment in a dormant form, with a protective cell wall, called a?

- A. Lamblia
- B. Shell
- C. Cyst
- D. None of the above

### **Giardia lamblia**

163. Which of the following bugs has been responsible for more community-wide outbreaks of disease in the U.S. than any other, and drug treatment are not 100% effective?

- A. Giardia lamblia
- B. Cryptosporidiosis
- C. Giardiasis
- D. None of the above

### **Primary Waterborne Diseases Section**

164. Vibrio cholerae, the basics. It's a virus. It causes diarrheal illness, also known as cholera. It is typically associated with aquatic environments, shell stocks, and human. Vibrio cholerae has also been associated with ship ballast water.

- A. True
- B. False

165. Legionnaire's disease, which causes a severe pneumonia, and the second, \_\_\_\_\_, which is a non-pneumonia illness; it's typically an influenza-like illness, and it's less severe.

- A. Pontiac fever
- B. Yellow fever
- C. Typhoid fever
- D. None of the above

166. Legionella, prevention. Legionella in water systems. Hot water in tanks should be maintained between \_\_\_\_\_degrees Centigrade.

- A. 81 to 100
- B. 110 to 210
- C. 71 and 77
- D. None of the above

167. Which of the following is typically associated with soil and water?

- A. Hepatitis A virus
- B. Legionella
- C. Pseudomonas
- D. None of the above

168. Schistosomatidae, the basics. It is a parasite. It is acquired through dermal contact, cercarial dermatitis. It is commonly known as?

- A. Swimmer's itch
- B. Beaver fever
- C. Hemorrhagic colitis
- D. None of the above

169. Schistosomatidae prevention strategies for this pathogen include Placing boric acid on berms or interrupting the life cycle of the parasite by treating birds with a lead.

- A. True
- B. False

### **Waterborne Bacterial Diseases**

170. Campylobacteriosis outbreaks have most often been associated with food, especially chicken and un-pasteurized milk, as well as un-chlorinated water. These organisms are also an important cause of "travelers' diarrhea." Medical treatment generally is not prescribed for campylobacteriosis because recovery is usually rapid.

- A. True
- B. False

171. Cholera, Legionellosis, salmonellosis, shigellosis, yersiniosis, are other bacterial diseases that can be transmitted through water. All bacteria in water are readily killed or inactivated with chlorine or other disinfectants.

- A. True
- B. False

172. Campylobacteriosis is the most common diarrheal illness caused by bacteria. Other symptoms include abdominal pain, malaise, fever, nausea and vomiting; and begin three to five days after exposure. The illness is frequently over within two to five days and usually lasts no more than 10 days.

- A. True      B. False

### **Chain of Custody Procedures**

173. If both parties involved in the transfer must sign, date and note the time on the chain of custody record, this is known as?

- A. TC Plan      C. Samples transfer possession  
B. Sample siting plan      D. None of the above

175. The recipient will then attach the \_\_\_\_\_ showing the transfer dates and times to the custody sheets.

- A. Shipping invoices      C. Sample siting plan  
B. Chain of custody release      D. None of the above

175. If the samples are split and sent to more than one laboratory, prepare one chain of custody record for all the samples.

- A. True      B. False

### **Factors in Chlorine Disinfection: Concentration and Contact Time**

176. The CXT formula demonstrates that if an operator chooses to decrease the chlorine concentration, the required \_\_\_\_\_ must be lengthened.

- A. Chlorine concentration      C. Contact time  
B. Temperature      D. None of the above

177. As \_\_\_\_\_ are used, contact times may be reduced.

- A. Chlorine concentration      C. Higher strength chlorine solutions  
B. Temperature      D. None of the above

### **Water Treatment Section - Preliminary Treatment Process**

#### **Preliminary Treatment**

178. Weeds, leaves, and trash, if not removed, these will cause problems to the treatment plant's pumps and equipment, the best way to protect the plant is?

- A. Screening      C. Change source  
B. Super settling      D. None of the above

179. According to the text, wire mesh screens need maintenance and require?

- A. Manual cleaning      C. No cleaning  
B. PM cleaning      D. None of the above

180. Mechanical bar screens vary in size and use some type of horizontal raking mechanism that travels horizontally down the bars to scrap the debris off.

- A. True      B. False

#### **Pre-Sedimentation**

181. Sand and grit will damage plant equipment and pipes, so it must be removed with either rectangular or round shaped basin are called?

- A. Filtration basin(s)      C. Sedimentation basin(s)  
B. Coagulation basin(s)      D. None of the above

182. Which of the following treatment terms is used after the flocculation process?

- A. Filtration basin(s)
- B. Coagulation basin(s)
- C. Sedimentation basin(s)
- D. None of the above

183. Scrapers on the bottom move the settled sludge to one or more hoppers at the influent end of the tank, it may have a \_\_\_\_\_ or traveling bridge used to collect the sludge.

- A. Screw conveyor
- B. Conveyor belts
- C. Manual skimmer
- D. None of the above

184. Most clarifiers will have baffles to prevent backflow from entering the effluent.

- A. True
- B. False

### Flights and Chains

185. Flights and chains remove the scum from the \_\_\_\_\_ of the basin.

- A. Scum box
- B. Surface
- C. Armature
- D. None of the above

186. The flights are usually concrete flights mounted on parallel chains and the motor shaft is connected through a shaft which turns the gear.

- A. True
- B. False

187. To prevent damage to the flights and chains due to overloads, a \_\_\_\_\_ is used.

- A. Bearing
- B. Reducer
- C. Shear pin
- D. None of the above

### Circular Clarifiers

188. The most common type of circular clarifier has a center pier or column.

- A. True
- B. False

189. Which of the following systems use graded silica sand filter media?

- A. Conventional technology
- B. Reconditioning cycle
- C. Chemical pretreatment
- D. None of the above

190. Filtration occurs only within the last few inches of the coarser materials at the bottom of the bed.

- A. True
- B. False

191. The media become progressively finer and denser in the lower layers.

- A. True
- B. False

192. As suspended particles accumulate in a Filter bed, the pressure drop through the filter increases.

- A. True
- B. False

193. According to the text, when the pressure difference between filter inlet and outlet increases by 5 - 10 psi from the beginning of the cycle, the filter should be reconditioned. Operating beyond this pressure drop increases the chance of fouling - called " Mud-balling " - within the filter.

- A. True
- B. False

194. Which of the following processes uses alum and cationic polymer to neutralize the charge of colloidal particles?

- A. Filtration
- B. Reconditioning
- C. Flocculation
- D. None of the above

195. Which of the following compounds combines with alkalinity in the raw water to form a white precipitate that neutralizes suspended particles' electrical charge?

- A. Activated sodium
- B. PAC
- C. Alum
- D. None of the above

196. Which of the following systems uses a 30 to 50 mg/L alum dosage to form a large floc that requires extensive retention time to permit settling?

- A. Conventional technology
- B. Chemical pretreatment
- C. Slow Sand Filtration
- D. None of the above

197. Which of the following processes lasts about 5 to 10 minutes?

- A. Filter-to-Waste
- B. Reconditioning cycle
- C. Fast rinse
- D. None of the above

198. Which of the following terms is often used to enhance filter performance?

- A. Conventional technology
- B. Chemical pretreatment
- C. Fast rinse
- D. None of the above

199. Feeding chemicals such as alum, ferric chloride, or a cationic polymer neutralizes the particle charges, allowing the particles to cling to one another and be trapped by the filter media.

- A. True
- B. False

200. Which of the following terms may increase filtered water clarity, measured in NTU, by 90% compared with filtration alone?

- A. Chemical pretreatment
- B. Reconditioning cycle
- C. Fast rinse
- D. None of the above

201. Water treatment systems use settling tanks unit to allow for\_\_\_\_\_.

- A. Gravity
- B. Particle(s)
- C. Settling time
- D. Sedimentation and settling

202. The main aim of tube settlers is to minimize the \_\_\_\_\_ that a small floc particle must settle before agglomerating into larger particles.

- A. Gravity
- B. Vertical distance
- C. Settling time
- D. Solids

203. Water treatment is a major requirement both for raw water for drinking and wastewater management, both have particles that need to sediment in order to obtain clear water.

- A. True
- B. False

204. Tube settler design reduces the depth significantly compared to the conventional clarifier. This helps in reduction of \_\_\_\_\_.

- A. Gravity
- B. Particle(s)
- C. Settling time
- D. Solids

### Conventional Water Treatment Process Introduction

205. \_\_\_\_\_ along with pre-chlorination for removal of dissolved iron when present with small amounts relative of manganese
- A. Disinfection      C. Pre-treatment  
B. Coagulation      D. Aeration
206. \_\_\_\_\_ to remove particles from water either by passage through a sand bed that can be washed and reused or by passage through a purpose- designed filter that is washable.
- A. Disinfection      C. Pre-treatment  
B. Coagulation      D. Filtration
207. \_\_\_\_\_ for killing bacteria viruses and other pathogens.
- A. Disinfection      C. Pre-treatment  
B. Coagulation      D. Aeration along with pre-chlorination
208. \_\_\_\_\_ or slow-sand filtration
- A. Disinfection      C. Pre-treatment  
B. Coagulation      D. Coagulation or flocculation
209. \_\_\_\_\_ for algae control and arresting biological growth
- A. Sodium hydroxide      C. Pre-treatment  
B. UV      D. Ferric Chloride
210. Coagulant aids, also known as polyelectrolytes – to improve \_\_\_\_\_ and for more robust floc formation
- A. Disinfection      C. Pre-treatment  
B. Coagulation      D. Aeration along with pre-chlorination
211. \_\_\_\_\_ for settling and the removal of suspended solids trapped in the floc
- A. Disinfection      C. Pre-treatment  
B. Coagulation      D. Sedimentation

### Treatment Design and Plant Operation

212. SCADA (Supervisory Control and Data Acquisition) automation of water treatment is common in the US. Source water quality through the seasons, scale, and environmental impact can dictate capital costs and operating costs. End use of the treated water dictates the necessary quality monitoring technologies.
- A. True      B. False

### SWTR Rule

213. Turbidity is caused by particles suspended in water. These particles scatter or reflect light rays, making the water appear cloudy.
- A. True      B. False
214. Turbidity changes in the distribution system can indicate developing problems. Increases in turbidity may also be caused by changes in velocity or inadequate flushing following main replacement.
- A. True      B. False



### **Zeta Potential Introduction**

215. Zeta potential is a physical property exhibited by all solid-liquid and liquid-liquid colloidal systems. Surrounding the surface of all dispersed particles is a thick layer of ions that have the same charge of the particle's surface called the ATP layer.

A. True      B. False

216. The zeta potential is defined as the voltage at the edge of the slipping (shear) plane with respect to the bulk-dispersing medium, where ions, molecules and other agents are no longer associated with a particle's surface.

A. True      B. False

217. If two adjacent particles have sufficiently high zeta potentials of the same sign, they will agglomerate due to repulsive electrostatic forces between particles with unlike charges.

A. True      B. False

### **Solubility of Substances in Water**

218. Water is an excellent solvent for many compounds. Some dissolve in it as molecules while others, called electrolytes, dissociate and dissolve not as neutral molecules but as charged species called ions.

A. True      B. False

219. Compounds exist as solid ionic crystals dissolve in water as ions, and most of them are not soluble in water.

A. True      B. False

220. "Highly soluble" is a somewhat elastic description, but generally means soluble to at least the extent of forming 0.1 to 1.0 molar aqueous solutions.

A. True      B. False

221. Salts which are very soluble in water than this at room temperature are called highly soluble salts.

A. True      B. False

### **Purpose of Coagulation**

222. Chemical Coagulation in the water/wastewater treatment is the process of bringing suspended matter in untreated water together for the purpose of settling and for the preparation of the water for filtration.

A. True      B. False

### **Turbidity Particles**

223. The ability of particles to remain suspended in water is a function of hydrogen ion activity.

A. True      B. False

224. Turbidity particles can range in size from molecular to 50 microns (a tremendous range).

A. True      B. False

225. Particles that are greater than one micron in diameter are considered silt, and settle out due to their relatively large size and density in a matter of days with the need to coagulation.

A. True      B. False

### Olation

226. Olation involves the bridging of two or more of these large molecules to form even larger, positively charged ions. A typical molecule can contain eight aluminum ions, twenty hydroxide ions, and will have a +4 charge.

- A. True      B. False

### Zeta Potential

227. The Zeta Potential is reduced to zero in order for coagulation to occur, because the forces of attraction are predominant.

- A. True      B. False

### Coagulants – Alum and Ferric

228. Aluminum Sulfate is also known as alum, filter alum, and alumina sulfate. Alum is the most widely used coagulant. Alum is available in dry form as a powder or in lump form. It can also be purchased and fed as a liquid.

- A. True      B. False

229. Alum has an exact formula due to the constant water molecules of hydration that may be attached to the aluminum sulfate molecule.

- A. True      B. False

230. Once in water, alum can react with hydroxides, carbonates, bicarbonates, and other anions to form \_\_\_\_\_.

- A. pH                      C. Large, positively charged molecules  
B. Alkalinity              D. None of the above

231. Carbon dioxide and sulfate are generally byproducts of these reactions. During the reactions, alum acts as \_\_\_\_\_ to reduce the pH and alkalinity of the water supply. It is important that sufficient alkalinity be present in the water supply for the various reactions to occur.

- A. Inorganic coagulant(s)      C. Byproducts of these reactions  
B. An acid                      D. None of the above

232. Alum can be effective in the pH range of 5.5 to 7.8, but seems to work best in most water supplies in a pH range of 6.8 to 7.5. Below a pH range of 5.5, alkalinity in the water supply is generally insufficient.

- A. True      B. False

233. The aluminum ions become soluble rather than insoluble and do not participate in the hydration and \_\_\_\_\_ necessary to make the alum effective as a coagulant. In these instances the plant may experience higher than normal filtered water turbidities, and much of the aluminum will pass through the filters.

- A. Post filtration alum coagulation      C. Byproducts of these reactions  
B. Olation reaction(s)                      D. None of the above

234. When the pH level of the water is above 7.8 after the addition of the alum, the aluminum ions again become soluble, and the efficiency of coagulation is decreased. Under these conditions, aluminum ions again penetrate the filters, and \_\_\_\_\_ can occur in the clear well and in the distribution system in some cases.

- A. Post filtration alum coagulation      C. Byproducts of these reactions  
B. Olation reaction(s)                      D. None of the above

### Ferric Chloride (Ferric)

235. Ferric chloride is becoming more extensively used as a coagulant due partially to the fact that the material can be purchased as a liquid.

- A. True      B. False

236. As a result, many plants are replacing alum with ferric chloride to eliminate the penetration of aluminum ions through the plant filters. Ferric chloride also reacts as an acid in water to reduce

- \_\_\_\_\_.
- A. pH                      C. Olation  
B. Alkalinity            D. None of the above

237. \_\_\_\_\_ are available, such as potash alum, ammonia alum, ferrous sulfate (copperas), and chlorinated copperas.

- A. Other inorganic coagulants      C. Byproducts of these reactions  
B. Olation reaction(s)                D. None of the above

238. Typical dosages of the inorganic coagulants range from 50 pounds per million gallons of water treated under ideal conditions to as high as 800 to 1000 pounds per million gallons of water treated under \_\_\_\_\_ conditions.

- A. Worst case            C. Increased  
B. Decreased            D. None of the above

### Factors Influencing Coagulation

#### Effects of pH

239. The pH range in which a coagulation process occurs may be the single most important factor in \_\_\_\_\_ coagulation. The vast majority of coagulation problems are related to improper pH levels.

- A. Improper              C. Proper  
B. Optimum              D. None of the above

240. Whenever possible, coagulation should be conducted in \_\_\_\_\_. When this is not done, lower coagulation efficiency results, generally resulting in a waste of chemicals and a lowered water quality.

- A. The optimum pH zone      C. Collision between the colloids  
B. The coagulation process    D. None of the above

241. Each of the inorganic salt coagulants has its own characteristic \_\_\_\_\_ pH range.

- A. Improper              C. Little or no effect  
B. Optimum              D. None of the above

242. In many plants, it is necessary to adjust the pH level in the coagulation process. In most cases, this involves the addition of lime, caustic soda, or soda ash to maintain a minimum pH level. In some cases, however, acids may be necessary to raise or lower the pH level to an \_\_\_\_\_ range.

- A. Improper              C. Little or no effect  
B. Optimum              D. None of the above

243. In some water plants, the acidic reactions of the inorganic salts are taken advantage of when the raw water pH levels are \_\_\_\_\_. In these instances, overfeed of the coagulant is intentionally induced in order for the coagulation process to occur in the optimum range.

- A. Improper              C. Higher than desired  
B. Optimum              D. None of the above

### Effects of Salts

244. Since no natural waters are completely pure, each will have various levels of cations and anions such as calcium, sodium, magnesium, iron, manganese, sulfate, chloride, phosphate, and others. Some of these ions may affect the efficiency of \_\_\_\_\_.

- A. All chemical reactions
- B. The coagulation process
- C. Collision between the colloids
- D. None of the above

245. Generally, mono and divalent cations such as sodium, calcium, and magnesium have \_\_\_\_\_ on the coagulation process.

- A. Improper
- B. Optimum
- C. Little or no effect
- D. None of the above

246. Trivalent cations do not have an adverse effect on the process in most instances. In fact, significant concentrations of naturally occurring iron in a water supply has resulted in the ability to feed \_\_\_\_\_ dosages of inorganic salt coagulants.

- A. Improper
- B. Optimum
- C. Lower than normal
- D. None of the above

### Nature of Turbidity

247. Generally, higher turbidity levels require higher coagulant dosages. However, seldom is the relationship between turbidity level and coagulant dosage linear. Usually, the additional coagulant required is \_\_\_\_\_ when turbidities are much higher than normal due to higher collision probabilities of the colloids during high turbidities.

- A. Improper
- B. Optimum
- C. Relatively small
- D. None of the above

248. Conversely, low turbidity waters can be very difficult to coagulate due to the difficulty in inducing \_\_\_\_\_. In this instance, floc formation is poor, and much of the turbidity is carried directly to the filters.

- A. All chemical reactions
- B. The coagulation process
- C. Collision between the colloids
- D. None of the above

249. Organic colloids may be present in a water supply due to pollution, and these colloids can be difficult to remove in the coagulation process. In this situation, \_\_\_\_\_ coagulant dosages are generally required.

- A. Improper
- B. Higher
- C. Slowly
- D. None of the above

### Water Temperature

250. Cold water temperatures can cause two factors which add to the difficulty of the coagulation process. As water temperatures approach freezing, almost all chemical reactions occur more \_\_\_\_\_.

- A. Improper
- B. Higher
- C. Slowly
- D. None of the above

251. It can be difficult to evenly disperse the coagulants into the water. In addition, floc settling characteristics become poor due to the higher density of the water during near freezing temperatures. As a result, the coagulant process becomes less efficient, and higher coagulant dosages are generally used to compensate for these effects.

- A. True
- B. False

### Mixing Effects

252. Poor or inadequate mixing results in an uneven dispersion of the coagulant. Unfortunately, many older plants were designed with mixing facilities which generally do not accomplish mixing in the most efficient manner. As a result, it becomes necessary to use higher than necessary dosages of coagulant to achieve an optimum level of efficiency in the process.

- A. True      B. False

253. The effects of high turbidity and warm water temperatures can tend to aggravate the lack of adequate mixing facilities in some plants.

- A. True      B. False

### Effect of the Coagulant

254. The choice of the proper coagulant for the given conditions is of critical importance in maintaining an efficient coagulation scheme under widely varying conditions. The chemicals most commonly used in the coagulation process are Aluminum Sulfate, Ferric Chloride, Ferric Sulfate, and Cationic Polymers.

- A. True      B. False

### Corrosion Control Introduction

255. Corrosion is the deterioration of a substance by chemical action. Lead, cadmium, zinc, copper and iron might be found in water when metals in water distribution systems corrode. Drinking water contaminated with certain metals (such as \_\_\_\_\_) can harm human health.

- A. Lead                                      C. Lead and cadmium  
B. Lead and copper                      D. None of the above

### Cathodic Protection

#### Sacrificial Anode Systems

256. Sacrificial anodes are pieces of metal more electrically active than the steel piping system. Because these anodes are more active, the corrosive current will exit from them rather than the piping system.

- A. True      B. False

257. Sacrificial anodes can be attached to the existing piping system or coated steel for a pre-engineered cathodic protection system. An asphalt coating is not considered a suitable dielectric coating.

- A. True      B. False

### Coagulation and Flocculation Summary

#### Rapid Sand Filtration

258. Which term is the most prevalent form of water treatment technology in use today?

- A. Conventional technology              C. Rapid Sand filtration  
B. Sedimentation process                D. None of the above

259. Rapid Sand filtration process employs a combination of \_\_\_\_\_ in order to achieve maximum effectiveness.

- A. Filtration                                      C. Physical and chemical processes  
B. Sedimentation process                    D. None of the above

## Coagulation

260. At the Water Treatment Plant, alum is added to the water in the "flash mix" to cause microscopic impurities in the water to clump together.

- A. True                      B. False

261. The alum and the water are mixed rapidly by the?

- A. Cationic polymers                      C. Shaker  
B. Flash mixer                              D. None of the above

262. What is the process of joining together particles in water to help remove organic matter called?

- A. Cationic binding                      C. Flocculation  
B. Coagulation                              D. None of the above

263. Aluminum Sulfate is also excellent for removing nutrients such as phosphorous in wastewater treatment.

- A. True                      B. False

264. Fine particles must be coagulated, or "stuck together" to form larger particles that can be filtered, this is achieved through the use of?

- A. Sedimentation chemicals                      C. Flocculation chemicals  
B. Coagulant chemicals                              D. None of the above

265. Which of the following terms are so small, their charge per volume is significant?

- A. Aluminum Sulfate molecules                      C. Colloidal particles  
B. Coagulant chemicals                              D. None of the above

266. Coagulation is necessary to meet the current regulations for almost all potable water plants using surface water.

- A. True                      B. False

267. Coagulant chemicals such as alum work by neutralizing the negative charge, which allows the particles to come together.

- A. True                      B. False

268. Liquid \_\_\_\_\_ is usually a 48.86% solution.

- A. Cationic polymers                      C. Aluminum Sulfate  
B. Soda ash                                      D. None of the above

269. Which of the following terms can be thought of as positively charged strings that attract the particles to them, and in the process, form a larger particle?

- A. Cationic polymers                      C. Lime  
B. Coagulation helpers                              D. None of the above

270. Which of the following is the most widely used coagulant in water treatment?

- A. Cationic polymers                      C. Aluminum Sulfate  
B. Salts    D. None of the above

## Flocculation

271. Flocculation is the process of bringing together destabilized or coagulated particles to form larger masses which can be settled and/or filtered out of the water being treated.

- A. True                      B. False

272. Flocculation is the process where the suspended particles can collide, \_\_\_\_\_, and form heavier particles called "floc".

- A. Equalization
- B. Agglomerate
- C. Destabilized or coagulated particles
- D. None of the above

273. Gentle \_\_\_\_\_ and appropriate detention times (the length of time water remains in the basin) help facilitate the flocculation process.

- A. Equalizing
- B. Agitation of the water
- C. Settling
- D. None of the above

274. Inside the contact chambers, water is slowly mixed allowing the coagulated particles, called "floc," and the particles become larger and stronger.

- A. True
- B. False

275. Which of the following happens in the water when bacteria and other microorganisms are caught in the floc structure?

- A. Equalize the basin
- B. Floc particles mix
- C. Agitate the water
- D. None of the above

### Pre-Sedimentation

276. Contingent on the quality of the source water, some plants have pre-sedimentation, which allows larger \_\_\_\_\_ in a reservoir or lake reducing solid removal loads.

- A. Equalization of the basin
- B. Particles time to settle
- C. Floc particles mix
- D. None of the above

### Sedimentation

277. Sedimentation is the process of destabilizing coagulated particles in water.

- A. True
- B. False

278. In which process does the velocity of the water is decreased so that the suspended material, including flocculated particles, can settle out by gravity?

- A. Sedimentation
- B. Flocculation
- C. Rapid Sand filtration
- D. None of the above

### Water Filtration Key Terms

#### Declining Rate Filters

279. The filter flow rate will vary with?

- A. Head loss
- B. Uniform media
- C. Effluent control
- D. None of the above

280. Declining Rate Filters system often requires \_\_\_\_\_ to provide adequate media submergence.

- A. Head loss
- B. Uniform media
- C. Effluent control structure
- D. None of the above

#### Detention Time

281. Detention time is actual time required for a small amount of water to pass through a Sedimentation basin at a given rate of flow, or the calculated time required for a small amount of liquid to pass through a tank at a given rate of flow.

- A. True
- B. False

### Disinfection

282. Chlorine kills or “inactivates” harmful microorganisms in water.

- A. True      B. False

283. Chlorine is added again after filtration for?

- A. Residual      C. Post-disinfection  
B. Contact time      D. None of the above

### Jar Testing

284. Jar testing traditionally has been done on an infrequent basis in most water treatment plants to control THMs.

- A. True      B. False

### pH

285. According to the text, pH is an expression of a basic or acid condition of a liquid. The range is from 0-14, zero being the most acid and 14 being the most alkaline. A pH of 7 is considered to be neutral.

- A. True      B. False

286. According to the text, which of the following has a pH between 6.0 and 8.5?

- A. Acids      C. Natural water  
B. Disinfectants      D. None of the above

### Caustic

287. A strong chemical - NaOH is used in the treatment process to neutralize acidity, and to lower the pH value.

- A. True      B. False

### Polymer

288. Polymer is a water treatment chemical that when combined with other types of coagulants, aids in binding small suspended particles to larger particles to help in the settling and filtering processes.

- A. True      B. False

### Post-Chlorine

289. The operator should make sure that the chlorinated water holds a residual in the distribution system.

- A. True      B. False

### Pre-Chlorination

290. Before the filtration process, chlorination helps control fish and vegetation.

- A. True      B. False

### Hydrofluosilicic Acid

291.  $\text{H}_2\text{SiF}_6$  a clear fuming corrosive gas, with a pH ranging from 8 to 9 and used in water treatment to fluoridate drinking water.

- A. True      B. False

### Taste and Odor Control

292. Which of the following is occasionally added for taste and odor control?

- A. Turbidity powder      C. Powdered activated carbon (PAC)  
B. Fluoride      D. None of the above



### Water Quality

293. Water quality testing needs to be conducted throughout the water treatment process.

- A. True                      B. False

294. Water quality testing procedures should analyze turbidity, pH, and chlorine residual continuously.

- A. True                      B. False

295. Some water quality items are tested several times per day, some once per quarter and others once per year.

- A. True                      B. False

### Chemical Feed and Rapid Mix

296. To improve the subsequent treatment processes, chemicals may be added to the water, and may include pH adjusters and coagulants.

- A. True                      B. False

297. Alum is a coagulant chemical, that neutralize negative charges on small particles, allowing them to stick together and form larger particles that are more easily removed by sedimentation or filtration.

- A. True                      B. False

### Short-Circuiting

298. Short-Circuiting is a condition that occurs in tanks or basins when some of the water travels faster than the rest of the flowing water.

- A. True                      B. False

299. Short-Circuiting is usually undesirable, since it may result in shorter contact, reaction, or settling times in comparison with the?

- A. Presumed detention times                      C. Modification of the conventional process  
B. Sedimentation/clarification process                      D. None of the above

### Tube Settlers

300. Tube settlers are a modification of the conventional process contains many metal "tubes" that are normally placed in?

- A. Flocculation basin                      C. An up-flow clarifier  
B. Sedimentation basin or clarifier                      D. None of the above

301. The slope of the tube settlers facilitates gravity settling of the solids to the bottom of the basin, where they can be?

- A. Adjusted for detention times                      C. Collected and removed  
B. Modified                      D. None of the above

302. The large surface settling area also means that adequate clarification can be obtained with detention times of 45 minutes or more.

- A. True                      B. False

### Adsorption Clarifiers

303. In the sedimentation/clarification process, turbidity is \_\_\_\_\_ of the coagulated and flocculated solids.

- A. Increased by adsorption                      C. Decreased by adsorption  
B. Reduced by adsorption                      D. None of the above

304. Water scouring cleans adsorption clarifiers followed by air flushing is a must.

- A. True                      B. False

305. Cleaning of the clarifier is initiated less often than filter backwashing because the clarifier removes less solids.

- A. True                      B. False

306. In the tube-settler type of package plant, the Sedimentation/clarification process is followed by mixed-media filtration and disinfection to complete the water treatment.

- A. True                      B. False

### **Clearwell**

307. The clearwell provides temporary storage for the treated water, which is the final step in the conventional treatment process.

- A. True                      B. False

### **Sampling**

308. Care should be taken not to disturb the bottom of the water source or along the sides. So as not to stir up any settled solids. This would create erroneous results. There are different techniques for both bacteriological and disinfection byproduct samplings. Collect the water sample at least 6 inches under the surface by plunging the container mouth down into the water and turning the mouth towards the current by dragging the container slowly horizontal.

- A. True                      B. False

### **Filtration Overview**

309. Filtration is a water treatment process step used to remove turbidity, dissolved organics, odor, taste and color.

- A. True                      B. False

310. According to the text, the filter is periodically cleaned by a reversal of flow and the \_\_\_\_\_ into a drain.

- A. Activated carbon filters      C. Rapid-sand filters  
B. Anthracite coal                  D. None of the above

### **Anthracite Coal or Activated Carbon**

311. Water is normally filtered at a rate of between 10 and 2 gpm per square foot, the water is filtered through an approximate 36" depth of graded sand.

- A. True                      B. False

312. Sodium hydroxide may also be included in the sand to improve the filtration process, especially for the removal of organic contaminants and taste and odor problems.

- A. True                      B. False

313. For a filter which of the following should be conducted on a routine basis, at least once per day?

- A. Filtration process performance      C. Post-disinfection performance  
B. Effluent control measurement      D. None of the above

314. Good chemical treatment management can often result in either early turbidity breakthrough or rapid head loss buildup.

- A. True                      B. False

315. All water treatment plants that use surface water are governed by the U.S. EPA's Surface Water Treatment Rules or SWTR.

- A. True                      B. False

### **EPA Filter Backwash Rule- Introduction**

316. The U.S. Environmental Protection Agency (EPA) has finalized the Long Term 1 Enhanced Surface Water Treatment Rule and Filter Backwash Rule (LT1FBR) to increase protection of finished drinking water supplies from contamination by Cryptosporidium and other microbial pathogens.

- A. True                      B. False

### **Background**

317. If finished water supplies contain microbiological contaminants, disease outbreaks may result. Disease symptoms may include diarrhea, cramps, nausea, possibly jaundice, headaches and fatigue.

- A. True                      B. False

318. The EPA has set enforceable drinking water treatment requirements to reduce the risk of waterborne disease outbreaks. Treatment technologies such as filtration and disinfection remove or inactivate microbiological contaminants.

- A. True                      B. False

### **LT1FBR Required**

319. The LT1FBR provisions does not apply to public water systems using surface water or ground water under the direct influence of surface water systems.

- A. True                      B. False

### **Turbidity**

320. Which of the following must comply with specific combined filter effluent turbidity requirements?

- A. Watershed                      C. Conventional and Direct filtration systems  
B. Disinfection profile                      D. None of the above

### **Disinfection Benchmarking**

321. Public water systems will be required to develop a(n) \_\_\_\_\_ unless they perform applicability monitoring which demonstrates their disinfection byproduct levels are less than 80% of the maximum contaminant levels.

- A. Disinfection profile                      C. Disinfection benchmark  
B. Direct filtration system                      D. None of the above

322. According to the text, if a system considers making a significant change to their disinfection practice they must develop a(n) \_\_\_\_\_ and receive State approval for implementing the change.

- A. Disinfection profile                      C. Disinfection benchmark  
B. Direct filtration systems                      D. None of the above

323. Which of the following that practice direct recycle, employ 20 or fewer filters to meet production requirements during a selected month, and recycle spent filter backwash water, thickener supernatant, and/or liquids from the dewatering process within the treatment process must perform a one month, one-time recycle self-assessment?

- A. Recycle systems                      C. Direct filtration systems  
B. Conventional systems                      D. None of the above

324. Which of the following will be required to return spent filter backwash water, thickener supernatant, and liquids from the dewatering process prior to the point of primary coagulant addition unless the State specifies an alternative location?

- A. Recycle systems
- B. Conventional systems
- C. Direct filtration systems
- D. None of the above

325. Which of the following recycling to the treatment process must provide detailed recycle treatment information to the State, which may require that modifications to the recycle practice be made?

- A. Recycle systems
- B. Conventional systems
- C. Direct filtration systems
- D. None of the above

### Filtration Process- Detailed

326. Removal of \_\_\_\_\_ plays an important role in the natural treatment of groundwater as it percolates through the soil.

- A. Suspended solids by filtration
- B. Serious problems in filter operation
- C. Coagulation and flocculation processes
- D. None of the above

327. Groundwater that has been softened or treated through iron and manganese removal will require filtration to remove floc created by?

- A. Suspended solids by filtration
- B. Serious problems in filter operation
- C. Coagulation and flocculation processes
- D. None of the above

328. According to the text, since surface water sources are subject to run-off and do not undergo natural filtration, it must be filtered to?

- A. Remove particles and impurities
- B. Filtration process can be compared to a sieve or microstrainer
- C. Suspended particles can easily pass
- D. None of the above

329. Which of the following which traps suspended material between the grains of filter media?

- A. Remove particles and impurities
- B. Filtration process can be compared to a sieve or microstrainer
- C. Suspended particles can easily pass
- D. None of the above

330. Which of the following may occur in the filter bed will happen especially if coagulation and flocculation of the water before filtration was not properly controlled?

- A. Coagulation and flocculation
- B. Filter operation
- C. Flocculation
- D. None of the above

### Direct Filtration Plant vs. Conventional Plant

331. The primary difference between Direct Filtration Plant vs. Conventional Plant is that the \_\_\_\_\_ or step is omitted from the Direct Filtration plant.

- A. Sedimentation process
- B. Reconditioning cycle
- C. Fast rinse
- D. None of the above

### Types of Filters

332. The oldest water filters developed were the slow sand filters, these have filter rates of around 0.05 gpm/ft<sup>2</sup> of surface area. This type of filter requires large filter areas.

- A. True
- B. False

333. What is the term for the mass of growing material that collects on the surface of the filter?  
A. Schmutzdecke C. Mud balls  
B. Zoological growth D. None of the above

334. Most water filters are classified by filtration rate, type of \_\_\_\_\_, or type of operation.  
A. Schmutzdecke C. Filter media  
B. Backwash capabilities D. None of the above

### Rapid Sand Filters

335. Rapid sand filters can accommodate filter rates 40 times more than?  
A. Fixed film C. Mixed media  
B. Slow sand filters D. None of the above

336. Filters in large water treatment plants are usually constructed next to each other in a row, allowing the piping from the Sedimentation basins to feed the filters from a central pipe gallery.  
A. True B. False

### Filter Sand

337. The filter sand used in rapid sand filters is normal play sand for the purpose of water filtration.  
A. True B. False

338. In a filter the gravel supports the filter sand and is usually graded in three to five layers, each generally 6-18 inches in thickness, depending on the type of underdrain used.  
A. True B. False

339. Which of the following will contain 24-30 inches of sand, but some newer filters are deeper?  
A. Rapid sand filters C. Sedimentation basins  
B. Slow rate filters D. None of the above

340. The coarser sand in the \_\_\_\_\_ has larger voids that do not fill as easily.  
A. Rapid filters C. Sedimentation basin  
B. Backwash trough D. None of the above

### False floor

341. The false floor design of a \_\_\_\_\_ is used together with a porous plate design or with screens that retain the sand when there is no undergravel layer.  
A. Backwash system C. Filter underdrain  
B. Leopold system D. None of the above

### Filtration Processes

342. The traditional design for many years is conventional filtration; this method provides effective treatment for just about any range of tastes and odors.  
A. True B. False

343. Conventional filtration success is due partially to the high quality raw water that precedes filtration steps.  
A. True B. False

344. Many treatment plants have converted rapid sand filters in to multi-media filters in an attempt to?  
A. Control raw-water turbidity C. Increase plant capacity  
B. Lower capital cost D. None of the above

345. Direct filtration = no sedimentation follows the coagulation phase.

- A. True      B. False

346. According to the text, dual and multi-media filters are often used with Conventional Filtration.

- A. True      B. False

347. One of the benefits of this method is that it has a lower capital cost, but this method or process cannot handle large variations in raw water turbidity.

- A. Direct Filtration      C. Flocculation  
B. Sand Filtration      D. None of the above

### High Rate Filters

348. High rate filters, which operate at a rate up to ten times that of a rapid sand filter.

- A. True      B. False

349. Multi-media or mixed-media filters use three or four different materials, sand, anthracite coal, and garnet.

- A. True      B. False

350. In the design of the high rate filter, the top layers consist of a fine material with the coarse material farther down, allowing the suspended material to penetrate less into the filter.

- A. True      B. False

351. The filter bed material forms layers in the filter, depending on their weight and specific gravities.

- A. True      B. False

### Pressure Sand Filters

352. Filtration rates are twice as good as gravity filters.

- A. True      B. False

353. Which of the following terms or methods cracking of the filter bed can occur quite easily, allowing the iron and manganese particles to go straight through the filter?

- A. Slow sand/RO      C. Pressure filters  
B. Gravity filters      D. None of the above

354. Which of the following filtration types is contained under pressure in a steel tank?

- A. Slow sand/RO      C. Pressure sand filter  
B. Gravity filters      D. None of the above

355. In which of the following filtration types is the media usually sand or a combination of media?

- A. Slow sand/RO      C. Fast sand  
B. Gravity filters      D. None of the above

356. Which of the following filter types has a major disadvantage in that the backwash cannot be observed?

- A. Slow sand/RO      C. Pressure filters  
B. Gravity filters      D. None of the above

357. Filtration operation is divided into three steps: filtering, backwashing, and?

- A. Filter run      C. Return to waste  
B. Filtering to waste      D. None of the above

358. Which of the following is a low-pressure membrane filtration process that removes suspended solids and colloids generally larger than 0.1-micron diameter?

- A. Nanofiltration
- B. Microfiltration
- C. Semi-permeable
- D. None of the above

359. Which of the following is a relatively recent membrane process used most often with low total dissolved solids water such as surface water and fresh groundwater?

- A. Nanofiltration
- B. Microfiltration
- C. Semi-permeable
- D. None of the above

### Declining Rate

360. According to the text, which of the following terms or methods of control is used where the largest head loss through the plant?

- A. Declining Rate
- B. Gravity filters
- C. Fast sand
- D. None of the above

361. The rate through the declining rate filter is much greater in the beginning of a filter run than at the end when the?

- A. Filter run
- B. Filter is dirty
- C. Head loss is low
- D. None of the above

362. According to the text, which of the following allows the filter head to increase until the filter becomes plugged with particles and the Head loss is too great to continue operation of the filter?

- A. Declining Rate
- B. Gravity filters
- C. Fast sand
- D. None of the above

### Loss of Head Indicator

363. Which of the following is required to force the water through the filter?

- A. Filter run
- B. Force
- C. Head loss
- D. None of the above

364. Which of the following should be continuously measured to help determine when the filter should be backwashed?

- A. Filter run
- B. Force
- C. Head loss
- D. None of the above

365. Which of the following terms is measured in the difference by a piezometer connected to the filter above the media and the effluent line?

- A. Filter flow
- B. Force
- C. Head
- D. None of the above

### In-line Turbidimeter

366. Continuous turbidity monitors provide information about when the filter is approaching this point so that the operators can start the backwash before the turbidity is too great.

- A. True
- B. False

### Filtration Process

367. A rapid sand filter will have a flow of two-to-three gpm/square foot of filter area. The high rate filter may have four-to-six gpm/square foot applied to the surface.

- A. True
- B. False

368. Water from the source or, more commonly, from pre-treatment processes is applied to the top of the filter; it then flows downward. The water level above the filter bed is usually kept at two-to-six feet.

- A. True      B. False

369. When the filtration is started after being backwashed, there will be great head loss.

- A. True      B. False

370. Which of the following is restricted in filters with a control valve installed on the filter effluent pipe?

- A. Filter flow      C. Head  
B. Force      D. None of the above

371. Which of the following is the term for the water rate on a filter depending on the type of filter?

- A. Flow      C. Head  
B. Force      D. None of the above

372. Which of the following is almost fully closed when a filter is clean so that the desired water level on top of the filter is maintained?

- A. Headloss valve      C. Flow restrictor  
B. Constant rate flow valve      D. None of the above

373. As the filter becomes dirty, the valve opens gradually until the increase in the water level above the filter indicates that the filter needs?

- A. Headloss      C. Backwashing  
B. Flow redistributes      D. None of the above

374. As the filter becomes dirty, the flow through the filter becomes less and, if the plant has more than one filter, additional \_\_\_\_\_ across the other filters.

- A. Headloss      C. Backwashing  
B. Flow redistributes      D. None of the above

375. Which of the following is placed in the filter effluent pipe to prevent a filter inflow that is too great for the filter?

- A. Headloss valve      C. Flow restrictor  
B. Flow valve      D. None of the above

376. The filter eventually fills with suspended material, usually after 15 to 30 hours, it will need to be \_\_\_\_\_ to clean the media.

- A. Bumped      C. Backwashed  
B. Jetted      D. None of the above

### **Back Washing**

377. A normal backwash rate is between 1.2 to 1.5 gpm per square foot of filter surface area.

- A. True      B. False

378. Proper backwashing is a very important step in the operation of a filter.

- A. True      B. False

379. Treated water from storage is used for the backwash cycle. This treated water is taken from elevated storage tanks or pumped in from the raw water reservoir.

- A. True      B. False



380. Which of the following must be expanded to clean the filter during the backwash?

- A. Media
- B. Floc(s)
- C. Backwash rate
- D. None of the above

381. Filter expansion causes the filter grains to rub actively against each other, dislodging the \_\_\_\_\_ from the media.

- A. Media
- B. Floc(s)
- C. Backwash rate
- D. None of the above

382. Filter effluent- turbidity alone can cause high head loss and decreased filter flow rate, causing the pressure in the filter to drop below atmospheric pressure and cause the filter to \_\_\_\_\_ and stop filtering.

- A. Prevent headloss
- B. Air bind
- C. Lock
- D. None of the above

383. Some filters can operate longer than one week before needing to be?

- A. Bumped
- B. Jetted
- C. Backwashed
- D. None of the above

384. Long filter runs can cause the filter media to pack down so that it is difficult to \_\_\_\_\_ during the backwash.

- A. Control headloss
- B. Control floc(s)
- C. Expand the bed
- D. None of the above

### **Backwashing Process**

385. The normal method for opening the filter backwash valve involves draining the water level above the filter to a point six inches above the filter media.

- A. True
- B. False

386. When the backwash valve is opened, which action allows backwash water to start flowing into the filter and start?

- A. Controlling headloss
- B. Breaking the crust on the filter
- C. Some means of controlling the media carryover
- D. None of the above

387. When the surface wash is turned on it should be allowed to operate for several minutes to break up the ?

- A. Headloss
- B. Crust on the filter
- C. Suspended material away from the filter
- D. None of the above

388. The time elapsed from when the filter wash is started until full flow is applied to the filter should be greater than one minute.

- A. True
- B. False

389. According to the text, with a multi-media filter, the rate must be high enough to scrub the interface between the coal and the sand, where the highest amount of suspended solids will be removed from the media.

- A. True
- B. False

### **Disposal of Filter Backwash Water**

390. Water from the filter backwash can be returned directly to the environment.

- A. True
- B. False

391. The supernatant is then pumped back to the head of the treatment plant at a rate not exceeding ten percent of the?

- A. Daily flow
- B. Backwash water
- C. Raw water flow entering the plant
- D. None of the above

392. According to the text, the spent backwash water must be stored in storage tanks and returned slowly to the treatment process.

- A. True
- B. False

### Filter to Waste

393. When filtration is started after backwash, suspended material remains in the filter media until the turbidity in the effluent meets standards. Depending on the type of filter, this may last from 20-40 minutes.

- A. True
- B. False

394. Wasting is needed as some \_\_\_\_\_ following the backwash.

- A. Daily flow
- B. Backwash water
- C. Suspended material remains in the filter media
- D. None of the above

395. Which of the following terms should be done slowly after a backwash to prevent breakthrough of suspended material?

- A. Daily flow
- B. Backwash water
- C. Filtration should always be started
- D. None of the above

### Filter Aids

396. A normal dose of polymer for filter aiding will be less than 0.1 ppm, but the exact dose will be decided by the result of a jar test and by experimentation in the treatment plant.

- A. True
- B. False

397. Which of the following terms expresses that the polymer strengthens the bonds and prevents the shearing forces in the filter from breaking the floc apart when used?

- A. Filter media
- B. Lime
- C. Filter aid
- D. None of the above

### Filter Operating Problems

398. According to the text, there are three major types of filter problems. They can be caused by chemical treatment before the filter, \_\_\_\_\_, and backwashing of filters.

- A. Filter aid
- B. Control of filter flow rate
- C. Coagulation and flocculation stages
- D. None of the above

### Chemical Treatment before the Filter

399. Which of the following terms of the water treatment must be monitored continuously?

- A. Filter aid
- B. Backwash storage basin
- C. Coagulation and flocculation stages
- D. None of the above

400. Adjustments in the amount of coagulant added must be made as necessary to prevent the filter from becoming overloaded, this may cause the filter to prematurely reach its?

- A. Maximum headloss
- B. Control of filter flow rate
- C. Turbidity breakthrough
- D. None of the above

### Advanced Water Treatment Section

401. Water contains \_\_\_\_\_ of which impart a quality known as hardness?

- A. TDS
- B. Conductivity
- C. Various amounts of dissolved minerals
- D. None of the above

402. The precipitation process is generally known as the?

- A. Softening
- B. Chemical pretreating
- C. Lime process or lime soda process
- D. None of the above

403. Which of the following can be accomplished using membrane technology, electro dialysis, distillation, and freezing. Of these, the membrane methods seem to have the greatest use potential.

- A. Alkalinity
- B. Precipitation
- C. Softening
- D. None of the above

### Occurrence of Hard Water

404. Which of the following is caused by soluble, divalent, metallic cations, (positive ions having valence of 2)?

- A. Hard water
- B. Permanent hardness
- C. Carbonate hardness
- D. None of the above

405. Water hardness varies considerably and is due to different geologic formations, and is also a function of the contact time between water and?

- A. Low pH
- B. Carbonate-noncarbonate
- C. Limestone deposits
- D. None of the above

### Types of Hardness

406. Hardness can be categorized by either of two methods: calcium versus magnesium hardness and?

- A. Carbonate hardness
- B. Temporary hardness
- C. Carbonate versus non-carbonate hardness
- D. None of the above

### Carbonate-Noncarbonate Distinction

407. According to the text, the carbonate-noncarbonate distinction, is based on hardness from either the bicarbonate salts of calcium or the \_\_\_\_\_ involved in causing water hardness.

- A.  $\text{CaCO}_3$
- B. Water hardness
- C. Normal salts of calcium and magnesium
- D. None of the above

408. Because noncarbonated hardness cannot be removed or precipitated by prolonged boiling, it is sometimes called?

- A. Temporary hardness
- B. Permanent hardness
- C. Carbonate hardness
- D. None of the above

### Reverse Osmosis

409. RO membranes have very low MWC pore size that can reject ions at very high rates, including?

- A. Process liquid
- B. Chloride and sodium
- C. Bacterial and protozoan life
- D. None of the above

### Nanofiltration (NF) Section

410. Nanofiltration is a relatively recent membrane filtration process used most often with low total dissolved solids water with the purpose of softening (polyvalent cation removal) and removal of \_\_\_\_\_ such as natural organic matter and synthetic organic matter.

- A. Process liquid
- B. Chloride and sodium
- C. Disinfection by-product precursors
- D. None of the above

411. Nanofiltration is also becoming more widely used in food processing applications and for \_\_\_\_\_ and partial (monovalent ion) demineralization.

- A. Process liquid
- B. Simultaneous concentration
- C. Natural organic matter and synthetic organic matter
- D. None of the above

### Reverse Osmosis Process Section

412. Osmosis is a natural phenomenon in which a liquid - water in this case - passes through a semi-permeable membrane from a relatively dilute solution toward a more concentrated solution. This flow produces a measurable pressure, called osmotic pressure.

- A. True
- B. False

413. Reverse osmosis, also known as?

- A. Hyperfiltration
- B. Microfiltration or MF
- C. Nanofiltration
- D. None of the above

### Water Laboratory Analysis Section

#### pH Testing Section

414. When an atom loses \_\_\_\_\_ and thus has more protons than electrons, the atom is a positively-charged ion or cation.

- A. A proton
- B. Charge
- C. An electron
- D. None of the above

415. Mathematically, pH is the negative logarithm of the activity of the (solvated) hydronium ion, more often expressed as the measure of the?

- A. Electron concentration
- B. Alkalinity concentration
- C. Hydronium ion concentration
- D. None of the above

416. pH is defined as the decimal logarithm of the reciprocal of the \_\_\_\_\_,  $a_{H^+}$ , in a solution.

- A. Hydrogen ion activity
- B. Acid-base behavior
- C. Brønsted–Lowry acid–base theory
- D. None of the above

417. For strong acids and bases no calculations are necessary except in extreme situations. The pH of a solution containing a weak acid requires?

- A. The concentration value
- B. The solution of a quadratic equation
- C. Excess of alkaline concentrations
- D. None of the above

### Disinfection Section

#### Chlorine's Appearance and Odor

418. Chlorine is a greenish-yellow gas it will condense to an amber liquid at approximately \_\_\_\_\_ F or at high pressures.

- A. -29.2 degrees
- B. - 100 degrees
- C. 29 degrees
- D. None of the above

419. Prolonged exposures to chlorine gas may result in?  
A. Moisture, steam, and water      C. Olfactory fatigue  
B. Odor thresholds                      D. None of the above

**Chlorine Gas**  
**Pathophysiology**

420. The odor threshold for chlorine gas is approximately?  
A. 0.3-0.5 parts per million (ppm)      C. 3-5 parts per million (ppm)  
B. 3 parts per million (ppm)              D. None of the above

**Reactivity**

421. Cylinders of chlorine may burst when exposed to elevated temperatures. When there is Chlorine in solution, this forms?  
A. Hydrogen sulfide      C. A corrosive material  
B. Oxomonosilane      D. None of the above

**Flammability**

422. When there is a fire that involves Chlorine, the firefight should be fought downwind from the minimum distance possible.  
A. True      B. False

423. Which term is used when disinfection decreases, as the concentration of the chlorine increases?  
A. pH increases                              C. Required contact time  
B. Chlorine level and water quality      D. None of the above

**Chlorination Chemistry**

424. The hypochlorite ion is a much weaker disinfecting agent than Hypochlorous acid, about 100 times less effective.  
A. True      B. False

425. According to the text, pH and temperature affect the ratio of hypochlorous acid to hypochlorite ions. As the temperature is decreased, the \_\_\_\_\_ increases.  
A. Reduction Ratio                      C. "CT" disinfection concept  
B. Ratio of hypochlorous acid          D. None of the above

**Chlorine Exposure Limits**

426. What is OSHA's PEL?  
A. 10 PPM                      C. 1,000 PPM  
B. 1 PPM                      D. None of the above

427. Chlorine's Physical and chemical properties: A yellowish green, nonflammable and liquefied gas with an unpleasant and irritating smell.  
A. True      B. False

428. Liquid chlorine is about \_\_\_\_\_ times heavier than water  
A. 1.5                      C. 2.5  
B. 10                      D. None of the above

429. Gaseous chlorine is about \_\_\_\_\_ times heavier than air.  
A. 1.5                      C. 2.5  
B. 10                      D. None of the above

### Chlorine Dioxide

430. Which term provides good Giardia and virus protection but its use is limited by the restriction on the maximum residual of 0.5 mg/L ClO<sub>2</sub>/chlorite/chlorate allowed in finished water?

- A. Chlorinated byproducts
- B. Chlorine dioxide
- C. Ammonia residual(s)
- D. None of the above

431. If chlorine dioxide is being used as an oxidant, the preferred method of generation is to entrain this term or substance into a packed reaction chamber with a 25% aqueous solution of sodium chlorite (NaClO<sub>2</sub>).

- A. Chloramine
- B. Chlorine gas
- C. Chlorine dioxide
- D. None of the above

432. According to the text, which chemical is explosive and can cause fires in feed equipment if leaking solutions or spills are allowed to dry out?

- A. Dry sodium chlorite
- B. Chlorine dioxide
- C. Ammonia
- D. None of the above

433. Chlorine dioxide may be used for either taste or odor control or as a?

- A. Chloramine
- B. Pre-disinfectant
- C. Gas
- D. None of the above

434. Total residual oxidants (including chlorine dioxide and chlorite, but excluding Chlorine dioxide) shall not exceed 0.50 mg/L during normal operation or 0.30 mg/L (including chlorine dioxide, chlorite and chlorate) during periods of extreme variations in the raw water supply.

- A. True
- B. False

### Ozone

435. Ozone is a very effective disinfectant for both Giardia and viruses

- A. True
- B. False

436. When determining Ozone CT (contact time) values must be determined for the ozone basin alone; an accurate \_\_\_\_\_ must be obtained for the contact chamber, and residual levels.

- A. Residual
- B. T10 value
- C. Contact time
- D. None of the above

437. Ozone does not provide a system residual and should be used as a primary disinfectant only in conjunction with?

- A. Dry sodium chlorite
- B. Chlorine dioxide
- C. Free and/or combined chlorine
- D. None of the above

438. Ozone does not produce chlorinated byproducts (such as trihalomethanes) but it may cause an increase in such byproduct formation if it is fed ahead of free chlorine; ozone may also produce its own oxygenated byproducts such as Cl<sub>2</sub> + NH<sub>4</sub>.

- A. True
- B. False

439. Ozonation must include adequate ozone leak detection alarm systems, and an ozone off-gas destruction system.

- A. True
- B. False

**Pump and Motor Section**  
**Common Hydraulic Terms**

440. Which of the following definitions is the engineering science pertaining to liquid pressure and flow?

- A. Hydraulics
- B. Hydrology
- C. Hydrokinetics
- D. None of the above

441. Which of the following definitions is the pressure exerted by the atmosphere at any specific location?

- A. Pressure, Atmospheric
- B. Pressure, Static
- C. Pressure, Gauge
- D. None of the above

442. Which of the following definitions is pressure above zero absolute, i.e. the sum of atmospheric and gauge pressure?

- A. Pressure, Atmospheric
- B. Pressure, Static
- C. Pressure, Gauge
- D. None of the above

443. Which of the following definitions is the force per unit area, usually expressed in pounds per square inch?

- A. Pressure, Absolute
- B. Pressure
- C. Pressure, Gauge
- D. None of the above

444. Which of the following definitions is the pressure differential above or below ambient atmospheric pressure?

- A. Pressure, Absolute
- B. Pressure
- C. Pressure, Gauge
- D. None of the above

445. Which of the following definitions is height of a column or body of fluid above a given point expressed in linear units?

- A. Head, Friction
- B. Head, Static
- C. Head
- D. None of the above

446. Which of the following definitions is required to overcome the friction at the interior surface of a conductor and between fluid particles in motion?

- A. Head, Friction
- B. Head, Static
- C. Head
- D. None of the above

447. Which of the following definitions is the pressure in a fluid at rest?

- A. Head, Friction
- B. Pressure, Static
- C. Head
- D. None of the above

448. Which of the following definitions is the height of a column or body of fluid above a given point?

- A. Head, Friction
- B. Head, Static
- C. Head
- D. None of the above

449. Sea level pressure is approximately 2.31 pounds per square inch absolute, 1 bar = .433psi.

- A. True
- B. False

### General Pumping Fundamentals

450. Here are the important points to consider about suction piping when the liquid being pumped is below the level of the pump: Sometimes suction lift is also referred to as 'positive suction head'.

- A. True      B. False

451. According to the text, suction lift is when the level of water to be pumped is below the?

- A. Impeller      C. Centerline of the pump  
B. Suction      D. None of the above

452. The suction side of pipe should be one diameter smaller than the pump inlet.

- A. True      B. False

453. The required eccentric reducer should be turned so that the top is flat and the bottom tapered.

- A. True      B. False

### Pumps

454. Pumps are excellent examples of?

- A. Hydrostatics      C. Multi-stage pumps  
B. Quasi-static devices      D. None of the above

455. Positive displacement pumps have a piston (or equivalent) moving in a closely-fitting cylinder and forces are exerted on the fluid by motion of the piston.

- A. True      B. False

456. More complicated pumps have valves check valves that open to allow \_\_\_\_\_, and close automatically to prevent reverse flow.

- A. Pistons      C. Passage in one direction  
B. Diaphragms      D. None of the above

457. According to the text, the force pump has \_\_\_\_\_ in the cylinder, one for supply and the other for delivery.

- A. Two check valves      C. Rotors  
B. Diaphragms      D. None of the above

458. In a positive displacement pump, supply valve opens when the cylinder \_\_\_\_\_, the delivery valve when the cylinder volume decreases.

- A. Volume increases      C. Air space increases  
B. Volume decreases      D. None of the above

459. Diaphragm pumps are force pumps in which the oscillating diaphragm takes the place of the piston.

- A. True      B. False

### Pump Categories

460. The key to understanding a pump's operation is that a pump is to move water and generate the \_\_\_\_\_ we call pressure.

- A. Delivery force      C. Diaphragm pressure  
B. Impeller force      D. None of the above



461. With a centrifugal pump the pressure is not referred to in pounds per square inch but rather as the equivalent in elevation, called?

- A. Inward force
- B. Head
- C. Delivery force
- D. None of the above

462. According to the text, pumps may be classified based on the application they serve.

- A. True
- B. False

### Basic Water Pump

463. The centrifugal pumps work by spinning water around in a circle inside a?

- A. Vortex
- B. Cylinder
- C. Cylindrical pump housing
- D. None of the above

464. As the water slows down and its kinetic energy decreases, that water's pressure potential energy increases.

- A. True
- B. False

465. As the water spins, the pressure near the outer edge of the pump housing becomes much lower than near the center of the impeller.

- A. True
- B. False

466. The impeller blades cause the water to move faster and faster.

- A. True
- B. False

467. The impellers may be of either a semi-open or closed type.

- A. True
- B. False

468. According to the text, without an inward force, an object will travel in a straight line and will not complete the?

- A. Circle
- B. Distance
- C. Center
- D. None of the above

469. In a centrifugal pump, the inward force is provided by high-pressure water near the outer edge of the?

- A. Pump housing
- B. Impeller blade(s)
- C. Base
- D. None of the above

470. In the operation of the pump, the water at the edge of the \_\_\_\_\_ inward on the water between the impeller blades and makes it possible for that water to travel in a circle.

- A. Inward force
- B. Pump pushes
- C. Center of the impeller
- D. None of the above

### Venturi (Bernoulli's law):

471. A venturi is a pipe that has a gradual restriction that opens up into a gradual enlargement.

- A. True
- B. False

472. The area of the restriction in a venture will have a \_\_\_\_\_ than the enlarged area ahead of it.

- A. Inward force
- B. Lower pressure
- C. Higher pressure
- D. None of the above

473. Which of the following best describes a pump whose impeller has no vanes but relies on fluid contact with a flat rotating plate turning at high speed to move the liquid?

- A. Submersible
- B. Blower
- C. Viscous drag pump
- D. None of the above

### Types of Water Pumps

474. The water production well industry almost exclusively uses Turbine pumps, which are a type of centrifugal pump.

- A. True
- B. False

475. The most common type of water pumps used for municipal and domestic water supplies are?

- A. Axial flow
- B. Variable displacement pumps
- C. Rotary pumps
- D. None of the above

476. Which of the following will produce at different rates relative to the amount of pressure or lift the pump is working against?

- A. Pump's lifting capacity
- B. Atmospheric pressure
- C. Variable displacement pump
- D. None of the above

477. Impellers are rotated by the pump motor, which provides the \_\_\_\_\_ needed to overcome the pumping head.

- A. Pump's lifting capacity
- B. Atmospheric pressure
- C. Horsepower
- D. None of the above

478. The size and number of stages, horsepower of the motor and \_\_\_\_\_ are the key components relating to the pump's lifting capacity.

- A. Pumping head
- B. Atmospheric pressure
- C. Horsepower
- D. None of the above

479. Which of the following terms are variable displacement pumps that are by far used the most?

- A. Axial flow
- B. Centrifugal pumps
- C. Turbine pumps
- D. None of the above

480. According to the text, the turbine pump utilizes impellers enclosed in single or multiple bowls or stages to?

- A. Pump head
- B. Lift water
- C. Horsepower
- D. None of the above

481. Vertical turbine pumps are commonly used in groundwater wells. These pumps are driven by a shaft rotated by a motor on the surface.

- A. True
- B. False

482. The shaft turns the impellers within the pump housing while the?

- A. Desired pumping rate is obtained
- B. Horsepower turns the shaft
- C. Water moves up the column
- D. None of the above

483. The rotating shaft in a line shaft turbine is actually housed within the column pipe that delivers the water to the surface.

- A. True
- B. False

484. The size of the \_\_\_\_\_ are selected based on the desired pumping rate and lift requirements.
- A. Impeller(s)            C. Column, impeller, and bowls  
B. Lantern ring            D. None of the above
485. According to the text, column pipe sections can be threaded or coupled together while the drive shaft is coupled and suspended within the column by?
- A. Column pipe            C. Lantern ring  
B. Spider bearings        D. None of the above
486. The water passing through the column pipe serves as the lubricant for the bearings.
- A. True            B. False
487. Which of the following terms, provide both a seal at the column pipe joints and keep the shaft aligned within the column?
- A. Column pipe            C. Lantern ring  
B. Spider bearings        D. None of the above
488. The oil tube is suspended within the column by \_\_\_\_\_, while the line shaft is supported within the oil tube by brass or redwood bearings.
- A. Column pipe            C. Spider flanges  
B. Spider bearings        D. None of the above
489. A continuous supply of \_\_\_\_\_ lubricates the drive shaft as it proceeds downward through the oil tube.
- A. Grease            C. Water  
B. Oil            D. None of the above
490. A small hole located at the top of the \_\_\_\_\_ allows excess oil to enter the well. This results in the formation of an oil film on the water surface within oil-lubricated wells.
- A. Pump bow unit        C. Column pipe  
B. Drive shaft            D. None of the above
491. Often an electric motor that is connected to the \_\_\_\_\_ by a keyway and nut.
- A. Drive shaft            C. Sprocket  
B. Rotor            D. None of the above
492. Where electricity is not readily available, fuel powered engines may be connected to the drive shaft by a?
- A. Gear            C. Right angle drive gear  
B. Drive shaft            D. None of the above
493. Oil and water lubricated systems will have a strainer attached to the \_\_\_\_\_ to prevent sediment from entering the pump.
- A. Intake            C. Inboard  
B. Diaphragm            D. None of the above
494. Time delays or ratchet assemblies are often installed on these motors to either prevent the motor from turning on before \_\_\_\_\_ stops or simply not allow it to reverse at all.
- A. Reverse rotation        C. Time delay or ratchet assembly  
B. Keyway and nut            D. None of the above

**There are three main types of diaphragm pumps:**

495. In the first type, the \_\_\_\_\_ with one side in the fluid to be pumped, and the other in air or hydraulic fluid.

- A. Vapor bubbles
- B. Chamber pressure
- C. Diaphragm is sealed
- D. None of the above

496. The diaphragm is flexed, causing the volume of the pump chamber to increase and decrease.

- A. True
- B. False

497. A pair of \_\_\_\_\_ prevents reverse flow of the fluid.

- A. Return valves
- B. Diaphragms
- C. Non-return check valves
- D. None of the above

498. The second type of diaphragm pump works with volumetric positive displacement, but differs in that the prime mover of the diaphragm is neither oil nor air; but is?

- A. Electro-mechanical
- B. Chamber pressure
- C. Volumetric positive displacement
- D. None of the above

499. The third type of diaphragm pump has one or more springs with the fluid to be pumped on both sides.

- A. True
- B. False

500. When the volume of a chamber of either type of pump is increased (the diaphragm moving up), the pressure decreases, and fluid is drawn into the?

- A. Chamber
- B. Diaphragm
- C. Keyway
- D. None of the above