

**Registration form**

**Disinfection Basics CEU Training Course \$200.00  
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*

Address: \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

Email \_\_\_\_\_ Fax ( \_\_\_\_\_ ) \_\_\_\_\_

Phone:  
Home ( \_\_\_\_\_ ) \_\_\_\_\_ Work ( \_\_\_\_\_ ) \_\_\_\_\_

Operator ID# \_\_\_\_\_ Exp Date \_\_\_\_\_

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

Water Treatment \_\_\_\_\_ Distribution \_\_\_\_\_ Collection \_\_\_\_\_

Wastewater Treatment \_\_\_\_\_ Other \_\_\_\_\_

*Your certificate will be emailed to you in about two weeks.*

**Technical Learning College PO Box 3060, Chino Valley, AZ 86323  
Toll Free (866) 557-1746 Fax (928) 272-0747 [info@tlch2o.com](mailto:info@tlch2o.com)**

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***We will stop mailing the certificate of completion we need your e-mail address. We will e-mail the certificate to you, if no e-mail address; we will mail it to you.***

## **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 caused by this CEU education training course material.

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.

**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.

*You can obtain a printed version of the course from TLC for an additional \$69.95 plus shipping charges.*

**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. Do not solely trust our list for it may be outdated. It is your sole responsibility to ensure this course is accepted for credit.

## **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.

**Do not solely depend on TLC's Approval list for it may be outdated.**

**A second certificate of completion for a second State Agency \$50 processing fee.**

**All downloads are electronically tracked and monitored for security purposes.**

**Some States and many employers require the final exam to be proctored.**

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

# Disinfection Basics CEU Course Answer Key

Name \_\_\_\_\_

Phone \_\_\_\_\_

You are solely responsible in ensuring that this course is accepted for credit by your State.

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

*Method of Course acceptance confirmation. Please fill this section*

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

What is the approval number if Applicable? \_\_\_\_\_

PA DEP Students are required to complete the original version of the text. \_\_\_\_\_  
Please initial

*You are responsible to ensure that TLC receives the Assignment and Registration Key.*

*Please call us to ensure that we received it. No refunds.*

*You can use Adobe Acrobat DC Program to complete the assignment.*

*Please select one answer. You can circle, underline, bold or X the answer.*

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*This course contains general EPA's SDWA federal rule requirements. Please be aware that each state implements water / sampling procedures/safety/ environmental / building 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 fully in compliance and do not follow this course for proper compliance.*

**Please fax the answer key to TLC  
(928) 272-0747  
Always call to confirm that we received your paperwork.**



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

**DISINFECTION BASICS CEU TRAINING 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.**

1. Please rate the difficulty of your course.

Very Easy 0 1 2 3 4 5 Very Difficult

2. Please rate the difficulty of the testing process.

Very Easy 0 1 2 3 4 5 Very Difficult

3. Please rate the subject matter on the exam to your actual field or work.

Very Similar 0 1 2 3 4 5 Very Different

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

5. What would you do to improve the Course?

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How about the price of the course? Poor \_\_ Fair\_\_ Average\_\_ Good \_\_ Great \_\_

How was your customer service? Poor \_\_ Fair\_\_ Average\_\_ Good \_\_ Great \_\_

Any other concerns or comments.

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***Always call to confirm that we received the paperwork.  
Fax (928) 468-0675***



## Disinfection Basics CEU Course Assignment

*The Assignment (Exam) is also 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 the start of this course to complete in order to receive your Professional Development Hours (**PDHs**) or Continuing Education Unit (**CEU**). A score of 70 % is necessary to pass this course. We prefer if this exam is proctored. No intentional trick questions. If you should need any assistance, please email all concerns and the completed manual to [info@tlch2o.com](mailto:info@tlch2o.com).

We would prefer that you utilize the enclosed answer sheet in the front, but if you are unable to do so, type out your own answer key. Please include your name and address on your manual and make copy for yourself.

You can e-mail or fax your Answer Key along with the Registration Form to TLC. **(S) Means answer may be plural or singular. Multiple Choice Section, One answer per question and please use the answer key.**

### Waterborne Pathogens Chapter 1

1. Bacteria, viruses and protozoan that causes disease are known as pathogens.

- A. True      B. False

### How Diseases are Transmitted.

2. For another person to become infected, he or she must take that pathogen in through the mouth.

- A. True      B. False

3. This term means when in nature it is different from other types of pathogens such as the viruses that cause influenza (the flu) or the bacteria that cause tuberculosis.

- A. Fecal Coliform and E coli      D. Waterborne Pathogen(s)  
B. Giardia lamblia      E. Coliform bacteria  
C. Microorganism(s)      F. None of the Above

4. According to the text, \_\_\_\_\_ are spread by secretions that are coughed or sneezed into the air by an infected person.

- A. Fecal Coliform and E coli      D. Influenza virus and tuberculosis bacteria  
B. Giardia lamblia      E. Coliform bacteria  
C. Microorganisms      F. None of the Above

### Safe Drinking Water Act (SDWA) Review

5. The states are expected to administer and enforce these regulations for public water systems (systems that either have 25 or more service connections or regularly serve an average of 50 or more people daily for at least 60 days each year).

- A. True      B. False

6. Public water systems must provide water treatment, ensure proper drinking water quality through monitoring, and provide public notification of contamination problems.

- A. True      B. False

**Relating to prevention of waterborne disease, the SDWA required EPA to:**

7. Set numerical standards, referred to as Maximum Contaminant Levels (MCLs — the highest allowable contaminant concentrations in drinking water) or treatment technique requirements for contaminants in public water supplies;

- A. True      B. False

8. All systems must disinfect, and are not required to filter if certain source water quality criteria and site-specific criteria are met.

- A. True      B. False

9. The regulations set guidelines for determining if treatment, including turbidity (suspended particulate matter) removal and disinfection recommendations, is adequate for filtered systems.

- A. True      B. False

**Microbes**

10. Coliform bacteria are common in the environment and are considered harmful.

- A. True      B. False

11. The presence of coliform bacteria in drinking water indicates that the water may be contaminated with germs that can cause disease.

- A. True      B. False

12. Microbes in human wastes can cause short-term effects, such as diarrhea, cramps, nausea, headaches, or other symptoms and are caused by?

- A. Fecal Coliform and E coli      D. Cryptosporidiosis  
B. Giardia lamblia      E. Coliform bacteria  
C. Microorganisms      F. None of the Above

13. What is the bacteria whose presence indicates that the water may be contaminated with human or animal wastes?

- A. Fecal Coliform and E coli      D. Bac-T  
B. Protozoa      E. Coliform bacteria  
C. Thermophilic      F. None of the Above

14. What is the parasite that enters lakes and rivers through sewage and animal waste? It causes cryptosporidiosis, a mild gastrointestinal disease.

- A. Fecal Coliform and E coli      D. Cryptosporidiosis  
B. Giardia lamblia      E. Cryptosporidium  
C. Microorganisms      F. None of the Above

15. Giardia lamblia is a parasite that enters lakes and rivers through sewage and animal waste. It causes?

- A. Fecal Coliform and E coli      D. Cryptosporidiosis  
B. Gastrointestinal illness      E. Coliform bacteria  
C. Microorganisms      F. None of the Above

## Conclusion

16. Because of emerging waterborne diseases, a new dimension to the global epidemiology of cholera-an ancient scourge-was provided by the emergence of?

- A. Cholera
- B. Legionella pneumophila
- C. Shigellosis
- D. Vibrio cholerae O139
- E. Campylobacter
- F. None of the Above

17. Water authorities are reassessing the adequacy of current water-quality regulations because of outbreaks of chlorine resistant \_\_\_\_\_.

- A. Campylobacter
- B. Pathogen
- C. Pontiac fever
- D. Cryptosporidium
- E. Shigella dysenteriae
- F. None of the Above

18. Lately, all of the following have been associated with waterborne illnesses: hepatitis viruses, Campylobacter jejuni, microsporidia, cyclospora, \_\_\_\_\_, calciviruses and environmental bacteria like Mycobacterium spp, aeromonads, Legionella pneumophila and multidrug-resistant Pseudomonas aeruginosa.

- A. Yersinia enterocolitica
- B. Legionella pneumophila
- C. Shigellosis
- D. Emergence of disinfection resistant variants
- E. Campylobacter
- F. None of the Above

## Salmonella Typhi

19. Humans are the reservoir for the Salmonella typhi pathogen, which causes diarrheal illness, and also known as?

- A. Campylobacter
- B. Pathogen
- C. Pontiac fever
- D. Typhoid fever
- E. Shigella dysenteriae
- F. None of the Above

20. Prevention strategies for this pathogen include source protection, halogenation of water, and?

- A. Adding chlorine
- B. Adding sodium chlorite
- C. Adding KNO<sub>4</sub>
- D. Adding NH<sub>4</sub>
- E. Boiling water for one minute
- F. None of the Above

## Shigella Species

21. Shigella species, in the United States two-thirds of the shigellosis in the U.S. is caused by Shigella sonnei, and the remaining one-third is caused by Shigella flexneri.

- A. True
- B. False

22. Campylobacter, the basics. It's a bacterium. It causes diarrheal illness. Campylobacter is primarily associated with poultry, animals, and humans.

- A. True
- B. False

23. 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

24. Legionnaire's disease, which causes a severe pneumonia, and the second, \_\_\_\_\_, which is a nonpneumonia illness; it's typically an influenza-like illness, and it's less severe.
- A. Campylobacter      D. Typhoid fever  
 B. Pathogen            E. Shigella dysenteriae  
 C. Pontiac fever      F. None of the Above
25. Legionella, prevention. Legionella in water systems. Hot water in tanks should be maintained between \_\_\_\_\_ degrees Centigrade.
- A. 81 to 100            D. 71 and 77  
 B. 110 to 210         E. 75 and 85  
 C. 75 – 212            F. None of the Above
26. Pseudomonas, the basics. It's a protozoon. It is caused by visual contact with water. It can cause dermatitis, which is an inflammation of the skin, or it can cause otitis, which is an infection of the ear.
- A. True            B. False
27. Which of the following terms is typically associated with soil and water?
- A. Hepatitis A virus      D. Pseudomonas  
 B. Diarrheal illness      E. Waterborne outbreaks  
 C. Cryptosporidium      F. None of the Above
28. Pseudomonas prevention. Proper maintenance and disinfection of recreational water systems is important in preventing \_\_\_\_\_.
- A. Pathogen            D. Pseudomonas  
 B. Cryptosporidium      E. Salmonellosis  
 C. Hepatitis A virus      F. None of the Above
29. Humans are the reservoir for the Norovirus. Prevention strategies for this pathogen include?
- A. Maintaining water systems      D. Containment protection  
 B. Source protection                E. Internal protection  
 C. Chlorine monoxide                F. None of the Above
30. Cryptosporidium causes diarrheal illness known as \_\_\_\_\_.
- A. Vomiting            D. Cryptosporidiosis  
 B. Hemorrhagic colitis      E. Salmonellosis  
 C. Diarrhea            F. None of the Above
31. Cryptosporidium is typically associated with animals and humans, and it can be acquired through consuming fecally contaminated food, contact with fecally contaminated soil and water.
- A. True            B. False
32. Giardia prevention strategies for this pathogen include \_\_\_\_\_; filtration, coagulation, and halogenation of drinking water.
- A. Maintaining hot water systems      D. Primary protection  
 B. Source protection                      E. Secondary measurements  
 C. Sulfur dioxide                          F. None of the Above

33. 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. Pseudomonas
  - E. Salmonellosis
  - F. None of the Above

### Water Bacteriological Monitoring

#### Repeat Sampling

34. Repeat sampling replaces the old check sampling with a more comprehensive procedure to try to \_\_\_\_\_ areas in the system.
- A. Double check the routine sample
  - B. Identify problem
  - C. Originate the sampling location
  - D. Sample
  - E. Calculate MCL compliance
  - F. None of the Above
35. According to the text, whenever a Routine sample is total coliform or fecal coliform present, a set of repeat samples must be collected within how many hours after being notified by the laboratory.
- A. 12
  - B. 24
  - C. 48
  - D. 10
  - E. 2
  - F. None of the Above
36. Repeat samples must be collected from: The original sampling location of the?
- A. Routine sample
  - B. Surface water
  - C. Coliform present sample
  - D. Sample
  - E. MCL area
  - F. None of the Above
37. Within five (5) service connections upstream from the?
- A. Routine sample
  - B. Surface water
  - C. Original sampling location
  - D. Sample
  - E. MCL location
  - F. None of the Above
38. Within five (5) service connections downstream from the?
- A. Routine sample site
  - B. Surface water location
  - C. Original sampling location
  - D. Sample area
  - E. MCL compliance area
  - F. None of the Above
39. Samples should be taken elsewhere in the \_\_\_\_\_ or at the wellhead, if necessary.
- A. Sewage system
  - B. Surface system
  - C. Sampling location
  - D. Distribution system
  - E. MCL compliance calculation
  - F. None of the Above
40. In a very small system if the system has only \_\_\_\_\_, the repeat samples must be collected from the same sampling location over a four-day period or on the same day.
- A. Routine water
  - B. Surface water
  - C. One sampling location
  - D. One service connection
  - E. MCL compliance zone
  - F. None of the Above
41. If a repeat sample is necessary, all repeat samples are included in the?
- A. Routine sample
  - B. Surface water
  - C. Original sampling location
  - D. Sample
  - E. MCL compliance calculation
  - F. None of the Above

42. Generally speaking, and depending on your State, if a system which normally collects fewer than five (5) routine samples per month has a coliform present sample; it must collect five (5) routine samples the following \_\_\_\_\_ regardless of whether a MCL violation occurred or if repeat sampling was coliform absent.

- A. Week
- B. Hour
- C. Immediately
- D. Day
- E. Month or quarter
- F. None of the Above

**Positive or Coliform Present Results**

43. According to the text, if you are notified of a positive test result you need to contact either the Drinking Water Program or your local county health department within 24 hours, or by the next business day after the?

- A. Results are reported to you
- B. Positive violation
- C. Repeat sampling immediately
- D. Sample violation
- E. MCL compliance violation
- F. None of the Above

44. Which of the following is important to initiate as the corrective measures will be based on those results?

- A. Storage and distribution
- B. Repeat sampling immediately
- C. Upgrading of the wellhead area
- D. Perform routine procedures
- E. Corrective measures
- F. None of the Above

**Maximum Contaminant Levels (MCLs)**

45. State and federal laws establish standards for drinking water quality. Under normal circumstances when these guidelines are being met, the water is somewhat safe to drink with little threat to human health.

- A. True
- B. False

46. EPA had developed standards that are known as maximum contaminant levels (MCL). When a particular contaminant exceeds this term a potential health threat may occur.

- A. Coliform bacteria count
- B. MCL
- C. Standards
- D. HPC
- E. CFU
- F. None of the Above

47. This acronym generally expresses properties of the contaminants, risk assessments and factors, short-term (acute) exposure and long-term (chronic) exposure.

- A. Coliform bacteria
- B. MCLs
- C. Standards
- D. HPC
- E. CFU
- F. None of the Above

48. When you as the operator take samples to ensure your water is in compliance with the MCL, there are two types of \_\_\_\_\_ for coliform bacteria.

- A. Coliform bacteria
- B. MCLs
- C. Standards
- D. MCL violations
- E. CFU
- F. None of the Above

49. The first type of \_\_\_\_\_ 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. Coliform bacteria
- B. MCLs
- C. Standards
- D. MCL violations
- E. CFU
- F. None of the Above



### Heterotrophic Plate Count HPC

50. Heterotrophic Plate Count (HPC) --- formerly known as the Standard plate count, 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

51. Colonies may arise from pairs, chains, clusters, or single cells, are included in the term?

- A. Coliform bacteria units      D. HPC units  
B. MCLs units      E. Colony-forming units  
C. Standards      F. None of the Above

### Spread Plate Method

52. During this method, colonies are on the \_\_\_\_\_ where they can be distinguished readily from particles and bubbles.

- A. Agar surface      D. Bottom  
B. Surface growth area      E. Material  
C. Top      F. None of the Above

53. During the Spread Plate Method, colonies can be transferred quickly, and \_\_\_\_\_ easily can be discerned and compared to published descriptions.

- A. Colonies grow      D. Heterotrophic organisms will grow  
B. Surface growth      E. Colony morphology  
C. Low counts      F. None of the Above

### Membrane Filter Method

54. This method permits testing large volumes of \_\_\_\_\_ and is the method of choice for low-count waters.

- A. Colonies      D. Heterotrophic organisms  
B. Surface water      E. MCL  
C. Low-turbidity water      F. None of the Above

### Heterotrophic Plate Count (Spread Plate Method)

55. \_\_\_\_\_ use inorganic carbon sources, this is in contrast to Heterotrophic organisms utilize organic compounds as their carbon source?

- A. Colonies      D. Heterotrophic organisms  
B. Surface growth      E. Autotrophic organisms  
C. AGAR      F. None of the Above

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

- A. Colonies      D. Heterotrophic Plate Count  
B. Heat      E. MCL  
C. Agar      F. None of the Above

57. The R2A agar provides a medium that will support a large variety of?

- A. Colonies      D. Heterotrophic bacteria  
B. Bugs      E. MCL  
C. Germs      F. None of the Above

**Total Coliforms**

58. 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

59. 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. 5            D. 200
- B. 10          E. 40
- C. 100        F. None of the Above

60. For systems which collect \_\_\_\_\_ or more samples per month, no more than five (5) percent may be Positive, check with your state drinking water section or health department for further instructions.

- A. 5            D. 200
- B. 10          E. 40
- C. 100        F. None of the Above

**Acute Risk to Health (Fecal coliforms and E. coli)**

61. A(n) \_\_\_\_\_ to human health violation occurs if either one of the following happens:

- A. Routine analysis    D. Human health violation
- B. Drinking violation   E. Fecal coliform or E. coli is present
- C. Acute risk            F. None of the Above

62. A routine analysis shows total coliform present and followed by a repeat analysis that indicates?

- A. Routine analysis            D. Human health violation
- B. Drinking violation          E. Fecal coliform or E. coli present
- C. Water penalty                F. None of the Above

63. A routine analysis shows total and \_\_\_\_\_ is followed by a repeat analysis that indicates total coliform present.

- A. Routine analysis            D. Human health violations
- B. Drinking water violation   E. Fecal coliform or E. coli present
- C. MCL violation                F. None of the Above

64. \_\_\_\_\_ requires the water system to provide public notice via radio and television stations in the area?

- A. Routine analysis violation            D. Human health violation
- B. Drinking water rule violation        E. Acute health risk violation
- C. MCL violation                          F. None of the Above

65. According to the text, the type of contamination can pose an immediate threat to human health and notice must be given as soon as possible, but no later than 24 hours after notification from your laboratory of the test results.

- A. True      B. False

### Public Notice

66. A public notice is required to be issued by a water system whenever it fails to comply with an applicable MCL or \_\_\_\_\_, or fails to comply with the requirements of any scheduled variance or permit.

- A. Routine analysis
- B. Drinking water rule
- C. Treatment technique
- D. Human health violation
- E. Fecal coliform or E. coli present
- F. None of the Above

67. This term best describes what also is required whenever a water system fails to comply with its monitoring and/or reporting requirements or testing procedure.

- A. Routine analysis
- B. Drinking water rule
- C. MCL violation
- D. Public notice
- E. Fecal coliform or E. coli present count
- F. None of the Above

68. There shall be certain information, be issued properly and in a timely manner, and contain certain \_\_\_\_\_ on the public notice.

- A. Legal analysis
- B. Drinking water rule information
- C. NOVs
- D. Mandatory language
- E. Fecal language
- F. None of the Above

69. If there is a(n) \_\_\_\_\_ present to users, the timing and place of posting of the public notice may have different priorities.

- A. Routine analysis
- B. Drinking water rule
- C. Acute risk
- D. Human health violation
- E. Fecal coliform or E. coli present
- F. None of the Above

### The following are acute violations:

70. Which is term used for a violation of nitrate?

- A. Presence
- B. MCL
- C. MCLG
- D. Count
- E. Acute violations
- F. None of the Above

71. Concerning total coliforms - when fecal coliforms or E. coli are present in the distribution system and is a violation of the?

- A. Presence
- B. MCL
- C. MCLG
- D. Count
- E. Acute violations
- F. None of the Above

72. Any outbreak of \_\_\_\_\_, as defined by the rules.

- A. Total coliforms
- B. MCL
- C. Waterborne disease
- D. Radioactive bacteria
- E. Acute violations
- F. None of the Above

### Microbial Regulations

73. 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 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 Giardia and viruses by at least 99.9% and 99.99%, respectively.

- A. True
- B. False

74. The EPA established a MCL of 0.0010 for all public water systems and a 99% removal requirement for Cryptosporidium in filtered public water systems that serve at least 100,000 people. The new rule will tighten turbidity standards by December 2001.

- A. True      B. False

75. Color is an indicator of the physical removal of particulates, including pathogens.

- A. True      B. False

76. Which rule improves physical removal of Cryptosporidium, and to maintain control of pathogens?

- A. Long Term 1 Enhanced Surface Water Treatment Rule  
B. Maximum Contaminant Level Goal (MCLG)  
C. Stage 1 Disinfectants/Disinfection Byproducts Rule  
D. Surface Water Treatment Rule  
E. Interim Enhanced Surface Water Treatment Rule  
F. None of the Above

### **Bromate**

77. Fill in the missing information in order. \_\_\_\_\_ is a chemical that is formed when \_\_\_\_\_ used to disinfect drinking water reacts with naturally occurring \_\_\_\_\_ found in source water.

- A. Bromate, Ozone, Chlorite      D. Hydrogen sulfide, Water, Nitrogen  
B. Bromide, Bromate, Ozone      E. Bromate, Ozone, Bromide  
C. Bromate, Bromate, Bromate      F. None of the Above

78. What is the annual average for Bromate that was established in the Stage 1 Disinfectants/Disinfection Byproducts Rule?

- A. 1 part per billion      D. 10 parts per million  
B. 10 parts per billion      E. 500 parts per million  
C. 100 parts per billion      F. None of the Above

### **Chlorite**

79. According to the Stage 1 Disinfectants/Disinfection Byproducts Rule, what is the monthly average level of chlorite in drinking water?

- A. 1 part per million      D. 10 parts per million  
B. 10 parts per billion      E. 500 parts per million  
C. 100 parts per billion      F. None of the Above

### **Disinfection Introduction**

80. Selecting the right \_\_\_\_\_ requires understanding several factors governing the particular site and the water or wastewater to be treated.

- A. Operating costs      D. Operating method  
B. Disinfection weapon      E. Net-positive environmental benefit  
C. UV device      F. None of the Above

81. Safety. A system will often require significant safety protection—such as use of breathing apparatus and protective clothing—as well as high levels of operator training, it may be advisable to explore other, \_\_\_\_\_.

- A. Disinfectant systems      D. Less intensive systems  
B. Narrow tolerance      E. Acceptable standards  
C. Desired parameters      F. None of the Above

82. What should be made for the effects of both intentional and unintentional releases to the environment even if the disinfectant is considered relatively safe to use?

- A. Operating costs
- B. Other than chlorine
- C. Considerations
- D. Dosage
- E. Net-positive environmental benefit
- F. None of the Above

83. An operator's treatment intent should be to reduce the levels of pathogens to acceptable standards and understanding how effective the disinfectant system is in achieving?

- A. Target levels
- B. Narrow tolerance
- C. Desired parameters
- D. Net-positive environmental benefit
- E. Acceptable standards
- F. None of the Above

84. If the disinfection system is complex it may require additional staff time to ensure that it operates within the?

- A. Disinfectant system
- B. Narrow tolerance
- C. Desired parameters
- D. Net-positive environmental benefit
- E. Acceptable standards
- F. None of the Above

85. Other than chlorine, there are primarily four basic disinfection systems currently available—chlorination, ozone gas, ultraviolet radiation, and Chemical treatment.

- A. True
- B. False

86. An operator of an onsite water or wastewater treatment plant needs to consider some of the safeguards that need to be in place as well.

- A. True
- B. False

87. One decision an operator can make is to install a system could be the result of local concerns and potential to mitigate health risks, as well as?

- A. Improved community relations
- B. Narrow tolerance
- C. Desired parameters
- D. Net-positive environmental benefit
- E. Acceptable standards
- F. None of the Above

### Introduction to Chlorine (DDBP)

88. These terms means that chlorine is present as  $\text{Cl}$ ,  $\text{HOCl}$ , and  $\text{OCl}^-$  is called \_\_\_\_\_, and that which is bound but still effective is \_\_\_\_\_.

- A. Free available chlorine and Total
- B. Free and Residual
- C. Break point and Free
- D. Free available chlorine and Combined Chlorine
- E. Combined chlorine and Readily available
- F. None of the Above

89. Chloramines are formed by reactions with \_\_\_\_\_.

- A. Acid and  $\text{Cl}_2$
- B. Ammonia and  $\text{Cl}_2$
- C. THMS and  $\text{Cl}_2$
- D. Folic Acid and  $\text{Cl}_2$
- E. THMs and Haploidic acid
- F. None of the Above

90. While testing chlorine disinfection process, you will need to understand one especially important feature is the ease of overdosing to create a " \_\_\_\_\_ " concentration.

- A. Free available chlorine and Total
- B. Residual
- C. Break point and Free
- D. Free available chlorine and Combined Chlorine
- E. Combined chlorine and Readily available
- F. None of the Above

91. According to the text, this type of chlorine residual concentration residual is from 0.1 to 0.5 ppm.
- A. Free available chlorine and Total
  - B. Residual
  - C. Break point and Free
  - D. Free available
  - E. Combined chlorine and Readily available
  - F. None of the Above

92. Typically, this type of chlorine residual is 2 ppm?
- A. Free available chlorine and Total
  - B. Residual
  - C. Break point and Free
  - D. Combined Chlorine
  - E. Combined chlorine and Readily available
  - F. None of the Above

### Chlorine By-Products

93. The most common chlorination by-products found in U.S. drinking water supplies are?
- A. Chlorate and Chlorite
  - B. CO<sub>2</sub> and H<sub>2</sub>SO<sub>4</sub>
  - C. Trihalomethanes (THMs)
  - D. Ammonia and THMS
  - E. Chloramines
  - F. None of the Above

### The Principal Trihalomethanes are:

94. Chloroform, bromodichloromethane, chlorodibromomethane, and bromoform. Other less common chlorination by-products include the haloacetic acids and haloacetonitriles.
- A. True
  - B. False

95. The amount of THMs formed in drinking water can be influenced by a number of factors, including the season and the source of the water.
- A. True
  - B. False

96. THM concentrations are generally higher in winter than in summer, because concentrations of natural organic matter are greater and more chlorine is required to disinfect at colder temperatures.
- A. True
  - B. False

97. THM levels are also low when wells or large lakes are used as the drinking water source, because organic matter concentrations are generally low in these sources. The opposite — high organic matter concentrations and high THM levels — is true when rivers or other surface waters are used as the source of the drinking water.
- A. True
  - B. False

### Health Effects

98. The available studies on health effects do not provide conclusive proof of a relationship between exposure to THMs and cancer or reproductive effects, but indicate the need for further research to confirm their results and to assess the potential health effects of chlorination by-products other than THMs.
- A. True
  - B. False

### Risks and Benefits of Chlorine

99. Many cities utilize the use of ozone to disinfect their source water and to reduce formation of this parameter?
- A. Chlorate and Chlorite
  - B. CO<sub>2</sub> and H<sub>2</sub>SO<sub>4</sub>
  - C. Trihalomethanes (THMs)
  - D. Ammonia and THMS
  - E. Chloramines
  - F. None of the Above

100. \_\_\_\_\_ is a highly effective disinfectant, it breaks down quickly, so that small amounts of \_\_\_\_\_ or other disinfectants must be added to the water to ensure continued disinfection as the water is piped to the consumer's tap.

- A. Ozone, Chlorine
- B. UV, Chlorine
- C. Chlorite, Chlorine
- D. Chlorine Dioxide, Chlorine
- E. Chloramines, Chlorine
- F. None of the Above

101. Modifying water treatment facilities to use \_\_\_\_\_ can be expensive, and \_\_\_\_\_ treatment can create other undesirable by-products that may be harmful to health if they are not controlled (e.g., bromate).

- A. Ozone
- B. UV
- C. Chlorite
- D. Chlorine Dioxide
- E. Chloramines
- F. None of the Above

102. This term is a weaker disinfectant than chlorine, especially against viruses and protozoa; however, they are very persistent and, as such, can be useful for preventing re-growth of microbial pathogens in drinking water distribution systems.

- A. Ozone
- B. UV
- C. Chlorite
- D. Chlorine Dioxide
- E. Chloramines
- F. None of the Above

103. Chlorine dioxide can be an effective disinfectant, but it forms?

- A. Chlorate and Chlorite
- B. CO<sub>2</sub> and H<sub>2</sub>SO<sub>4</sub>
- C. THMS
- D. Ammonia and THMS
- E. Chloramines
- F. None of the Above

104. It is extremely important that water treatment plants ensure that methods used to control chlorination by-products do not compromise the effectiveness of water disinfection.

- A. True
- B. False

### **Disinfection Byproduct Regulations Summary**

105. Regulators and the public have focused greater attention on potential health risks from chemical contaminants in drinking water. One such concern relates to disinfection byproducts (DBPs), chemical compounds formed unintentionally when chlorine and other disinfectants react with certain inorganic matter in water.

- A. True
- B. False

106. Water system managers may also consider switching from chlorine to alternative disinfectants to reduce formation of THMs and HAAs.

- A. True
- B. False

107. All chemical disinfectants form some DBPs. Much less is known about the byproducts of these alternatives than is known about chlorination byproducts. Furthermore, each disinfection method has other distinct advantages and disadvantages.

- A. True
- B. False

### **Halogens**

108. All Halogens have 7 electrons in their outer shells, giving them an oxidation number of -1. The halogens exist, at room temperature, in all three states of matter:

- A. True
- B. False

## Principles of Modern Chemistry

109. What is the study of elementary particles, atoms, molecules, substances, metals, crystals and other aggregates of matter?

- A. Nuclear chemistry
- B. Neurochemistry
- C. Organic chemistry
- D. Analytical chemistry
- E. Traditional chemistry
- F. None of the Above

110. Chemistry is generally the study of various result of interactions between atoms, leading to rearrangements of the \_\_\_\_\_ which hold atoms together. Such behaviors are studied in a chemistry laboratory.

- A. Chemical bonds
- B. Chemical substance(s)
- C. Chemical(s)
- D. Chemical compound
- E. Physical chemistry
- F. None of the Above

111. Which of the following terms is a transformation of some substances into one or more different substances?

- A. Chemical element(s)
- B. An electron
- C. Atom
- D. A chemical reaction
- E. Energy and entropy
- F. None of the Above

112. \_\_\_\_\_ means the basis of a chemical transformation is the rearrangement of electrons in the chemical bonds between atoms. It can be symbolically depicted through a, which usually involves atoms as subjects.

- A. Chemical element(s)
- B. Metamorphous
- C. Chemistry
- D. Chemical reaction
- E. Chemical equation
- F. None of the Above

113. The number of atoms on the left and the right in the equation for a \_\_\_\_\_ is equal.

- A. Chemical transformation
- B. Atomic balance
- C. Chemical propertie(s)
- D. The type of chemical reaction(s)
- E. Mixture of substances
- F. None of the Above

114. What is the term that expresses a type of chemical reaction and the energy changes that may accompany it are constrained by certain basic rules?

- A. Chemical substance(s)
- B. Atomic balancing
- C. Chemical propertie(s)
- D. Chemical law(s)
- E. Mixture of substances
- F. None of the Above

115. What important considerations are invariably important in almost all chemical studies?

- A. Chemical element(s)
- B. An electron
- C. The type of chemical reaction(s)
- D. Mixture of substances
- E. Energy and entropy
- F. None of the Above

116. What are classified in terms of their structure, phase, as well as their chemical compositions?

- A. Chemical substance(s)
- B. Atom(s)
- C. Chemical propertie(s)
- D. The type of chemical reaction(s)
- E. Mixture of substances
- F. None of the Above



**Matter**

117. This term is generally defined as anything that has rest mass and volume (it takes up space) and is made up of particles.

- A. Chemical element(s)
- B. An electron
- C. Atom
- D. Matter
- E. Energy and entropy
- F. None of the Above

118. The particles that make up matter have rest mass as well - not all particles have rest mass, such as?

- A. Chemical element(s)
- B. An electron
- C. Atom
- D. The photon
- E. Energy and entropy
- F. None of the Above

119. According to the text, Matter can be a pure chemical substance or?

- A. Chemical bond(s)
- B. Chemical substance(s)
- C. Chemical(s)
- D. Forms of energy
- E. A mixture of substances
- F. None of the Above

**Atom**

120. What is the space that contains dense core the atomic nucleus?

- A. Chemical element(s)
- B. An electron
- C. Atom
- D. Photon
- E. Electron cloud
- F. None of the Above

121. The nucleus is dense; the mass of a nucleon is 1,836 times that of an electron, yet the radius of \_\_\_\_\_ is about 10,000 times that of its nucleus.

- A. Nucleus
- B. An electron
- C. An atom
- D. Ion
- E. Cloud
- F. None of the Above

122. What is the smallest entity that can be envisaged to retain the chemical properties of the element?

- A. Nucleus
- B. An electron
- C. The atom
- D. Negatively-charged electron(s)
- E. Positively charged proton(s)
- F. None of the Above

**Element**

123. The standard presentation of the \_\_\_\_\_ is in the periodic table, which orders elements by atomic number.

- A. Chemical element(s)
- B. An electron
- C. Atom
- D. Photon
- E. Energy and entropy
- F. None of the Above

**Compound**

124. The properties of a compound bear little similarity to those of its?

- A. Chemical bond(s)
- B. Elements
- C. Chemical(s)
- D. Forms of energy
- E. Physical chemistry
- F. None of the Above

### Substances versus Mixtures

125. All matter consists of various elements and \_\_\_\_\_, but these are often intimately mixed together.

- A. Chemical compounds
- B. Chemical substance(s)
- C. Isomer(s)
- D. Mixture(s)
- E. Chemical mixtures
- F. None of the Above

### Chemicals versus Chemical Substances

126. What is the best term that is synonymous with "chemical" for professional chemists, the meaning of the word chemical varies for non-chemists?

- A. Organometallic compound(s)
- B. Chemical mixtures
- C. Isomer(s)
- D. Mixture(s)
- E. Chemical substance(s)
- F. None of the Above

### Molecule

127. What is the best term that composes familiar substances such as water, air, and many organic compounds like alcohol, sugar, gasoline, and the various pharmaceuticals.

- A. Identifiable molecules
- B. Ions
- C. A molecule
- D. Existence of identifiable molecule(s)
- E. Isolated chemical element(s)
- F. None of the Above

128. One of the main characteristics of a \_\_\_\_\_ is its geometry often called its structure.

- A. Molecule(s)
- B. Ionic compounds
- C. Structure
- D. Charged polyatomic collection(s)
- E. A chemical substance
- F. None of the Above

### Substance and Mixture

129. What is the best term that is a kind of matter with a definite composition and set of properties?

- A. Molecule(s)
- B. Ionic compounds
- C. Structure
- D. Charged polyatomic collection(s)
- E. A chemical substance
- F. None of the Above

### Mole and Amount of Substance

130. The mole is a unit of measurement that denotes an amount of substance also called?

- A. An amount of substance
- B. A triple point
- C. Crystal structure
- D. Chemical amount
- E. Multipole balance
- F. None of the Above

### Bonding

131. Atoms sticking together in \_\_\_\_\_ are said to be bonded with one another.

- A. An amount of substance
- B. A triple point
- C. Molecules or crystals
- D. Pressure or temperature
- E. Multipole balance
- F. None of the Above

132. More than simple attraction and repulsion, the energies and distributions characterize the availability of an electron to bond to?

- A. Chemical element(s)
- B. An electron
- C. Another atom
- D. Photon
- E. A chemical bond
- F. None of the Above

## Energy

133. What type of transformation is accompanied by a change in one or more of these kinds of structures, it is invariably accompanied by an increase or decrease of energy of the substances involved?

- A. Chemical reaction(s)
- B. Energy exchange
- C. Chemical equation
- D. Breaking of chemical bonds
- E. Chemical
- F. None of the Above

## pH Section

134. What is the theory that states that an acid is a substance that produces Hydronium ions when it is dissolved in water, and a base is one that produces hydroxide ions when dissolved in water?

- A. Newton's
- B. Alkalinity
- C. Lord Calvin's
- D. Amadeus
- E. Arrhenius
- F. None of the Above

135. What is the term associated with a charged species, an atom or a molecule, that has lost or gained one or more electrons?

- A. A proton
- B. Ion
- C. Anti-matter
- D. An electron
- E. A cation
- F. None of the Above

136. What is a substance that has the ability to reduce other substances and is said to be reductive in nature?

- A. Protons
- B. An electron donor
- C. Anti-matter
- D. Electrons
- E. Cations
- F. None of the Above

137. In chemistry, pH is a measure of the acidity or basicity of an aqueous solution. Solutions with a pH less than 7 are said to be acidic and solutions with a pH greater than 7 are basic or alkaline. Pure water has a pH very close to?

- A. 5
- B. 6
- C. 7
- D. 7.7
- E. 7.5
- F. None of the Above

138. According to the manual, which of the following parameter/methods/measurements determine a parameter using a concentration cell with transference by measuring the potential difference.

- A. Primary pH standard values
- B. Alkalinity
- C. pH
- D. pH measurement(s)
- E. Measurement of pH
- F. None of the Above

139. Mathematically speaking, pH is the negative logarithm of the activity of the (solvated) hydronium ion, often expressed as the measurement of?

- A. Electrons
- B. Alkalinity
- C. Hydronium ion concentration
- D. Cation measurement(s)
- E. Ions
- F. None of the Above

140. When measuring alkalinity in determining a stream's ability to neutralize acidic pollution from rainfall or wastewater, this measurement can be one of the best measures of the sensitivity of the stream to acid inputs.

- A. True
- B. False

141. One definition of pH is that it is defined as the decimal logarithm of the reciprocal of the \_\_\_\_\_,  $a_{H^+}$ , in a solution.

- A. Hydrogen ion activity
- B. Ion-selective electrode(s)
- C. (Solvated) hydronium ion
- D. Brønsted–Lowry acid–base theory
- E. Acid-base behavior
- F. None of the Above

142. When using a visual comparison of the test solution with a standard color chart, measuring pH values should be done to the?

- A. Universal indicator
- B. Colorwheel measurement
- C. Nearest whole number
- D. Spectrophotometer Example
- E. Lab test
- F. None of the Above

143. According to the manual, this device/method/calculation consists of a mixture of indicators which shows a continuous color change from pH 2 to pH 10.

- A. Universal indicator
- B. Colorimeter of spectrophotometer
- C. Spectrophotometer
- D. Excess of alkaline earth metal concentrations
- E. A set of non-linear simultaneous equations
- F. None of the Above

144. Which of the following terms is an example of a mathematical procedure for calculating the concentrations of all chemical species that are present in the solution?

- A. Universal indicator
- B. pH log
- C. A set of linear equations
- D. Chemical speciation calculation
- E. A set of non-linear simultaneous equations
- F. None of the Above

145. According to the manual, under normal circumstances, strong acids and bases are compounds that, for practical purposes, are completely dissociated in water, this means that the concentration of hydrogen ions in acidic solution can be taken to be equal to the concentration of the acid. The pH is then equal to minus the logarithm of?

- A. The concentration value
- B. The pH
- C. The Spectrophotometer
- D. End-point pH
- E. A set of non-linear simultaneous equations
- F. None of the Above

146. The sum of all the titratable bases is the Alkalinity of water and its acid-neutralizing capacity. What would cause the measured value to vary significantly?

- A. Acid
- B. Alkalinity
- C. pH
- D. pH measurement(s)
- E. End-point pH
- F. None of the Above

147. For strong acids and bases no calculations are necessary except in extreme situations. The pH of a solution containing a weak acid requires the solution of a quadratic equation.

- A. True
- B. False

148. If the pH of a solution contains a weak base, this may require?

- A. The solution of a cubic equation
- B. The solution of a linear equation
- C. The solution of a squared equation
- D. A set of linear simultaneous equations
- E. A set of non-linear simultaneous equations
- F. None of the Above

149. While the general case requires the pH solution of?

- A. The solution of a cubic equation
- B. The solution of a linear equation
- C. The solution of a squared equation
- D. A set of linear simultaneous equations
- E. A set of non-linear simultaneous equations
- F. None of the Above

150. Because alkalinity is significant in many uses and treatments of natural waters and wastewaters, the measured values also may include contributions from \_\_\_\_\_ or other bases if these are present.

- A. Acids
- B. Light metals
- C. Rare earths
- D. Borates, phosphates, silicates
- E. Caustics
- F. None of the Above

151. Since pH is a logarithmic scale, a difference of one pH unit is equivalent to a \_\_\_\_\_ difference in hydrogen ion concentration

- A. 1
- B. 2
- C. 5
- D. 10
- E. 100
- F. None of the Above

152. According to the manual, this key water measurement is used in the interpretation and control of water and wastewater treatment processes.

- A. Acid
- B. Alkalinity
- C. pH
- D. Chemical ion
- E. Hydrogen bond formation
- F. None of the Above

153. These compounds for all practical purposes, are completely dissociated in water.

- A. Strong acids and bases
- B. Strong bases
- C. Chemical ions in chains
- D. Strong bases and weak acids
- E. Weak acids and weak bases
- F. None of the Above

154. Sodium hydroxide, NaOH, is an example of?

- A. Strong acid and base
- B. Strong base
- C. Weak base
- D. Strong base and weak acid
- E. Weak acids and weak bases
- F. None of the Above

155. According to the text, what is the pH of pure water at 50 °C?

- A. 7.7
- B. 8.0
- C. 9.0
- D. 6.55
- E. 7.00
- F. None of the Above

### Hard Water Section

156. Water contains various amounts of \_\_\_\_\_, some of which impart a quality known as hardness. Consumers frequently complain about problems attributed to hard water, such as the formation of scale on cooking utensils and hot water heaters.

- A. Water hardness
- B. Carbonate hardness
- C. The calcium-magnesium distinction
- D. Calcium (Ca) and magnesium (Mg)
- E. Dissolved minerals
- F. None of the Above

### Occurrence of Hard Water

157. Hard water is caused by soluble, divalent, \_\_\_\_\_, (positive ions having valence of 2). The principal chemicals that cause water hardness are calcium (Ca) and magnesium (Mg).

- A. Water hardness
- B. Metallic cations
- C. Carbon dioxide (CO<sub>2</sub>)
- D. Calcium (Ca) and magnesium (Mg)
- E. Noncarbonate hardness
- F. None of the Above

## Chlorine Section

### Chlorine's Appearance and Odor (QA/QC)

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

- A. 32 degrees
- B. - 100 degrees
- C. 129 degrees
- D. 29 degrees
- E. -29.2 degrees
- F. None of the Above

### Reactivity

159. Conditions Contributing to Instability: Cylinders of chlorine may burst when exposed to elevated temperatures. When there is Chlorine in solution, this forms?

- A. Hydrogen sulfide
- B. Oxomonosilane
- C. Ammonia
- D. A characteristic pungent odor
- E. A corrosive material
- F. None of the Above

160. Contact between chlorine and arsenic, bismuth, boron, calcium, activated carbon, carbon disulfide, glycerol, hydrazine, iodine, methane, oxomonosilane, potassium, propylene, and silicon should be avoided.

- A. True
- B. False

161. Chlorine reacts with hydrogen sulfide and water to form this substance?

- A. Hydrogen sulfide
- B. Oxomonosilane
- C. Sodium Chloride
- D. Chlorinates
- E. Hydrochloric acid
- F. None of the Above

162. According to the text, chlorine is also incompatible with?

- A. Air
- B. Ammonia
- C. Sodium Chloride
- D. Hydrogen sulfide
- E. Moisture, steam, and water
- F. None of the Above

### Flammability

163. Keep unnecessary people away; isolate the hazard area and deny entry. For a massive fire in a cargo area, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from the area and let the fire burn. Emergency personnel should stay out of low areas and Ventilate closed spaces before entering.

- A. True
- B. False

### What Happens to Chlorine When it Enters the Environment?

164. When chlorine is released to soil, chlorine will react with moisture forming?

- A. Free oxygen radicals
- B. Chlorine gas
- C. Hydrochloric acid
- D. A greenish-yellow, noncombustible gas
- E. Hypochlorous acid and hydrochloric acid
- F. None of the Above

165. According to the text, chlorine does not accumulate in the?

- A. Food chain
- B. Bacteria and viruses
- C. In air
- D. Water
- E. Treatment filter
- F. None of the Above

166. When released to air, chlorine will react with water to form hypochlorous acid and hydrochloric acid, which are removed from the atmosphere by generation of free oxygen radicals.

- A. True
- B. False

167. Chlorine reacts with water to form hypochlorous acid and hydrochloric acid. The hypochlorous acid breaks down rapidly. The hydrochloric acid also breaks down; its breakdown products will raise the pH of the water (makes it more basic).  
A. True      B. False

### Disinfectant Qualities

168. Chlorine is so important in poultry processing that the US Department of Agriculture requires an almost constant chlorine rinse for much of the cutting equipment. In fact, no proven economical alternative to chlorine disinfection exists for use in Meat and poultry processing facilities.  
A. True      B. False

### Properties

169. Because it is highly reactive, chlorine is usually found in nature bound with other elements like sodium, potassium, and magnesium.  
A. True      B. False

170. In studying and \_\_\_\_\_ -- compounds that have at least one atom of the element carbon in their molecular structure. All living organisms, including humans, are composed of organic compounds.  
A. Synthesizing organic compounds      D. Organic compounds  
B. Chlorine disinfection compounds      E. Abundant chemical elements  
C. Chlorine inorganic compounds      F. None of the Above

171. Various states of chlorine includes when chlorine is isolated as a free element, chlorine is a greenish yellow gas, which is \_\_\_\_\_. It turns to a liquid state at  $-34^{\circ}\text{C}$  ( $-29^{\circ}\text{F}$ ), and it becomes a yellowish crystalline solid at  $-103^{\circ}\text{C}$  ( $-153^{\circ}\text{F}$ ).  
A. 2.5 times heavier than water      D. 2.5 times heavier than air  
B. 2.5 times lighter than air      E. 25 times heavier than air  
C. 10 times heavier than air      F. None of the Above

### Chlorine's Effectiveness

172. There are several factors when considering chlorine residual. The effectiveness of chlorination depends on the \_\_\_\_\_ of the water, the concentration of the chlorine solution added, the time that chlorine is in contact with the organism, and water quality.  
A. Chlorine residual      D. Chlorination  
B. Color change      E. Required contact time  
C. Chlorine demand      F. None of the Above

173. Sometimes chlorine is not available for disinfection because \_\_\_\_\_ in the water (like iron, manganese, hydrogen sulfide, and ammonia).  
A. pH increases      D. Required contact time  
B. Chlorine level and water quality      E. Part of it combines with other chemicals  
C. Free chlorine residual      F. None of the Above

174. The amount of chlorine required to achieve disinfection and that reacts with the other chemicals is the?  
A. Chlorine residual      D. Total  
B. Color change      E. Free chlorine residual  
C. Chlorine demand      F. None of the Above

175. The \_\_\_\_\_ to disinfect decreases, as the concentration of the chlorine increases.

- A. pH increases
- B. Chlorine level and water quality
- C. Free chlorine residual
- D. Required contact time
- E. Not available for disinfection
- F. None of the Above

176. Chlorination is more effective as?

- A. Chlorine residual
- B. Colors change
- C. Chlorine demand
- D. Water cools down
- E. Water temperature increases
- F. None of the Above

177. Chlorination becomes more alkaline and is less effective as the?

- A. Water's pH increases
- B. Water quality increases
- C. Free chlorine residual drops
- D. Required contact time is maximized
- E. Contact time
- F. None of the Above

178. Chlorination is less effective in?

- A. Clear water
- B. Color change
- C. Warm temps
- D. Day time
- E. Cloudy (turbid) water
- F. None of the Above

179. By adding a little more chlorine to what is already sufficient, this action will generally result in \_\_\_\_\_ that can be measured easily.

- A. pH increases
- B. Chlorine level and water quality
- C. Chlorine demand
- D. Required contact time
- E. A free chlorine residual
- F. None of the Above

### Chemistry of Chlorination

180. The hypochlorite ion is a much weaker disinfecting agent than Hypochlorous acid, about 100 times less effective.

- A. True
- B. False

181. 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
- B. CT actual
- C. Free chlorine residual
- D. "CT" disinfection concept
- E. Ratio of hypochlorous acid
- F. None of the Above

182. Under normal water conditions, hypochlorous acid will also chemically react and break down into the hypochlorite ion.

- A. True
- B. False

183. Temperature plays a small part in the acid ratio. Although the ratio of \_\_\_\_\_ is greater at lower temperatures, pathogenic organisms are actually harder to kill.

- A. Hypochlorous acid
- B. The amount of chlorine
- C. Chlorine Demand
- D. Total chlorine
- E. pH value and temperature
- F. None of the Above



184. If all other things were equal, \_\_\_\_\_ and a lower pH are more conducive to chlorine disinfection.

- A. Lower pH
- B. Hypochlorous acid
- C. Higher water temperatures
- D. Lower water temperature
- E. The hypochlorite ion
- F. None of the Above

185. The disassociation of chlorine gas

(OCI<sup>-</sup>): HOCl H<sup>+</sup> + OCI<sup>-</sup> Also expressed HOCl → H<sup>+</sup> + OCI<sup>-</sup>  
(hypochlorous acid) (hydrogen) (hypochlorite ion)

- A. True
- B. False

186. All three forms of chlorine produce Sodium hypochlorite when added to water.

- A. True
- B. False

187. Hypochlorous acid is a strong acid but a weak disinfecting agent. The amount of hypochlorous acid depends on the pH and temperature of the water.

- A. True
- B. False

### Types of Residual

188. \_\_\_\_\_ is all chlorine that is available for disinfection.

- A. Chlorine residual
- B. Chlorine demand
- C. Free chlorine
- D. Break-point chlorination
- E. Total chlorine
- F. None of the Above

189. Total chlorine residual = free + \_\_\_\_\_.

- A. Chlorine residual
- B. Chlorine demand
- C. Free chlorine
- D. Combined chlorine residual
- E. Total chlorine residual
- F. None of the Above

190. In water, there are always other substances (interfering agents) such as iron, manganese, turbidity, etc., which will combine chemically with the chlorine. This is called the \_\_\_\_\_.

- A. Chlorine residual
- B. Chlorine demand
- C. Pathogen reduction
- D. Break-point chlorination
- E. Total chlorine residual
- F. None of the Above

191. Which of the following terms is a much stronger disinfecting agent?

- A. Free chlorine
- B. Total residual
- C. Free chlorine residual
- D. "CT" disinfection concept
- E. T10 of the process unit
- F. None of the Above

192. Which of the following terms is where the chlorine demand has been satisfied, and any additional chlorine will be considered free chlorine?

- A. Chlorine residual
- B. Chlorine demand
- C. Free chlorine
- D. Break-point chlorination
- E. Total chlorine residual
- F. None of the Above

### Residual Concentration/Contact Time (CT) Requirements

193. Since monitoring for very low levels of pathogens in treated water is analytically very difficult, utilizing the \_\_\_\_\_ is recommended to demonstrate satisfactory treatment.

- A. Free chlorine
- B. Total residual
- C. Free chlorine residual
- D. "CT" disinfection concept
- E. T10 of the process unit
- F. None of the Above

### Calculation and Reporting of CT Data

194. Reduction Ratio should be reported, along with the appropriate pH, temperature, and?

- A. Reduction Ratio
- B. CT actual
- C. Free chlorine residual
- D. Disinfectant residual
- E. T10 of the process unit
- F. None of the Above

195. This term must be greater than 1.0 to be acceptable.

- A. Reduction Ratio
- B. CT actual
- C. Free chlorine residual
- D. "CT" disinfection concept
- E. T10 of the process unit
- F. None of the Above

196. You can also calculate and record actual log reductions. Reduction Ratio = CT actual divide by?

- A. Reduction Ratio
- B. CT
- C. Free chlorine residual
- D. "CT" disinfection concept
- E. CT required
- F. None of the Above

197. Which term shall be calculated daily, using either the maximum hourly flow and the disinfectant residual at the same time, or by using the lowest CT value if it is calculated more frequently?

- A. Free chlorine
- B. Total residual
- C. Free chlorine residual
- D. "CT" disinfection concept
- E. Disinfection CT values
- F. None of the Above

### Chlorine Review

198. What term describes the minimum amount of Chlorine needed to react in a water purification system; used as a monitoring measurement by system operators?

- A. Chlorine Demand
- B. Liquid
- C. Total chlorine
- D. Monitoring measurement
- E. Ammonia or organic amines
- F. None of the Above

199. Operator may add \_\_\_\_\_ to chlorinated public water supplies to provide inorganic chloramines.

- A. Combined chlorine
- B. Liquid
- C. Total chlorine
- D. Ammonia
- E. Organic amines
- F. None of the Above

200. What term describes the concentration of residual chlorine in water present as dissolved gas ( $\text{Cl}_2$ ), hypochlorous acid ( $\text{HOCl}$ ), and/or hypochlorite ion ( $\text{OCl}^-$ ).

- A. Chlorine Demand
- B. Chlorine total
- C. Free Chlorine
- D. Total chlorine
- E. Residual chlorine
- F. None of the Above

201. What term describes the concentration of chlorine in the water after the chlorine demand has been satisfied? The concentration is normally expressed in terms of total chlorine residual, which includes both the free and combined or?

- A. Chlorine Residual
- B. Chlorine Demand
- C. Combined
- D. Total chlorine
- E. Residual chlorine
- F. None of the Above

202. \_\_\_\_\_ describes the amount of chlorine used up in a water purification system; used as a monitoring measurement by system operators.

- A. Chlorine Residual
- B. Chlorine Demand
- C. Combined Chlorine Residual
- D. Total chlorine
- E. Residual chlorine
- F. None of the Above

203. What term describes the residual chlorine existing in water in chemical combination with ammonia or organic amines that can be found in natural or polluted waters?

- A. Chlorine Residual
- B. Chlorine Demand
- C. Combined Chlorine Residual
- D. Total chlorine
- E. Residual chlorine
- F. None of the Above

204. Which of the following terms of at least 1.0 mg/L should be maintained in the clear well or distribution reservoir immediately downstream from the point of post-chlorination and .2 mg/L in the distribution system to guard against backflow?

- A. Chlorine Demand
- B. Chlorine total
- C. Free chlorine residual
- D. Total chlorine
- E. Residual chlorine
- F. None of the Above

205. \_\_\_\_\_ describes the total of free residual and combined residual chlorine in a water purification system; and used as a monitoring measurement by system operators?

- A. Chlorine Demand
- B. Chlorine total
- C. Total Chlorine Residual
- D. Total combined chlorine
- E. Residual chlorine
- F. None of the Above

206. What term describes the total chlorine is essentially equal to free chlorine since the concentration of ammonia or organic nitrogen compounds will be very low. When chloramines are present in the municipal water supply, then total chlorine will be higher than free chlorine.

- A. Chlorine Demand
- B. Chlorine total
- C. Combined chlorine
- D. Total chlorine
- E. Residual chlorine
- F. None of the Above

207. The correct procedure to follow in changing a chlorine cylinder, hook up the Chlorinator to the container or cylinder with the chlorine valve turned on. Use the liquid side not the gas if using a 1-ton container. Remove the cylinder valve outlet cap and check the valve face or damage.

- A. True
- B. False

208. When changing the cl<sub>2</sub> cylinder, clean with wire brush if necessary. If the valve face is smooth, clean proceed with hooking up the cylinder. Check the inlet face of the \_\_\_\_\_ and clean if necessary.

- A. Fusible plug
- B. Chlorine cylinder
- C. Chlorinator
- D. Chlorine valve
- E. Yoke
- F. None of the Above

209. Place a new lead gasket on the chlorinator inlet, place the chlorinator on the cylinder valve, install the yoke clamp and slowly tighten the Yoke clamp until the two faces are against the lead gasket. Tighten the yoke, compressing the gasket one-half to three quarters turn, do not over tighten. Replace the lead gasket with every change out.

- A. True      B. False

### Common Terms

210. What is the best term that describes chlorine addition of chlorine at the plant headworks or prior to other water treatment or groundwater production processes and mainly used for disinfection and control of tastes, odors, and aquatic growth?

- A. Chlorination      D. Demand  
B. Post-chlorination      E. Pre-chlorination  
C. Chlorine Demand      F. None of the Above

211. \_\_\_\_\_ best describes the sum of free and combined chlorine.

- A. Organic amine(s)      D. Breakpoint chlorination  
B. Disinfection      E. Total Chlorine  
C. Free chlorine      F. None of the Above

212. When chlorinating most potable water supplies, total chlorine is essentially equal to \_\_\_\_\_ since the concentration of ammonia or organic nitrogen compounds (needed to form combined chlorine) will be very low.

- A. Chlorination      D. Total chlorine  
B. The amount of chlorine      E. Free chlorine  
C. Chlorine Demand      F. None of the Above

213. What term best describes the residual chlorine existing in water in chemical combination with ammonia or organic amines that can be found in natural or polluted waters?

- A. Combined chlorine      D. Breakpoint chlorination  
B. Disinfection      E. Total chlorine residual  
C. Free chlorine      F. None of the Above

214. Ammonia is sometimes deliberately added to chlorinated public water supplies to provide?

- A. Chlorination      D. Flavor  
B. Inorganic chloramines      E. Increase pH value  
C. Chlorine Demand      F. None of the Above

215. What term best describes the concentration of residual chlorine in water present as dissolved gas ( $\text{Cl}_2$ ), hypochlorous acid ( $\text{HOCl}$ ), and/or hypochlorite ion ( $\text{OCI}^-$ )?

- A. Organic amine(s)      D. Breakpoint chlorination  
B. Disinfection      E. Total chlorine residual  
C. Free chlorine      F. None of the Above

216. What term best describes the minimum amount of chlorine needed to react in a water purification system; used as a monitoring measurement by system operators?

- A. Chlorination      D. Total chlorine  
B. The amount of chlorine      E. Disinfection  
C. Chlorine Demand      F. None of the Above

217. What term best describes the concentration of chlorine in the water after the chlorine demand has been satisfied.

- A. Chlorine Residual
- B. Disinfection
- C. Free chlorine
- D. Breakpoint chlorination
- E. Total chlorine residual
- F. None of the Above

218. What term best describes this missing term, which includes both the free and combined or chemically bound chlorine residuals?

- A. Chlorine Residual
- B. Disinfection
- C. Free chlorine
- D. Chlorine Demand
- E. Total chlorine residual
- F. None of the Above

219. What term best describes the addition of chlorine after a process or adding chlorine downstream to meet a Demand in the system.

- A. Chlorination
- B. Post-chlorination
- C. Chlorine Demand
- D. Demand
- E. Pre-chlorination
- F. None of the Above

220. Solid chlorine is about 1.5 times heavier than water and gaseous chlorine is about 2.5 times heavier than air. Atomic number of chlorine is 17. Cl is the elemental symbol and Cl<sub>2</sub> is the chemical formula.

- A. True
- B. False

221. What term best reacts with bacteria as if it was very corrosive and burns the skin or covering killing the bacteria?

- A. Chlorine tablet(s)
- B. Chlorine
- C. Solid chlorine
- D. Sodium and calcium hypochlorite
- E. Calcium hypochlorite
- F. None of the Above

222. What term best describes the addition of Cl<sub>2</sub> to the water until the Cl<sub>2</sub> demand is satisfied. Until all the microorganisms are killed?

- A. Organic amine(s)
- B. Disinfection
- C. Free chlorine
- D. Breakpoint chlorination
- E. Total chlorine residual
- F. None of the Above

223. What term best describes the amount of chlorine used up in a water purification system; used as a monitoring measurement by system operators?

- A. Chlorination
- B. Total
- C. Chlorine Demand
- D. Total chlorine
- E. Combined Chlorine Residual
- F. None of the Above

224. According to the text, a free chlorine residual of at least 10 mg/L should be maintained in the clear well or distribution reservoir immediately downstream from the point of post-chlorination and 2 mg/L in the distribution system to guard against backflow.

- A. True
- B. False

225. What term best describes the total of free residual and combined residual chlorine in a water purification system; used as a monitoring measurement by system operators?
- A. Organic amine(s)    D. Breakpoint chlorination  
 B. Disinfection        E. Total Chlorine Residual  
 C. Free chlorine        F. None of the Above
226. If chloramines are present in the municipal water supply, total chlorine should be higher than?
- A. Organic amine(s)        D. Breakpoint chlorination  
 B. Disinfection            E. Total chlorine residual  
 C. Free chlorine            F. None of the Above
227. What term best describes the method of water disinfection where gaseous, liquid, or dissolved chlorine is added to a water supply system?
- A. Chlorination            D. Sterilization  
 B. Disinfection            E. Free chlorine  
 C. Chlorine Demand        F. None of the Above
228. What term best describes the killing of everything?
- A. Sterilization            D. Breakpoint chlorination  
 B. Disinfection            E. Total chlorine meltdown  
 C. Free chlorine            F. None of the Above
229. Physical and chemical properties of chlorine: A yellowish green, nonflammable and liquefied gas with an unpleasant and irritating smell. Can be readily compressed into a clear, amber-colored liquid, a noncombustible gas, and a Strong oxidizer.
- A. True            B. False
230. Hook up the chlorinator to the container or cylinder with the chlorine valve turned off. Use the \_\_\_\_\_ not the liquid if using a 1-ton container.
- A. Cylinder valve outlet cap    D. Safety device  
 B. Cylinder valve            E. Gas side  
 C. Yoke                      F. None of the Above
231. Check the valve face for damage after removing the \_\_\_\_\_ and clean with wire brush if necessary. If the valve face is smooth, clean proceed with hooking up the cylinder.
- A. Cylinder valve outlet cap    D. Safety device  
 B. Cylinder valve            E. Lead gasket  
 C. Yoke                      F. None of the Above
232. According to the text, always check the \_\_\_\_\_ of the chlorinator and clean if necessary.
- A. Cylinder valve outlet cap    D. Inlet face  
 B. Cylinder valve            E. Gasket  
 C. Yoke                      F. None of the Above
233. Tighten the \_\_\_\_\_, compressing the gasket one-half to three quarters turn, do not over tighten. Replace the lead gasket with every change out.
- A. Cylinder valve outlet cap    D. Safety device  
 B. Cylinder valve            E. Lead gasket  
 C. Yoke                      F. None of the Above

### Chlor-Alkali Membrane Process

234. The electrolysis occurs in a cell containing electrodes submerged in solutions called electrolytes. One electrode is referred to as the anode and is submerged in?

- A. Chlorination
- B. Caustic soda
- C. Chlorine ion
- D. Chlor-alkali membrane process
- E. A salt water solution
- F. None of the Above

235. The second electrode is the cathode and is submerged in a \_\_\_\_\_ solution.

- A. Oxidizing chemical(s)
- B. A salt water solution
- C. Sodium
- D. Sodium hydroxide (caustic soda)
- E. Sodium and chlorine ions
- F. None of the Above

236. Which of the following terms is used to keep the two different solutions from mixing. This particular method of producing chlorine is called the chlor-alkali membrane process?

- A. A membrane
- B. Caustic soda
- C. Chlorine ion
- D. Chlor-alkali membrane process
- E. Required contact time
- F. None of the Above

### Chlorine's Effectiveness

237. Chlorination depends on the chlorine demand of the water, the concentration of the chlorine solution added, the time that \_\_\_\_\_ is in contact with the organism, and water quality.

- A. Oxidizing chemical(s)
- B. Chlorine
- C. Sodium
- D. Caustic soda
- E. Sodium and chlorine ions
- F. None of the Above

238. This term is less effective in cloudy (turbid) water.

- A. Oxidizing chemical(s)
- B. Chlorination
- C. Sodium
- D. Caustic soda
- E. Sodium and chlorine ions
- F. None of the Above

239. \_\_\_\_\_ is less effective as the water's pH increases (becomes more alkaline).

- A. Chlorination
- B. Caustic soda
- C. Chlorine ion
- D. Chlor-alkali membrane process
- E. Required contact time
- F. None of the Above

240. When chlorine is added to the water supply, part of it combines with other chemicals in water (like iron, manganese, \_\_\_\_\_) and is not available for disinfection.

- A. Hydrogen sulfide, and ammonia
- B. Caustic soda
- C. Chlorine ion
- D. Chlor-alkali membrane process
- E. Required contact time
- F. None of the Above

241. This term best describes an amount of substance that reacts with the other chemicals and the amount required to achieve disinfection is the chlorine demand of the water.

- A. Oxidizing chemical(s)
- B. Chlorine
- C. Sodium
- D. Caustic soda
- E. Sodium and chlorine ions
- F. None of the Above

242. If the concentration of the \_\_\_\_\_ increases, the required contact time to disinfect decreases.
- A. Chlorination
  - B. Caustic soda
  - C. Chlorine
  - D. Chlor-alkali membrane process
  - E. Required contact time
  - F. None of the Above

243. Which of the following terms is more effective as water temperature increases?
- A. Oxidizing chemical(s)
  - B. Chlorination
  - C. Sodium
  - D. Caustic soda
  - E. Sodium and chlorine ions
  - F. None of the Above

### **Oxidation Chemistry**

244. Oxidizing chemicals are often utilized in water treatment programs include: chlorine, chlorine dioxide, bromine, bromine/chlorine releasing compounds, ozone and Hydrogen peroxide.
- A. True
  - B. False

245. One oxidant is chlorine dioxide, which destroys these proteins depriving the cell of its ability to carry out \_\_\_\_\_ and quickly kills it.
- A. Effects of life
  - B. Numerous processes
  - C. Functionality
  - D. Operations of Cellular amino acids
  - E. Fundamental life functions
  - F. None of the Above

### **Chlorine Gas Section**

246. When chlorine is added into the water stream, chlorine hydrolyzes into?

- A. HCL
- B. Sodium hypochlorite
- C. Bromoform
- D. Chlorine Acid
- E. Hypochlorous acid (HOCl), and hydrochloric acid (HCl)
- F. None of the Above

247. When chlorine hydrolyzation occurs, it provides an active toxicant, \_\_\_\_\_, which is pH-dependent. In alkaline cooling systems, it readily dissociates to form the hypochlorite ion (OCI-).

- A. HCl
- B. HOCl
- C. High chlorine concentrations
- D. pH of 7.0 than at pH 8.5
- E. The hypochlorite ion (OCI-)
- F. None of the Above

248. Considerably more \_\_\_\_\_ is present at a pH of 7.0 than at pH 8.5.

- A. HCl
- B. HOCl
- C. High chlorine concentrations
- D. Alkanitinity
- E. Hypochlorite ion (OCI-)
- F. None of the Above

249. Chlorine can be non-selective, making it very sensitive to contamination from either cooling water makeup or from in-plant process leaks. \_\_\_\_\_, organic acids and organic compounds, sulfides, iron and manganese all easily react with HOCl.

- A. Chlorine
- B. Sodium hypochlorite
- C. Ammonia
- D. Chlorine gas
- E. Hypochlorous acid (HOCl), and hydrochloric acid (HCl)
- F. None of the Above

250. What is the term that best describes the amount of chlorine needed to react with contamination species and it must be satisfied before active HOCl is available to provide a free chlorine residual?

- A. Chlorine demand
- B. HOCl
- C. High chlorine concentration
- D. Total residual
- E. The hypochlorite ion (OCI-)
- F. None of the Above



251. The combination of high chlorine demand in process-contaminated systems and the dissociation process in alkaline systems creates the need for greater chlorine feed to obtain the same microbial efficacy. This results in a higher concentration of HCl in the cooling system.

- A. True      B. False

252. Which of the following terms removes alkalinity, pH depression and system corrosion could occur. In low pH water, the passive metal oxide layers protecting the metal may resolubilize, exposing the surface to corrosion?

- A. HCl      D. pH of 7.0 than at pH 8.5  
B. HOCl      E. the hypochlorite ion (OCl-)  
C. High chlorine concentrations      F. None of the Above

253. According to the text, which substance can damage or penetrate the passive oxide layer, leading to localized damage of the metal surface?

- A. Chlorine      D. Chlorine gas  
B. Sodium hypochlorite      E. Hypochlorous acid (HOCl), and hydrochloric acid (HCl)  
C. The chloride ion (Cl-)      F. None of the Above

### Pathophysiology

254. According to the text, respiratory exposure to \_\_\_\_\_ may be prolonged because its moderate water solubility may not cause upper airway symptoms for several minutes. In addition, the density of the gas is greater than that of air, causing it to remain near ground level and increasing exposure time.

- A. Hydrochloric acid      D. The chemical species produced  
B. Chlorine gas      E. Plasma exudation  
C. The gas      F. None of the Above

255. Because chlorine gas is so dangerous, the odor threshold for chlorine is approximately?

- A. 1 parts per million (ppm)      D. 3-5 parts per million (ppm)  
B. 3 parts per million (ppm)      E. 0.3-0.5 parts per million (ppm)  
C. 10 parts per million (ppm)      F. None of the Above

### Mechanism of Activity

256. The mechanisms of cellular injury are believed to result from the oxidation of functional groups in cell components, from reactions with tissue water to form \_\_\_\_\_, and from the generation of free oxygen radicals.

- A. Generation of free oxygen radicals      D. A caustic effect  
B. Chlorine acid      E. Hypochlorous and hydrochloric acid  
C. Hydrochloric acid      F. None of the Above

257. Chlorine gas feeds out of the cylinder through a gas regulator. The cylinders are on a scale that operators use to measure the amount used each day. The chains are used to prevent the tanks from falling over.

- A. True      B. False

258. Chlorine gas should be stored in vented rooms that have panic bar equipped doors.

- A. True      B. False

### **Solubility Effects**

259. Which of the following terms may account for the toxicity of elemental chlorine and hydrochloric acid to the human body.

- A. Hydrochloric acid
- B. H<sub>2</sub>SO<sub>4</sub>
- C. Hypchloric acid
- D. Hypochlorous acid
- E. Sulfuric Acid
- F. None of the Above

### **Early Response to Chlorine Gas**

260. If you mix ammonia with chlorine gas, this compound reacts to form?

- A. Hypochlorous acid
- B. Chlorine gas
- C. Hydrochloric acid
- D. Sulfuric acid
- E. Chloramine gas
- F. None of the Above

261. The early response to the odor threshold for chlorine depends on the (1) concentration of chlorine gas, (2) duration of exposure, (3) water content of the tissues exposed, and (4) individual susceptibility.

- A. True
- B. False

### **Immediate Effects**

262. Which of the following answers is the best choice for the immediate effects of this substance's toxicity include acute inflammation of the conjunctivae, nose, pharynx, larynx, trachea, and bronchi?

- A. Hydrochloric acid
- B. Chlorine gas
- C. Hypochlorous gas
- D. Sulfuric acid
- E. HOCL
- F. None of the Above

### **Pathological Findings**

263. Chlorine is a highly reactive gas.

- A. True
- B. False

264. Chlorine gas is greenish yellow in color and very toxic. It is heavier than air and will therefore sink to the ground if released from its container. It is the toxic effect of Chlorine gas that makes it a good disinfectant, but it is toxic to more than just waterborne pathogens; it is also toxic to humans. It is a respiratory irritant and it can also irritate skin and mucus membranes.

- A. True
- B. False

265. Chlorine gas is sold as a compressed liquid, which is amber in color. Chlorine, as a solid, is heavier (less dense) than water. If the chlorine liquid is released from its container, it will quickly return back to its liquid state.

- A. True
- B. False

266. Chlorine gas is the most expensive form of chlorine to use. The typical amount of chlorine gas required for water treatment is 1-16 mg/L of water. Different amounts of chlorine gas are used depending on the quality of water that needs to be treated. If the water quality is good, a higher concentration of chlorine gas will be required to disinfect the water if the contact time cannot be increased.

- A. True
- B. False



275. Which substance decomposes in water to release chlorine and oxygen; sodium hypochlorite solutions can react with acids or ammonia to release chlorine or chloramine?

- A. Calcium hypochlorite
- B. Hypochlorous Acid (HOCl)
- C. Oxygen and chlorine
- D. Chlorine tablet(s)
- E. Hypochlorite ion
- F. None of the Above

**Description**

276. Solid chlorine stands alone as the safest form of chlorine disinfection. Requiring only minimal safety equipment for handling, users can breathe easy knowing our tablets are safe for both people and the environment. The elimination of costly scrubbers, containment, or hazard response capability, guarantees lower initial costs and reduced operating expense.

- A. True
- B. False

277. Sodium hypochlorite is generally available as a white powder, pellets, or flat plates. It decomposes readily in water or when heated, releasing oxygen and chlorine. It has a strong chlorine odor, but odor may not provide an adequate warning of hazardous concentrations.

- A. True
- B. False

**Capacity**

278. Which of the following shall have the capacity to dose enough chlorine to overcome the demand and maintain the required concentration of the "free" or "combined" chlorine.

- A. The chlorinator
- B. Constant flow rate(s)
- C. Uninterrupted chlorination
- D. Automatic proportional controlled
- E. Constant pre-established dosage
- F. None of the Above

**Methods of Control**

279. Which of the following shall be automatic proportional controlled, automatic residual controlled, or compound loop controlled?

- A. A chlorine feed system
- B. Constant flow rate(s)
- C. Uninterrupted chlorination
- D. Automatic proportional controlled
- E. Constant pre-established dosage
- F. None of the Above

280. Which piece of chlorination equipment adjusts the chlorine feed rate automatically in accordance with the flow changes to provide a constant pre-established dosage for all rates of flow?

- A. Manual chlorine feed systems
- B. Constant flow rate(s)
- C. Uninterrupted chlorination
- D. Automatic proportional controlled
- E. Constant pre-established dosage
- F. None of the Above

281. Which piece of chlorination equipment, the feed rate of the chlorinator is controlled by a flow proportional signal and a residual analyzer signal to maintain particular chlorine residual in the water?

- A. Gas vacuum line
- B. Compound loop control system
- C. Manual chlorine feed systems
- D. Mechanical gas proportioning equipment
- E. After post chlorination
- F. None of the Above

282. Which piece of chlorination equipment may be installed for groundwater systems with constant flow rates?

- A. Manual chlorine feed systems
- B. Constant flow rate(s)
- C. Uninterrupted chlorination
- D. Automatic proportional controlled
- E. Constant pre-established dosage
- F. None of the Above

### Standby Provision

283. As a safeguard against \_\_\_\_\_, standby chlorination equipment having the capacity to replace the largest unit shall be provided.

- A. Flow change(s)
- B. Constant flow rate(s)
- C. Uninterrupted chlorination
- D. Malfunction and/or shut-down
- E. Constant pre-established dosage
- F. None of the Above

284. For uninterrupted chlorination, \_\_\_\_\_ shall be equipped with an automatic changeover system. In addition, spare parts shall be available for all chlorinators.

- A. Flow change(s)
- B. Constant flow rate(s)
- C. Gas chlorinators
- D. Automatic proportional controlled
- E. Constant pre-established dosage
- F. None of the Above

### Weigh Scales

285. Scales for weighing cylinders shall be provided at all plants using chlorine gas to permit an accurate reading of total daily weight of chlorine used. At large plants, scales of the recording and indicating type are recommended. As a minimum, a platform scale shall be provided. Scales shall be of corrosion-resistant material.

- A. True
- B. False

### Securing Cylinders

286. All chlorine cylinders shall be securely positioned to safeguard against movement. Tag the cylinder "empty" and store flat and chained. Ton containers may be stacked.

- A. True
- B. False

### Chlorine Leak Detection

287. Which of the following related chlorine alarm equipment shall be installed at all water treatment plants using chlorine gas?

- A. Caustic soda solution reaction tanks
- B. Corrosion resistant
- C. Securely positioned
- D. Automatic chlorine leak detection
- E. Chlorine room ventilation system
- F. None of the Above

288. Which of the following related chlorine alarm equipment should be connected to a remote audible and visual alarm system and checked on a regular basis to verify proper operation?

- A. The chlorinator
- B. The facility
- C. All chlorine cylinders
- D. The chlorine gas leakage
- E. Chlorine leak detection equipment
- F. None of the Above

289. Which of the following related chlorine alarm equipment shall not automatically activate the chlorine room ventilation system in such a manner as to discharge chlorine gas?

- A. Caustic soda solution reaction tanks
- B. Corrosion resistant
- C. Leak detection equipment
- D. Automatic chlorine leak detection
- E. Chlorine room ventilation system
- F. None of the Above

290. During an emergency, if the chlorine room is occupied, the chlorine gas leakage shall be contained within the chlorine room itself in order to facilitate a proper method of clean-up.

- A. True
- B. False

291. Consideration should also be given to the provision of caustic soda solution reaction tanks for absorbing the contents of leaking one-ton cylinders where such cylinders are in use.

- A. True      B. False

292. Chlorine leak detection equipment may not be required for very small chlorine rooms with an exterior door (e.g., floor area less than 3m<sup>2</sup>).

- A. True      B. False

293. You can use a spray solution of ammonia or a rag soaked with sulfur dioxide to detect a small Cl<sub>2</sub> leak. If there is a leak, the sulfur dioxide will create a white colored smoke - Sulfuric chloride.

- A. True      B. False

### **Chlorine Room Design Requirements**

294. Where gas chlorination is practiced, the gas cylinders and/or the ton containers up to the vacuum regulators shall be housed in a gas-tight, well illuminated, corrosion resistant and?

- A. Mechanically ventilated enclosure      D. Automatic chlorine leak detection  
B. Corrosion resistant      E. Chlorine room ventilation system  
C. Securely positioned      F. None of the Above

### **Ventilation**

295. \_\_\_\_\_ should be louvered near the ceiling, the air being of such temperature as to not adversely affect the chlorination equipment?

- A. The ceiling      D. Automatic chlorine leak detection  
B. The chlorine room      E. Chlorine room ventilation system  
C. Air inlets      F. None of the Above

296. Which chlorine safety related equipment term should be outside the room at all entrance or viewing points, and a clear wire-reinforced glass window?

- A. Gas chlorine room      D. Automatic chlorine leak detection  
B. The chlorine room      E. Separate switches for fans and lights  
C. Chlorine room ventilation system      F. None of the Above

### **Heating**

297. \_\_\_\_\_ shall be protected to ensure that the chlorine maintains its gaseous state when entering the chlorinator?

- A. Cylinders or containers      D. Automatic chlorine leak detection  
B. Corrosion resistant      E. Chlorine room ventilation system  
C. Securely positioned      F. None of the Above

### **Storage of Chlorine Cylinders**

298. If necessary, \_\_\_\_\_ may be provided to simply store the chlorine gas cylinders, with no connection to the line.

- A. Cylinders or containers      D. Uncontrolled release of spilled gas  
B. The outside of the room      E. Air inlets  
C. A separate storage room      F. None of the Above

### Scrubbers

299. According to the text, facilities located within residential or densely populated areas, consideration shall be given to provide scrubbers for \_\_\_\_\_.

- A. A panic button
- B. The chlorine room
- C. Scrubber(s)
- D. The chlorine gas storage room
- E. The chlorine cylinder storage room
- F. None of the Above

### Chlorine Health Hazard Section

300. Which term expresses low levels of chlorine results in eye, nose, and throat irritation, sneezing, Excessive salivation, general excitement, and restlessness.

- A. Rambling
- B. Inhalation
- C. Acute exposure
- D. Chronic exposure
- E. Immediate attention after inhalation
- F. None of the Above

301. Which term expresses low levels of chlorine gas can result in a dermatitis known as chloracne, tooth enamel corrosion, coughing, sore throat, hemoptysis and increased susceptibility to tuberculosis?

- A. Rambling
- B. Inhalation
- C. Acute exposure
- D. Chronic exposure
- E. Immediate attention after inhalation
- F. None of the Above

### Inhalation

302. Which term expresses coughing, sneezing, shortness of breath, sensation of tightness in the chest, as well as severe restlessness or Anxiety, nausea, and vomiting?

- A. Rambling
- B. Inhalation
- C. Acute exposure
- D. Chronic exposure
- E. Immediate attention after inhalation
- F. None of the Above

303. The nose and throat may become irritated; a stinging and burning sensation may be experienced. Immediate fatalities can occur as a result of suffocation. Delayed fatalities can occur as a result of pulmonary edema (fluid in the lungs). For this reason, rest and immediate attention after inhalation is important.

- A. True
- B. False

304. If breathing has stopped, give artificial respiration; if breathing is difficult, give oxygen if equipment and trained personnel are available. If exposed person is breathing, place in a comfortable position and keep person warm and at rest until medical assistance becomes available.

- A. True
- B. False

### Eye/Skin Contact

305. Liquid and concentrated gas could produce severe?

- A. Burns and injury on contact
- B. Plasma exudation
- C. General excitement
- D. Chronic exposure to low levels of chlorine gas
- E. Inhalation due to stress
- F. None of the Above

### Pre-hospital Management

306. Rescue personnel are at low risk of noncardiogenic pulmonary edema contamination from victims who have been exposed only to gases released from hypochlorite solutions. However, clothing or skin soaked with industrial-strength bleach or similar solutions may be corrosive to rescuers and may release harmful gases.

- A. True      B. False

307. Ingestion of hydrochlorite solutions rarely causes pain in the mouth or throat, dysphagia, stridor, drooling, odynophagia, and vomiting.

- A. True      B. False

308. Chronic exposure to gases released from ammonia solutions can cause coughing, eye and nose irritation, lacrimation, and a burning sensation in the chest.

- A. True      B. False

### Hot Zone

309. Which term is the area that rescuers should be trained and appropriately attired before entering?

- A. Support Zone      D. Decontamination area  
B. Warm zone      E. Hot Zone  
C. Chemical-protective clothing area      F. None of the Above

### Rescuer Protection

310. Which of the following terms is irritating to the skin and eyes and in some cases may release toxic gases.

- A. Hydrothromine      D. Sodium dichloroisocyanurate (NaDCC)  
B. Hypochlorite      E. Ammonia  
C. Chloramine      F. None of the Above

311. Positive-pressure, self-contained breathing apparatus (SCBA) is recommended in response to situations that involve exposure to potentially unsafe levels of?

- A. Chlorine tablet(s)      D. Solid hypochlorite or concentrated solutions  
B. Hypochlorite      E. Hypochlorous Acid  
C. Chlorine gas      F. None of the Above

312. Chemical-protective clothing should be worn due to the risk of skin irritation and burns from direct contact with?

- A. Chlorine tablet(s)      D. Solid hypochlorite or concentrated solutions  
B. Hypochlorite      E. Hypochlorous Acid  
C. Chlorine gas      F. None of the Above

### ABC Reminders

313. If a person is over taken with chlorine gas exposure, quickly establish a \_\_\_\_\_, ensure adequate respiration and pulse.

- A. Support Zone      D. Delay decontamination  
B. Patient airway      E. Hot Zone to the Decontamination Zone  
C. Chemical-protective clothing      F. None of the Above



### Victim Removal

314. During the chlorine evacuation, if victims can walk, lead them out of the? A. Decontamination area D. Chemically contaminated zone  
B. Hot Zone E. Hot Zone to the Decontamination Zone  
C. Chemical-free zone F. None of the Above

### Decontamination Zone

315. Victims may be transferred immediately to the \_\_\_\_\_. All others require decontamination.  
A. Support Zone D. Decontamination area  
B. Patient Zone E. Hot Zone to the Decontamination Zone  
C. Chemical free zone F. None of the Above

### Rescuer Protection

316. Decontamination may be conducted by personnel wearing a lower level of protection than that worn in the \_\_\_\_\_, if exposure levels are determined to be safe.  
A. Support Zone D. Decontamination area  
B. Patient Zone E. Hot Zone  
C. Chemical free zone F. None of the Above

### ABC Reminders

317. Quickly establish a \_\_\_\_\_, ensure adequate respiration and pulse.  
A. Support Zone D. Decontamination zone  
B. Patient airway E. Chemical-protective clothing dressing area  
C. Hot Zone F. None of the Above

### Basic Decontamination

318. During a chlorine leak, \_\_\_\_\_ is critical.  
A. Decontamination D. Rapid decontamination  
B. Hot Zone E. Hot Zone to the Decontamination Zone  
C. Chemical-protective clothing F. None of the Above

### In Cases of Ingestion, Do Not Induce Emesis or Offer Activated Charcoal.

319. During a chlorine leak, victims who are conscious and able to swallow should be given 4 to 8 ounces of?  
A. Liquid D. Water or milk  
B. Warm water E. Cold water  
C. Milk only F. None of the Above

### Chlorine Dioxide Section

320.  $\text{ClO}_2$  generation uses chlorine gas and?  
A. Chlorine dioxide ( $\text{ClO}_2$ ) D.  $\text{NaOCl}$  and  $\text{HCl}$  in place of chlorine gas  
B. Sodium chlorite ( $\text{NaClO}_2$ ) E. Ozone  
C. Hypochlorous acid F. None of the Above
321. Chlorine gas is educted into a motive water stream in a  $\text{ClO}_2$  generator forming?  
A. Hypochlorous acid D. Sodium chlorate ( $\text{NaClO}_3$ ) and sulfuric acid  
B.  $\text{HOCl}$  and  $\text{HCl}$  E. Sodium thiosulfate  
C. Chlorine dioxide F. None of the Above

322. \_\_\_\_\_ is pumped into the stream and allowed to react in a generating column to produce  $\text{ClO}_2$ .

- A. Hypochlorous acid
- B.  $\text{HOCl}$  and  $\text{HCl}$
- C. Chlorine dioxide
- D. Sodium chlorite
- E. Sodium thiosulfate
- F. None of the Above

323. Which of the following compound(s) remains a gas in water, it does not have the corrosive tendencies of chlorine gas?

- A. Sodium chlorite ( $\text{NaClO}_2$ )
- B. Chlorine gas
- C. Chlorine dioxide or  $\text{ClO}_2$
- D. Sodium chlorate ( $\text{NaClO}_3$ )
- E.  $\text{NaOCl}$  and  $\text{HCl}$
- F. None of the Above

324. Which of the following compound(s) is a dissolved gas in water; there is no mineral acid or caustic soda formation as happens when using  $\text{HOCl}$ .

- A.  $\text{ClO}_2$
- B. Sodium chlorite ( $\text{NaClO}_2$ )
- C. Hypochlorous acid
- D.  $\text{NaOCl}$  and  $\text{HCl}$  in place of chlorine gas
- E. Heavily pH-dependent
- F. None of the Above

325. Which of the following compound(s) tends to be much less, if not very non-reactive, with many organic and inorganic compounds?

- A.  $\text{ClO}_2$
- B. Sodium chlorite ( $\text{NaClO}_2$ )
- C. Hypochlorous acid
- D.  $\text{NaOCl}$  and  $\text{HCl}$  in place of chlorine gas
- E. Heavily pH-dependent
- F. None of the Above

326. A more recent method of generation uses sulfuric acid and?

- A. Sodium chlorite ( $\text{NaClO}_2$ )
- B. Chlorine gas
- C. Chlorine dioxide
- D. Sodium chlorate ( $\text{NaClO}_3$ )
- E.  $\text{NaOCl}$  and  $\text{HCl}$
- F. None of the Above

327. \_\_\_\_\_ is a non-specific oxidant which readily reacts with various organic and inorganic compounds that may be present in a cooling water system.

- A. Chlorine dioxide ( $\text{ClO}_2$ )
- B. Sodium chlorite ( $\text{NaClO}_2$ )
- C. Hypochlorous acid
- D.  $\text{NaOCl}$  and  $\text{HCl}$  in place of chlorine gas
- E. Sodium chlorate ( $\text{NaClO}_3$ ) and sulfuric acid
- F. None of the Above

328. Which of the following compound(s) is considerably more selective than chlorine in the presence of various compounds, which allows it to be more effective in contaminated systems?

- A.  $\text{ClO}_2$
- B. Sodium chlorite ( $\text{NaClO}_2$ )
- C. Hypochlorous acid
- D.  $\text{NaOCl}$  and  $\text{HCl}$  in place of chlorine gas
- E. Sodium chlorate ( $\text{NaClO}_3$ ) and sulfuric acid
- F. None of the Above

329. \_\_\_\_\_ can be in fact, be two-and-one-half times more reactive than chlorine.

- A.  $\text{ClO}_2$
- B. Sodium chlorite ( $\text{NaClO}_2$ )
- C. Hypochlorous acid
- D.  $\text{NaOCl}$  and  $\text{HCl}$  in place of chlorine gas
- E. Sodium chlorate ( $\text{NaClO}_3$ ) and sulfuric acid
- F. None of the Above

330. Which of the following terms as a water disinfectant increased in the 1970s when it was discovered that it did not promote THM formation?

- A. Sulfur Dioxide
- B. Chlorine gas
- C. Chlorine dioxide
- D. Sodium chlorate ( $\text{NaClO}_3$ ) and sulfuric acid
- E. UV
- F. None of the Above

331. This compound is used in the paper industry, has been an acceptable and effective alternative to chlorination in cooling systems?

- A. Chlorine dioxide ( $\text{ClO}_2$ )
- B. Sodium chlorite ( $\text{NaClO}_2$ )
- C. Hypochlorous acid
- D.  $\text{NaOCl}$  and  $\text{HCl}$  in place of chlorine gas
- E. Sodium thiosulfate
- F. None of the Above

332. This compound is a yellow-green gas with an irritating odor not unlike Chlorine.

- A. Sodium thiosulfate
- B. Chlorine
- C. Chlorine dioxide
- D. Sodium chlorate ( $\text{NaClO}_3$ ) and sulfuric acid
- E. Ozone
- F. None of the Above

333. This compound cannot be compressed and shipped in a container, so it must be generated on site.

- A. Sodium thiosulfate
- B. Chlorine
- C. Chlorine dioxide
- D. Sodium chlorate ( $\text{NaClO}_3$ ) and sulfuric acid
- E. Ozone
- F. None of the Above

334. Which of the following compound(s) under efficient generation, THMs are not formed and THM precursor(s) are reduced. In one application, THM formation was reduced from 34 m g/l to 1 m g/l?

- A.  $\text{ClO}_2$
- B. Sodium chlorite ( $\text{NaClO}_2$ )
- C. Hypochlorous acid
- D.  $\text{NaOCl}$  and  $\text{HCl}$  in place of chlorine gas
- E. Sodium chlorate ( $\text{NaClO}_3$ ) and sulfuric acid
- F. None of the Above

335. \_\_\_\_\_ is formed from the dissolution of chlorine gas or sodium hypochlorite in water, has satisfactorily controlled microorganisms in cooling water systems.

- A. Chlorine tablet(s)
- B. Hydrochlorous acid
- C. Chlorine gas
- D. Solid hypochlorite or concentrated solutions
- E. Hypochlorous Acid
- F. None of the Above

### Water Disinfection Methods Review

336. Water systems add \_\_\_\_\_ to destroy microorganisms that can cause disease in humans.

- A. Alkalinity and pH
- B. Hydrogen peroxide
- C. Hypochlorous acid
- D. Oxidizing and biocidal properties
- E. Disinfectants
- F. None of the Above

337. S.W.T.R. requires public water systems to disinfect water obtained from surface water supplies or groundwater sources under the influence of \_\_\_\_\_.

- A. Alkalinity and pH
- B. Surface water
- C. Hypochlorous acid
- D. Oxidizing and biocidal properties
- E. Hazardous trihalomethanes (THM)
- F. None of the Above

338. The following primary methods of disinfection are chlorination, chloramines, ozone, and ultraviolet light. Other disinfection methods include chlorine dioxide, \_\_\_\_\_.

- A. Alkalinity and pH
- B. Hydrogen peroxide
- C. Hypochlorous acid
- D. Oxidizing and biocidal properties
- E. Potassium permanganate, and nanofiltration
- F. None of the Above

339. Since certain forms of chlorine react with \_\_\_\_\_ naturally present in many water sources to form harmful chemical by-products.

- A. Alkalinity and pH
- B. Organic material
- C. Hypochlorous acid
- D. Oxidizing and biocidal properties
- E. Hazardous trihalomethanes (THM)
- F. None of the Above

### Physical Methods

340. Formation of \_\_\_\_\_ in water and wastewater effluent treated with chlorine has prompted research to seek alternative disinfecting methods that would minimize environmental and public health impacts.

- A. Alkalinity
- B. Mutagenic and carcinogenic agents
- C. Hypochlorous acid
- D. Oxidizing and biocidal properties
- E. Hazardous trihalomethanes (THM)
- F. None of the Above

### Chemical Methods

341. Chemical methods depend mostly on selected chemicals with oxidizing and biocidal properties. Their practical applications range from removing \_\_\_\_\_ to disinfecting water supplies, wastewater treatment effluent, or industrial waters.

- A. Alkalinity and pH
- B. Undesirable constituents
- C. Hypochlorous acid
- D. Oxidizing and biocidal properties
- E. Hazardous trihalomethanes (THM)
- F. None of the Above

342. Which of the following compound(s) used for disinfection, other than chlorine and some of its compounds, potassium permanganate, and hydrogen peroxide?

- A. Ammonia
- B. Sodium chlorite ( $\text{NaClO}_2$ )
- C. Hydrochlorous acid
- D.  $\text{NaOCl}$  and  $\text{HCl}$  in place of chlorine gas
- E. Ozone
- F. None of the Above

343. Ozonation enhances the \_\_\_\_\_ despite its inherent weakness in leaving practically no residual in the distribution system.

- A. Effectiveness and cost
- B. Protecting public health
- C. Mode of disinfection
- D. Coagulation process
- E. Superiority over chlorination
- F. None of the Above

344. Interhalogen compounds, formed from two different halogens, resemble their parent substances in properties and germicidal characteristics. The interhalogens  $\text{BrCl}$ ,  $\text{ICl}$ , and  $\text{IBr}$  have recently been investigated as possible alternative disinfectants for water and wastewater effluent. Added to water, they rapidly hydrolyze to the corresponding hypohalous acids, which are stronger oxidants and disinfectants than hypochlorous acid. For instance,  $\text{BrCl}$  is hydrolyzed to  $\text{HCl}$  and  $\text{HOBr}$

- A. True
- B. False

345. Improved germicidal activity is counterbalanced by the formation of haloforms. They react with humates in water or wastewater effluent by the haloform reaction (HOBr, for example, reacts with humates yielding bromoform). In this context, hypobromite would be formed in Seawater by reaction of the natural bromides with hypochlorites in chlorinated wastewater effluent or cooling waters from power plants.
- A. True            B. False

### Chlorination and Dechlorination

346. Which of the following compound(s) and some of its derivatives will continue as an integral part of the disinfection process in water and wastewater treatment.
- A. Chlorine tablet(s)            D. Solid hypochlorite or concentrated solutions  
B. Hydrochlorous acid            E. Hypochlorous Acid  
C. Chlorine                        F. None of the Above

### pH Scale

347. Alkalinity is the capacity of water to increase acids. This increase is caused by the water's content of carbonate, bicarbonate, hydroxide and occasionally borate, silicate and phosphate.
- A. True            B. False

348. pH is an expression of the intensity of the basic or acid condition of a liquid. EPA has a suggested range of 5.5 to 7.5 for pH (called a primary maximum contaminant level or MCL).
- A. True            B. False

349. Alkalinity and pH are similar because water is never strongly basic (high pH) to have a natural alkalinity.
- A. True            B. False

### Disinfection Rule Review

350. Chlorine is the most widely used water disinfectant due to its effectiveness and cost. Using chlorine as a drinking water disinfectant has prevented millions of water borne diseases, such as typhoid, cholera, dysentery, and diarrhea. Most states require community water systems to use chlorination.
- A. True            B. False

351. At this time, an MCL is set for only \_\_\_\_\_, and proposed for additional disinfection byproducts.
- A. TTHM and HAA5 Rule            D. Disinfection byproducts (DBPs) Rule  
B. DBP MCLsRule                    E. Total Trihalomethanes  
C. A community water system (CWS)            F. None of the Above

352. The \_\_\_\_\_ rules apply to all community and non-community water systems using a disinfectant such as chlorine, chloramines, ozone and chlorine dioxide.
- A. TTHM and HAA5 Rule            D. Disinfection byproducts (DBPs) Rule  
B. DBP MCLsRule                    E. Disinfectants and Disinfection Byproducts (DBP)  
C. A community water system (CWS)            F. None of the Above

353. The Long Term 2 Enhanced Surface Water Treatment Rule (LT2) rule applies to all water systems using \_\_\_\_\_ under the influence of a surface water, as well as groundwater/surface water blends.

- A. Surface water, groundwater
- B. DBP MCLs Rule
- C. A community water system (CWS)
- D. Disinfection byproducts (DBPs) Rule
- E. Total Trihalomethanes
- F. None of the Above

354. This term/rule/requirement began in 2006 with the characterization of raw water Cryptosporidium and E. coli levels. Systems serving <10,000 monitor for E. coli only every two weeks for one year. Compliance with the LT2 requirements begin in April 2013.

- A. DBPs requirements
- B. Disinfectants requirements
- C. SDWA in 1996
- D. Stage 1 Disinfectant and Disinfection Byproduct Rule
- E. The LT2 requirements
- F. None of the Above

355. This term/rule/requirement applies to all public water systems using groundwater. The GWR requirements begin in March 2009 with 6-months investigative monitoring (IM) for source water E. coli, for systems currently applying disinfection only. All other requirements for the GWR began back in Dec 2009.

- A. Groundwater Rule (GWR)
- B. Compliance
- C. SDWA in 1996
- D. Long Term 2 Enhanced Surface Water Treatment Rule (LT2)
- E. Interim Enhanced Surface Water Treatment Rule
- F. None of the Above

356. This term/rule/requirement requires EPA to develop rules to balance the risks between microbial pathogens and disinfection byproducts (DBPs). It is important to strengthen protection against microbial contaminants, especially Cryptosporidium, and at the same time, reduce potential health risks of DBPs.

- A. Amendments to the SDWA in 1996
- B. Disinfectants
- C. SDWA in 1996
- D. Stage 1 Disinfectant and Disinfection Byproduct Rule
- E. The LT2 requirements
- F. None of the Above

357. The Stage 1 Disinfectants and Disinfection Byproducts Rule and this term/rule/requirement announced in December 1998, are the first of a set of rules under the 1996 SDWA Amendments.

- A. Groundwater Rule (GWR)
- B. Compliance
- C. SDWA in 1996
- D. Long Term 2 Enhanced Surface Water Treatment Rule (LT2)
- E. Interim Enhanced Surface Water Treatment Rule
- F. None of the Above

### Public Health Concerns

358. While disinfectants are effective in controlling many microorganisms, they react with natural organic and inorganic matter in source water and distribution systems to form \_\_\_\_\_. Results from toxicology studies have shown several DBPs (e.g., bromodichloromethane, bromoform, chloroform, dichloroacetic acid, and bromate) to be carcinogenic in laboratory animals.

- A. DBPs
- B. Chlorine and chloramine
- C. Stage 2 DBPR
- D. Classes of DBPs
- E. Ultraviolet light
- F. None of the Above

359. This term/rule/requirement and Disinfection Byproducts Rule applies to all community and nontransient non-community water systems that treat their water with a chemical disinfectant for either primary or residual treatment.

- A. Groundwater Rule (GWR)
- B. The Stage 1 Disinfectants
- C. SDWA in 1996
- D. Long Term 2 Enhanced Surface Water Treatment Rule (LT2)
- E. Interim Enhanced Surface Water Treatment Rule
- F. None of the Above

360. This term/rule/requirement and Disinfection Byproduct Rule updates and supersedes the 1979 regulations for total trihalomethanes. In addition, it will reduce exposure to three disinfectants and many disinfection byproducts.

- A. DBPs
- B. The Stage 1 Disinfectant
- C. SDWA in 1996
- D. Stage 1 Disinfectant and Disinfection Byproduct Rule
- E. The LT2 requirements
- F. None of the Above

### Alternative Disinfectants Chapter 5 Ultraviolet Disinfection

361. The microorganisms spend maximum time and contact with the outside of the quartz tube and the source of the \_\_\_\_\_.

- A. Sterilizer
- B. UV rays
- C. UV disinfection
- D. UV reactor
- E. Electromagnetic energy
- F. None of the Above

362. The basic design flow of water of certain UV units is in the order of \_\_\_\_\_ for each inch of the lamp. Further, the units are designed so that the contact or retention time of the water in the unit is not less than \_\_\_\_\_.

- A. 2.0 gpm - 60 seconds
- B. 20 gpm - 15 seconds
- C. 2.0 gpm - 100 seconds
- D. 1.5 gpm - 60 seconds
- E. 2.0 gpm - 15 seconds
- F. None of the Above

363. A disinfection process involves exposing water to \_\_\_\_\_, which inactivates various microorganisms. The technique has enjoyed increased application in wastewater treatment but very limited application in potable water treatment.

- A. Sterilizer
- B. UV rays
- C. UV disinfection
- D. Ultraviolet (UV) radiation
- E. Electromagnetic energy
- F. None of the Above

364. In UV, quartz is often used in this case since practically none of the UV rays are absorbed by the quartz, ordinary glass cannot be used since it will absorb the \_\_\_\_\_, leaving little for disinfection.

- A. Bromine
- B. UV rays
- C. UV disinfection
- D. UV reactor
- E. Chemical process
- F. None of the Above

365. According to the text, the \_\_\_\_\_ will consist of a various number of lamps and tubes, depending upon the quantity of water to be treated.

- A. UV sterilizer
- B. UV rays
- C. UV disinfection
- D. UV reactor
- E. Electromagnetic energy
- F. None of the Above

366. Ensuring that the \_\_\_\_\_ maintains good contact with the water requires control of the water level within the channel to ensure that the UV is making total contact at the designed depths.

- A. UV
- B. Contact
- C. Channel
- D. UV reactor
- E. Ballasts and shields
- F. None of the Above

367. Heat is generated by the electric components of the UV system, adequate ventilation and cooling must be applied to the \_\_\_\_\_ to reduce heat build-up, otherwise the ballasts could fail.

- A. UV arrays
- B. UV rays
- C. UV disinfection
- D. UV reactor
- E. Electromagnetic energy
- F. None of the Above

368. Because of the great electrical consumption of this system, combined with the cost of routine replacement of \_\_\_\_\_, should be considered against other systems.

- A. UV capacitor
- B. UV Flux
- C. UV disinfection
- D. UV reactor
- E. Ballasts and shields
- F. None of the Above

369. The germicidal effect of UV is thought to be associated with its reduction by various inorganic components essential to the cell's functioning.

- A. True
- B. False

370. Which term represents the transfer of electromagnetic energy from a mercury arc lamp to a pathogen's DNA material, thus affecting its ability to replicate itself?

- A. UV radiation
- B. UV rays
- C. UV disinfection
- D. UV reactor
- E. Electromagnetic energy
- F. None of the Above

371. \_\_\_\_\_ represents the intensity being emitted, the length of time that the wastewater comes in contact with the UV radiation, and the arrangement of the UV reactor?

- A. UV radiation
- B. UV arayment
- C. UV disinfection
- D. UV reactor
- E. Electromagnetic energy
- F. None of the Above

372. The contact time for the wastewater with the UV source is the shortest of any of the disinfectant strategies, lasting no longer than 20 to 30 seconds.

- A. True
- B. False

373. Disadvantages include the effects of turbidity in the water reducing the infiltration and therefore the effectiveness of ballasts and shields and the need to provide an effective cleaning and replacement program for the UV components.

- A. True
- B. False

374. The effective use of Ultraviolet treatment, the water to be disinfected can contain suspended solids. The water does not need to be colorless and can contain colloids, iron, manganese, taste, and odor.

- A. True
- B. False

### **Strongest Oxidizing Agent**

375. This compound is obtained by passing a flow of air or oxygen between two electrodes that are subjected to an alternating current in the order of 10,000 to 20,000 volts.

- A. Chloriamine
- B. Liquid Ozone
- C. Ozone
- D. Oxygen and nascent oxygen
- E. O<sub>2</sub>
- F. None of the Above



376. This compound is a light blue gas at room temperature.

- A. Chloramine
- B. Liquid Ozone
- C. Ozone
- D. Oxygen and nascent oxygen
- E. O<sub>2</sub>
- F. None of the Above

377. Ozone has a \_\_\_\_\_ similar to that sometimes noticed during and after heavy electrical storms. In use, ozone breaks down into oxygen and nascent oxygen.

- A. Self-policing pungent odor
- B. THMs
- C. Light blue gas
- D. Oxygen and nascent oxygen
- E. Strongest oxidizing agent
- F. None of the Above

378. Ozone does not form chloramines or \_\_\_\_\_, and while it may destroy some THMs, it may produce others when followed by chlorination.

- A. Carcinogens
- B. THMs
- C. Complete disinfectant
- D. Oxygen and nascent oxygen
- E. Flocculation and coagulation
- F. None of the Above

379. Ozone falls into the same category as other disinfectants in that it can produce?

- A. Carcinogens
- B. THMs
- C. DBPs
- D. Oxygen and nascent oxygen
- E. Strongest oxidizing agent
- F. None of the Above

380. This compound is very unstable and can readily explode. As a result, it is not shipped and must be manufactured on-site.

- A. Chloramine
- B. Liquid Ozone
- C. Ozone
- D. Oxygen and nascent oxygen
- E. O<sub>2</sub>
- F. None of the Above

381. Each water has its own \_\_\_\_\_, in the order of 0.5 ppm to 5.0 ppm. Contact time, temperature, and pH of the water are factors to be determined.

- A. Carcinogens
- B. THMs
- C. Ozone demand
- D. Oxygen and nascent oxygen
- E. Strongest oxidizing agent
- F. None of the Above

### **Alternate Disinfectants Section Summary**

#### **Chloramines**

382. This compound is a very weak disinfectant for Giardia and virus reduction. It is recommended that it be used in conjunction with a stronger disinfectant. It is best utilized as a stable distribution system disinfectant.

- A. Chlorine
- B. Chloramine
- C. Ozone
- D. Oxygen and nascent oxygen
- E. Strongest oxidizing agent
- F. None of the Above

383. In the production of chloramines, the ammonia residuals in the finished water, when fed in excess of stoichiometric amount needed, should be limited to inhibit growth of \_\_\_\_\_.

- A. Cryptosporidium
- B. Chlorine-based disinfectants
- C. Giardia lamblia
- D. An emerging parasitic protozoan pathogen
- E. Nitrifying bacteria
- F. None of the Above

## Chlorine Dioxide

384. Chlorine dioxide may be used for either taste and odor control or as?

- A. Post disinfectant
- B.  $\text{ClO}_2$ /chlorite/chlorate
- C. An oxidant
- D. Total residual oxidants
- E. A pre-disinfectant
- F. None of the Above

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

- A. Pre-disinfectant
- B.  $\text{ClO}_2$ /chlorite/chlorate
- C. An oxidant
- D. Chlorine dioxide and chlorite
- E. 25% aqueous solution of sodium chlorite ( $\text{NaClO}_2$ )
- F. None of the Above

386. According to the text, Chlorine dioxide provides good \_\_\_\_\_ protection but its use is limited by the restriction on the maximum residual of 0.5 mg/L  $\text{ClO}_2$ /chlorite/chlorate allowed in finished water.

- A. Pre-disinfectant
- B.  $\text{ClO}_2$ /chlorite/chlorate
- C. Level of
- D. Chlorine residual
- E. Giardia and virus
- F. None of the Above

387. Where chlorine dioxide is approved for use as an oxidant, the preferred method of generation is to entrain chlorine gas into a packed reaction chamber with a \_\_\_\_\_.

- A. Pre-disinfectant
- B.  $\text{ClO}_2$ /chlorite/chlorate
- C. An oxidant
- D. Total residual oxidants
- E. 25% aqueous solution of sodium chlorite ( $\text{NaClO}_2$ )
- F. None of the Above

388. Because dry sodium chlorite is dangerous and can be \_\_\_\_\_ in feed equipment if leaking solutions or spills are allowed to dry out.

- A. Prone to fire
- B. Choking risk
- C. An oxidant
- D. Oxidant
- E. Explosive and can cause fires
- F. None of the Above

## Ozone

389. This term must be determined for the ozone basin alone; an accurate T10 value must be obtained for the contact chamber, residual levels measured through the chamber and an average ozone residual calculated.

- A. Ozone CT (Contact time)
- B. Free and/or combined chlorine
- C. Residual levels
- D. Contact time
- E. Strongest oxidizing agent
- F. None of the Above

390. Ozone does not provide a \_\_\_\_\_ and should be used as a primary disinfectant only in conjunction with free and/or combined chlorine.

- A. Ozone CT
- B. Free and/or combined chlorine
- C. Residual level(s)
- D. System residual
- E. Risk
- F. None of the Above

391. Ozone does not produce this term 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 aldehydes, ketones, or carboxylic acids.

- A. Carcinogens
- B. Organics
- C. Carboxylic acids
- D. Oxygen and nascent oxygen
- E. Chlorinated byproducts
- F. None of the Above

**Respiratory Protection Section Chapter 6**

392. This definition means a situation that requires the use of respirators due to the unplanned generation of a hazardous atmosphere (often of unknown composition) caused by an accident, mechanical failure, or other means and that requires evacuation of personnel or immediate entry for rescue or corrective action.

- A. Employee Exposure
- B. Atmosphere-Supplying Respirator
- C. Emergency Respirator Use Situation
- D. Emergency situation
- E. Immediately Dangerous to Life or Health
- F. None of the Above

393. This definition means a gas mask that consists of a half-mask facepiece or mouthpiece, a canister, and associated connections, and that is designed for use during escape-only from hazardous atmospheres.

- A. Filter or Air-Purifying Element
- B. Escape Gas Mask
- C. Escape Only Respirator
- D. End-Of-Service-Life Indicator
- E. Filtering Facepiece
- F. None of the Above

394. This definition means a solid, mechanically produced particle with a size ranging from submicroscopic to macroscopic.

- A. Employee Exposure
- B. Atmosphere-Supplying Respirator
- C. Emergency Respirator Use Situation
- D. Emergency situation
- E. Immediately Dangerous to Life or Health
- F. None of the Above

395. This definition means a respirator intended to be used only for emergency exit.

- A. Filter or Air-Purifying Element
- B. Escape Gas Mask
- C. Escape Only Respirator
- D. End-Of-Service-Life Indicator
- E. Filtering Facepiece
- F. None of the Above

396. \_\_\_\_\_ means any occurrence such as, but not limited to, equipment failure, rupture of containers, or failure of control equipment that may or does result in an uncontrolled significant release of an airborne contaminant.

- A. Employee Exposure
- B. Atmosphere-Supplying Respirator
- C. Emergency Respirator Use Situation
- D. Emergency situation
- E. Immediately Dangerous to Life or Health
- F. None of the Above

397. This definition means an exposure to a concentration of an airborne contaminant that would occur if the employee were not using respiratory protection.

- A. Employee Exposure
- B. Atmosphere-Supplying Respirator
- C. Emergency Respirator Use Situation
- D. Emergency situation
- E. Immediately Dangerous to Life or Health
- F. None of the Above

398. This definition means a respirator that supplies the respirator user with breathing air from a source independent of the ambient atmosphere.

- A. Employee Exposure
- B. Atmosphere-Supplying Respirator
- C. Emergency Respirator Use Situation
- D. Emergency Situation
- E. Immediately Dangerous to Life or Health
- F. None of the Above

399. A pre-authorization and annual certification by a qualified physician will be required and maintained. Any changes in an Employees health or physical characteristics will be reported to the Occupational Health Department and will be evaluated by a qualified physician.

- A. True
- B. False

400. Only SCBAs will be used in oxygen deficient environments, environments with an unknown hazardous substance or unknown quantity of a known hazardous substance or any environment that is determined "Immediately Dangerous to Life or Health" (IDLH).

- A. True
- B. False

401. Employees with respirators loaned on "permanent check out" will be responsible for the sanitation, proper storage and security.

- A. True
- B. False

402. Respirators damaged by abnormal wear will be repaired or replaced by the Employee when returned.

- A. True
- B. False

403. The first Employee using a respirator and/or SCBA that are available for general use will be responsible for proper storage and sanitation.

- A. True
- B. False

404. Monthly and after each use, all respirators will be inspected with documentation to assure its availability for use.

- A. True
- B. False

405. All respirators will be located in a clean, convenient and sanitary location.

- A. True
- B. False

406. In the event that Employees must enter a confined space, work in environments with hazardous substances that would be dangerous to life or health should an RPE fail (a SCBA is required in this environment), and/or conduct a HAZMAT entry, a "buddy system" detail will be used with a Safety Watchman with constant voice, visual or signal line communication.

- A. True
- B. False

407. Employees will follow the established Emergency Response Program and/or Confined Space Entry Program when applicable.

- A. True
- B. False

408. Management will establish and maintain surveillance of jobs and work place conditions and degree of Employee exposure or stress to maintain the proper procedures and to provide the necessary RPE.

- A. True
- B. False

409. The Employer is responsible and need to have evaluated the respiratory hazard(s) in each workplace, identified relevant workplace and user factors and has based respirator selection on these factors. Also included are estimates of employee exposures to respiratory hazard(s) and an identification of the contaminant's chemical state and physical form.

A. True      B. False

**Filter Classifications** - These classifications are marked on the filter or filter package

**R-Series: Oil Resistant.** Approved for non-oil particulate contaminants

410. Examples: dust, fumes, mists not containing oil

A. True      B. False

**N-Series: Not Oil Resistant**

411. Approved for all particulate contaminants, including those containing oil Examples: dusts, mists, fumes, Time restriction of 8 hours when oils are present

A. True      B. False

**K-Series: Oil Proof**

412. Approved for all particulate contaminants including those containing oil Examples: dust, fumes, mists, See Manufacturer's time use restrictions on packaging

A. True      B. False

**Respirators for IDLH atmospheres.**

413. The following respirators will be used in IDLH atmospheres: A full face piece pressure demand SCBA certified by OSHA for a minimum service life of thirty hours.

A. True      B. False

414. A combination full face piece pressure demand supplied-air respirator (SAR) with auxiliary self-contained air supply.

A. True      B. False

415. Respirators provided only for escape from PEL atmospheres shall be NIOSH-certified for escape from the atmosphere in which they will be used.

A. True      B. False

416. The respirators selected shall be adequate to protect the health of the employee and ensure compliance with all other OSHA statutory and regulatory requirements, under routine and reasonably foreseeable emergency situations.

A. True      B. False

417. The respirator selected shall be appropriate for the chemical state and physical form of the contaminant.

A. True      B. False

**The respirators shall be cleaned and disinfected when:**

418. Respirators issued for the exclusive use of an employee shall be cleaned and disinfected as often as necessary to be maintained in a sanitary condition.

A. True      B. False

419. Respirators issued to more than one employee does not need to be cleaned and disinfected before being worn by different individuals

- A. True
- B. False

420. Respirators maintained for emergency use shall be cleaned and disinfected after each use

- A. True
- B. False

421. Respirators used in fit testing and training shall be cleaned and disinfected after each use.

- A. True
- B. False

422. Cleaning and Storage of respirators assigned to specific employees is the responsibility of OSHA.

- A. True
- B. False

### **Respirator Inspection**

423. All respirators/SCBAs, both available for "General Use" and those on "Permanent Check-out", will be inspected after each use and at least monthly.

- A. True
- B. False

424. Should any defects be noted, the respirator/SCBA will be taken to the program Administrator.

- A. True
- B. False

425. Damaged Respirators will be either repaired or replaced. The inspection of respirators loaned on "Permanent Check-out" is the responsibility of that trained Employee.

- A. True
- B. False

### **Respirators shall be inspected as follows:**

426. All respirators used in routine situations shall be inspected before each use and during cleaning

- A. True
- B. False

427. Means an individual who's legally permitted scope of practice (i.e., license, registration, or certification) allows him or her to independently provide, or be delegated the responsibility to provide, some or all of the health care services required by paragraph (e) of this section.

- A. Orinasal Respirator
- B. Oxygen Deficient Atmosphere
- C. Mist
- D. Physician or Other Licensed Health Care Professional
- E. None of the Above

428. A situation in which respiratory devices are recommended to provide adequate protection to workers entering an area where the contaminant concentration is above the IDLH or is unknown.

- A. Potential Occupational Carcinogen
- B. Positive Pressure Respirator
- C. Powered Air-Purifying Respirator
- D. Pressure Demand Respirator
- E. None of the Above

429. A respirator in which the pressure inside the respiratory inlet covering exceeds the ambient air pressure outside the respirator.

- A. Potential Occupational Carcinogen
- B. Positive Pressure Respirator
- C. Powered Air-Purifying Respirator
- D. Pressure Demand Respirator
- E. None of the Above

430. An air-purifying respirator that uses a blower to force the ambient air through air-purifying elements to the inlet covering.

- A. Potential Occupational Carcinogen
- B. Positive Pressure Respirator
- C. Powered Air-Purifying Respirator
- D. Pressure Demand Respirator
- E. None of the Above

431. A positive pressure atmosphere- supplying respirator that admits breathing air to the facepiece when the positive pressure is reduced inside the facepiece by inhalation.

- A. Potential Occupational Carcinogen
- B. Positive Pressure Respirator
- C. Powered Air-Purifying Respirator
- D. Pressure Demand Respirator
- E. None of the Above

432. The minimum anticipated protection provided by a properly functioning respirator or class of respirators to a given percentage of properly fitted and trained users.

- A. Potential Occupational Carcinogen
- B. Assigned Protection Factor
- C. Powered Air-Purifying Respirator
- D. Pressure Demand Respirator
- E. None of the Above

433. A surrogate measure of the workplace protection provided by a respirator.

- A. Qualitative Fit Test
- B. Quantitative Fit Test
- C. Workplace Protection Factor
- D. Simulated Workplace Protection Factor
- E. None of the Above

## **Chapter 7**

### **Sample Procedures**

434. Samples need to be kept on ice and shipped to a central laboratory for analysis of coliphage, C. perfringens, Cryptosporidium, Giardia, and enteric viruses by the current analytical methods. The single-agar layer (SAL), direct plating method with induction of streptomycin and ampicillin is recommended for detection of somatic and F-specific coliphage in streamwater samples.

- A. True B. False

435. After incubation, the plates are exposed to ammonium hydroxide, and all straw-colored colonies that turn dark pink to magenta are counted as?

- A. Enteric virus(es)
- B. Oocyst(s)
- C. Viral plaques
- D. *C. perfringens*
- E. *E. coli* host culture
- F. None of the Above

436. This analyses is done on 100-, 30-, and 10-mL volumes of streamwater. In the case of a high-flow or high-turbidity streamwater sample, lower sample volumes may be plated.

- A. Oocyst(s)
- B. *C. perfringens*
- C. The plates
- D. Large sample volumes
- E. Coliphage
- F. None of the Above

437. Method 1623 (U.S. Environmental Protection Agency, 1999c) is recommended for detection of *Cryptosporidium* oocysts and *Giardia* cysts in water. The oocysts are concentrated on a capsule filter from a 10-L water sample, eluted from the capsule filter with buffer, and concentrated by centrifugation. Immunomagnetic separation (IMS) is used to separate the oocysts from other particulates in the sample.

- A. True
- B. False

438. Fluorescently labeled antibodies and vital dye were used to make the final microscopic identification of?

- A. Enteric virus(es)
- B. Oocyst(s)
- C. Viral plaques
- D. Oocysts and cysts
- E. *E. coli* host culture
- F. None of the Above

#### **QA/QC Activities and Measures**

439. QA/QC activities and measures to take to reduce contamination.

Use a sterilization indicator, such as autoclave tape, in preparing Viral plaques and other equipment for collection of microbiological samples to determine whether adequate temperatures and pressures have been attained during autoclaving.

- A. True
- B. False

440. Prepare a separate set of *E. coli* host cultures for microbiological sampling at each site.

- A. True
- B. False

441. Always ensure a sterile working surface and monitor the incubators daily to ensure temperatures are appropriate for?

- A. Equipment blank(s)
- B. MF procedure blank(s)
- C. Sterile working surface
- D. Appropriate laboratory equipment
- E. The methods used
- F. None of the Above

442. Membrane-filtration (MF) equipment and MF procedure blanks are used to estimate?

- A. Equipment blank(s)
- B. Analytical bias
- C. Sterile working surface
- D. Appropriate laboratory equipment
- E. Prepare a MF procedure blank
- F. None of the Above



**Field personnel should do the following:**

443. Prepare \_\_\_\_\_, a 50- to 100-mL aliquot of sterile buffered water plated before the sample—for every sample by field personnel for total coliform, E. coli, and enterococci analyses to determine the sterility of equipment and supplies.

- A. Reagent water quality
- B. An environmental sample
- C. An MF equipment blank
- D. Protozoan Giardia and virus(es)
- E. Microbiological sampling
- F. None of the Above

444. Prepare a \_\_\_\_\_, a 50- to 100-mL aliquot of sterile buffered water plated after the sample— for every fourth sample to measure the effectiveness of the analyst's rinsing technique or presence of incidental contamination of the buffered water.

- A. Equipment blank(s)
- B. MF procedure blank(s)
- C. Sterile working surface
- D. Appropriate laboratory equipment
- E. Prepare a MF procedure blank
- F. None of the Above

445. If contamination from a MF equipment or \_\_\_\_\_ is found, results are suspect and are qualified or not reported.

- A. Reagent water quality
- B. An environmental sample
- C. An MF equipment blank
- D. Protozoan Giardia and virus(es)
- E. Procedure blank
- F. None of the Above

446. Which of the following terms for this type of analyses are different from the MF equipment blanks for bacterial analysis?

- A. Equipment blank(s)
- B. MF procedure blank(s)
- C. sterile working surface
- D. Appropriate laboratory equipment
- E. Prepare a MF procedure blank
- F. None of the Above

447. Which of the following terms are the same as equipment blanks except that they are generated under actual field conditions?

- A. Reagent water quality
- B. An environmental sample
- C. An MF equipment blank
- D. Field blanks
- E. Microbiological sampling
- F. None of the Above

**Quality Assurance and Quality Control in the Laboratory**

448. According to the text, microbiology laboratories must follow good laboratory practices—cleanliness, safety practices, procedures for \_\_\_\_\_, specifications for reagent water quality—as set forth by American Public Health Association.

- A. Reagent water quality
- B. An environmental sample
- C. An MF equipment blank
- D. Media preparation
- E. Microbiological sampling
- F. None of the Above

**Chloramines**

449. What are chemical compounds formed by combining a specific ratio of chlorine and ammonia in water?

- A. Chlorine dioxide
- B. Bromate
- C. Chloramines
- D. Trihalomethanes, haloacetic acids, bromate, and chlorite
- E. Disinfection byproducts
- F. None of the Above

450. \_\_\_\_\_ provides a durable residual, and are often used as a secondary disinfectant for long distribution lines and where free chlorine demand is high.

- A. Chlorine dioxide
- B. Bromate
- C. Chloramines
- D. Trihalomethanes, haloacetic acids, bromate, and chlorite
- E. Disinfection byproducts
- F. None of the Above

451. This term represents a compound that may also be used instead of chlorine in order to reduce chlorinated byproduct formation and to remove some taste and odor problems.

- A. Chlorine dioxide
- B. Bromate
- C. Chloramines
- D. Trihalomethanes, haloacetic acids, bromate, and chlorite
- E. Disinfection byproducts
- F. None of the Above

### Chlorine Dioxide

452. Which term represents a compound that may be generated on-site at water treatment facilities. In most generators, sodium chlorite and elemental chlorine are mixed in solution, which almost instantaneously forms?

- A. Chlorine dioxide (ClO<sub>2</sub>)
- B. Bromate
- C. Chloramine
- D. Ozone
- E. Disinfection compounds
- F. None of the Above

453. Chlorine dioxide characteristics are quite different from chlorine. In solution it is a dissolved gas, which makes it largely unaffected by pH but volatile and relatively easily stripped from ?

- A. Chlorine
- B. Sodium hypochlorite
- C. Chlorine dioxide
- D. Chlorine gas
- E. Solution
- F. None of the Above

454. Chlorine dioxide is also a strong disinfectant and a selective oxidant. While chlorine dioxide does produce?

- A. Chlorine
- B. Sodium hypochlorite
- C. Chlorine dioxide
- D. Chlorine gas
- E. A residual it is only rarely used for this purpose
- F. None of the Above

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

455. If the water contains \_\_\_\_\_, it results in the formation of a combined residual, which must be destroyed by applying an excess of chlorine.

- A. Free available residual
- B. Free available chlorine
- C. Chloramines
- D. Additional chlorine
- E. Ammonia
- F. None of the Above

456. Breakpoint chlorination is the name of the process of adding chlorine to water until the chlorine demand has been satisfied.

- A. True
- B. False

457. \_\_\_\_\_ means the amount of chlorine used up before a free available chlorine residual is produced.

- A. Free available residual
- B. Free available chlorine
- C. Chlorine demand
- D. No disinfection
- E. No residual
- F. None of the Above

458. What is the addition of chlorine that results in a chlorine residual that is directly proportional to the amount of chlorine added beyond the?

- A. Free available residual
- B. Free available chlorine
- C. Breakpoint
- D. No disinfection
- E. No residual
- F. None of the Above

### **Disinfection and Bioterrorism**

459. Disinfection is crucial to water system security, providing the 'front line' of defense against biological contamination.

- A. True
- B. False

460. Normal filtration and disinfection processes would increase the threats posed by a number of potential bioterrorism agents. In addition, water systems should maintain an ability to decrease disinfection doses in response to a particular threat.

- A. True
- B. False

### **Protecting Chlorine and Other Treatment Chemicals**

461. As part of your wellfield assessment, each water system must consider its transportation, storage and use of treatment chemicals.

- A. True
- B. False

### **Understanding Waterborne Viruses**

462. Which of the following terms does treatment processes and watershed management strategies do not necessarily protect against?

- A. F-specific coliphages
- B. Indicators of fecal contamination
- C. Enteric viruses
- D. Viruses
- E. Viral infection
- F. None of the Above

463. Because monitoring of enteric viruses is recognized as being difficult and time consuming, some researchers advocate the use of coliphage as?

- A. F-specific coliphages
- B. Indicators of fecal contamination
- C. Enteric viruses
- D. Viruses
- E. Indicator viruses for fecal contamination
- F. None of the Above

464. Which of the following terms that infect and replicate in coliform bacteria? The two main groups of coliphages that are considered as candidates for viral indicators are somatic and F-specific coliphages.

- A. Enteric viruses
- B. F-specific coliphages
- C. Viruses
- D. Indicators of viral contamination
- E. Coliphages are bacteriophages
- F. None of the Above

465. Somatic coliphages infect coliform bacteria by attachment to the outer cell membrane or cell wall. They are widely distributed in both fecal-contaminated and uncontaminated waters; therefore, they may not be reliable?

- A. F-specific coliphages
- B. Indicators of fecal contamination
- C. Enteric viruses
- D. Viruses
- E. Microorganisms
- F. None of the Above

466. Which of the following terms attach only to the F-pilus of coliforms that carry the F+ plasmid; F-pili are made only by bacteria grown at higher temperatures?

- A. Enteric viruses
- B. F-specific coliphages
- C. Viruses
- D. Indicators of viral contamination
- E. Coliphages are bacteriophages
- F. None of the Above

467. Which term is found in environmental samples presumably come from warm-blooded animals or sewage?

- A. F-specific coliphages
- B. Indicators of fecal contamination
- C. Enteric viruses
- D. Viruses
- E. Microorganisms
- F. None of the Above

468. This term represents coliphage is representative of the survival and transport of?

- A. Enteric viruses
- B. F-specific coliphages
- C. Viruses
- D. Indicators of viral contamination
- E. Coliphages are bacteriophages
- F. None of the Above

### Sampling Procedures

#### Streamwater Sample Collection

469. Consider that the spatial and temporal distribution of microorganisms in surface water can be as variable as the distribution of \_\_\_\_\_ because microorganisms are commonly associated with solid particles.

- A. Suspended sediment
- B. Indicators of fecal contamination
- C. Enteric viruses
- D. Viruses
- E. Microorganisms
- F. None of the Above

470. The standard samplers used in by the majority of samplers can be used to collect streamwater samples for bacterial and viral indicators, \_\_\_\_\_ providing that the equipment coming in contact with the water is properly cleaned and sterilized.

- A. Cryptosporidium, and Giardia
- B. Indicator organisms
- C. Cholera, polio, typhoid, hepatitis
- D. Cryptosporidium
- E. Giardia
- F. None of the Above

#### Cryptosporidium and Giardia Analysis

471. Special sterilization procedures are needed for equipment used in the collection of samples for?

- A. Total Organisms
- B. Indicator bugs
- C. Cholera, polio, typhoid, hepatitis
- D. Oocysts
- E. Cryptosporidium and Giardia
- F. None of the Above

472. Washing the equipment free of residual sodium hypochlorite solution with three rinses of filter-sterilized water; do not de-chlorinate the equipment using?

- A. Dibromochloromethane
- B. Bromoform
- C. Cl<sub>2</sub> and HOCl
- D. Sodium hypochlorite solution
- E. Sodium thiosulfate
- F. None of the Above

473. According to the text, composite the sample in a 10-L cubitainer that is pre-sterilized by the manufacturer. The cubitainer is sent in a cardboard box to laboratory for \_\_\_\_\_ analysis.

- A. Total Coliform (TC)
- B. Indicator organisms
- C. Cholera, polio, typhoid, hepatitis
- D. Cryptosporidium
- E. Giardia
- F. None of the Above

### Understanding Bacteriophage

474. Bacteriophages may have a lytic cycle or a lysogenic cycle, such as the T4 phage, \_\_\_\_\_ are broken open (lysed) and destroyed after immediate replication of the virion.

- A. Lysogenic cycle
- B. Bacterial cells
- C. Vibrio cholerae
- D. Phage virions
- E. Myovirus bacteriophages
- F. None of the Above

475. Which of the following is an example of a virus that remains dormant until host conditions deteriorate, perhaps due to depletion of nutrients; then it become active?

- A. Lysogenic cycle
- B. Endogenous phages
- C. Vibrio cholerae
- D. Phage virions
- E. Myovirus bacteriophages
- F. None of the Above

476. Which of the following is an example of a bacteriophage known to follow the lysogenic cycle and the lytic cycle is the?

- A. Podoviruses
- B. Phage's host range
- C. Myovirus bacteriophages
- D. Phage lambda of E. coli
- E. Viral genome
- F. None of the Above

### Water Disinfection

477. The primary methods used for the \_\_\_\_\_ in very small and small treatment systems are ozone, ultraviolet irradiation and chlorine.

- A. Chlorates are powerful oxidizers
- B. Adverse health effects
- C. Disinfection of water
- D. Microbiological contamination
- E. Sodium chloride
- F. None of the Above

478. \_\_\_\_\_ expresses that this is less widely used in small and very small water treatment systems, including chlorine dioxide, potassium permanganate, chloramines and peroxone (ozone/hydrogen peroxide)?

- A. Limit the effects of organic material
- B. Numerous alternative disinfection processes
- C. Residual level of disinfection
- D. Additional killing mechanism
- E. Pathogens
- F. None of the Above

479. According to the text, surface waters have been the focal point of \_\_\_\_\_ since their inception, as groundwaters (like wells) have been historically considered to be free of microbiological contamination.

- A. Chlorates are powerful oxidizers
- B. Adverse health effects
- C. Water disinfection regulations
- D. Microbiological contamination
- E. Sodium chloride
- F. None of the Above

### Chlorate Ion

480. Which of the following terms is predicted by VSEPR, about chlorate anions?

- A. Acid/base balance
- B. Stable perchlorates
- C. Formula ClO<sub>3</sub><sup>-</sup>
- D. Trigonal pyramidal structures
- E. Chemical formula CaCl<sub>2</sub>
- F. None of the Above

481. According to the text, \_\_\_\_\_ should be kept away from organics or easily oxidized materials?

- A. Chlorates are powerful oxidizers
- B. Adverse health effects
- C. Formula ClO<sub>3</sub>
- D. Microbiological contamination
- E. Sodium chloride
- F. None of the Above

### Chloride Ion

482. The chloride ion is formed when the \_\_\_\_\_, a halogen, gains an electron to form an anion (negatively-charged ion) Cl<sup>-</sup>.

- A. Chlorates are powerful oxidizers
- B. Adverse health effects
- C. Element chlorine
- D. Microbiological contamination
- E. Sodium chloride
- F. None of the Above

483. The salts of hydrochloric acid contain chloride ions and can be called chlorides. The chloride ion, and its salts such as sodium chloride, \_\_\_\_\_.

- A. Acid/base balance
- B. The stable perchlorates
- C. The formula ClO<sub>3</sub>
- D. Are very soluble in water
- E. The chemical formula CaCl<sub>2</sub>
- F. None of the Above

484. Methyl chloride, more commonly called chloromethane, (CH<sub>3</sub>Cl) is \_\_\_\_\_, which does not contain a chloride ion.

- A. Chlorates are powerful oxidizers
- B. Adverse health effects
- C. The chloride ion
- D. An organic covalently bonded compound
- E. Sodium chloride
- F. None of the Above

485. Other salts such as calcium chloride, magnesium chloride, potassium chloride have varied uses ranging from medical treatments to?

- A. Chemical formula CaCl<sub>2</sub>
- B. Cement formation
- C. Chlorite ion is ClO<sub>2</sub><sup>-</sup>.
- D. Corresponding anions Cl<sup>-</sup>, ClO<sup>-</sup>, ClO<sub>2</sub><sup>-</sup>, ClO<sub>3</sub><sup>-</sup>, or ClO<sub>4</sub><sup>-</sup>
- E. Chlorine dioxide
- F. None of the Above

486. Which of the following compounds or element is also the prosthetic group present in the amylase enzyme. Another example is calcium chloride with the chemical formula CaCl<sub>2</sub>.

- A. Chemical formula CaCl<sub>2</sub>
- B. A chloride ion
- C. Chlorite ion is ClO<sub>2</sub><sup>-</sup>.
- D. Corresponding anions Cl<sup>-</sup>, ClO<sup>-</sup>, ClO<sub>2</sub><sup>-</sup>, ClO<sub>3</sub><sup>-</sup>, or ClO<sub>4</sub><sup>-</sup>
- E. Chlorine dioxide
- F. None of the Above

### Chlorite Ion

487. The chlorite ion is \_\_\_\_\_ A chlorite is a compound that contains this group, with chlorine in oxidation state +3. Chlorites are also known as salts of chlorous acid.

- A. Chemical formula CaCl<sub>2</sub>
- B. Chloride
- C. ClO<sub>2</sub><sup>-</sup>
- D. Corresponding anions Cl<sup>-</sup>, ClO<sup>-</sup>, ClO<sub>2</sub><sup>-</sup>, ClO<sub>3</sub><sup>-</sup>, or ClO<sub>4</sub><sup>-</sup>
- E. Chlorine dioxide
- F. None of the Above

488. Chlorine can assume oxidation states of -1, +1, +3, +5, or +7 within the corresponding anions Cl<sup>-</sup>, ClO<sup>-</sup>, ClO<sub>2</sub><sup>-</sup>, ClO<sub>3</sub><sup>-</sup>, or ClO<sub>4</sub><sup>-</sup>, known commonly and respectively as?

- A. Chemical formula CaCl<sub>2</sub>
- B. Chloride
- C. Chlorite ion is ClO<sub>2</sub><sup>-</sup>.
- D. Chloride, hypochlorite, chlorite, chlorate, and perchlorate
- E. Chlorine dioxide
- F. None of the Above

### Haloacetic Acids

489. What type of substances are Haloacetic acids in which a halogen atom takes the place of a hydrogen atom in acetic acid?

- A. An anti-bonding orbital
- B. A single halogen
- C. Hypochlorite compounds
- D. Carboxylic acids
- E. Calcium hypochlorite
- F. None of the Above

490. The inductive effect caused by the \_\_\_\_\_ often result in the higher acidity of these compounds by stabilizing the negative charge of the conjugate base.

- A. High-test calcium hypochlorite(s)
- B. Calcium hypochlorite tablets
- C. Hypochlorous acid
- D. Electronegative halogens
- E. Chlorine dioxide
- F. None of the Above

### Contaminants in Drinking Water

491. \_\_\_\_\_ expresses an exposure to such substances in drinking water has been associated with a number of health outcomes by epidemiological studies, although the putative agent in such studies has not been identified.

- A. An anti-bonding orbital
- B. A single halogen
- C. Hypochlorite compounds
- D. Disinfection by-products
- E. Calcium hypochlorite
- F. None of the Above

### Hypochlorites

492. The same residuals are obtained as with gas chlorine, but the effect on the \_\_\_\_\_ of the treated water is different.

- A. High-test calcium hypochlorite(s)
- B. Calcium hypochlorite tablets
- C. Hypochlorous acid
- D. Negative charge
- E. pH
- F. None of the Above

493. Hypochlorite compounds contain an excess of \_\_\_\_\_ and tend to raise the pH of the water.

- A. An anti-bonding orbital
- B. Alkali
- C. Hypochlorite compounds
- D. A common undesirable by-product
- E. Calcium hypochlorite
- F. None of the Above

### Disinfection Byproducts

494. This term represents when disinfectants used in water treatment plants react with bromide and/or natural organic matter (i.e., decaying vegetation) present in the source water.

- A. Disinfection byproducts
- B. Other disinfectants
- C. Naturally occurring bromide
- D. Occurring organic and inorganic matter in water
- E. Most prevalent THM
- F. None of the Above

495. \_\_\_\_\_ represents which regulations have been established have been identified in drinking water, including trihalomethanes, haloacetic acids, bromate, and chlorite.

- A. Chlorine dioxide
- B. HAA5
- C. Trihalomethanes
- D. Trihalomethanes, haloacetic acids, bromate, and chlorite
- E. Disinfection byproducts
- F. None of the Above

### **Trihalomethanes (THM)**

496. \_\_\_\_\_ represents chloroform, bromodichloromethane, dibromochloromethane, and bromoform.

- A. Chlorine dioxide
- B. HAA5
- C. Trihalomethanes
- D. Trihalomethanes, haloacetic acids, bromate, and chlorite
- E. Chloroform
- F. None of the Above

### **Haloacetic Acids (HAA5)**

497. This term represents monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, and dibromoacetic acid.

- A. Chlorine dioxide
- B. HAA5
- C. Trihalomethanes
- D. Trihalomethanes, haloacetic acids, bromate, and chlorite
- E. Chloroform
- F. None of the Above

498. Bromate is a chemical that is formed when this compound is used to disinfect drinking water?

- A. Disinfection byproducts
- B. Other disinfectants
- C. Naturally occurring bromide
- D. Occurring organic and inorganic matter in water
- E. Ozone
- F. None of the Above

499. This term represents a byproduct formed when chlorine dioxide is used to disinfect water.

- A. Chlorite
- B. HAA5
- C. Trihalomethanes
- D. Trihalomethanes, haloacetic acids, bromate, and chlorite
- E. Chloroform
- F. None of the Above

500. Which is the most prevalent THM measured in chlorinated water, is probably the most thoroughly studied disinfection byproduct?

- A. Disinfection byproducts
- B. Other disinfectants
- C. Naturally occurring bromide
- D. Occurring organic and inorganic matter in water
- E. Chloroform
- F. None of the Above