

**Registration form**

**Modern Disinfection 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*

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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.

**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 Do not solely trust our list for it may be outdated.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.

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

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

<http://www.tlch2o.com/PDF/CEU%20State%20Approvals.pdf>

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

## **AFFIDAVIT OF EXAM COMPLETION**

I affirm that I personally completed the entire text of the course. I also affirm that I completed the exam without assistance from any outside source.

I understand that it is my responsibility to file or maintain my certificate of completion as required by the state or by the designation organization.

## **Grading Information**

In order to maintain the integrity of our courses we do not distribute test scores, percentages or questions missed.

Our exams are based upon pass/fail criteria with the benchmark for successful completion set at 70%. Once you pass the exam, your record will reflect a successful completion and a certificate will be issued to you.

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

# Modern Disinfection 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 \_\_\_\_\_

Did you receive 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 in compliance with your agency 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*

**MODERN DISINFECTION 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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## Modern Disinfection 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 answer key 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

#### How Diseases are Transmitted.

- Waterborne pathogens are primarily spread by the?  
A. Fecal-oral, or feces-to-mouth, route      D. Influenza route  
B. Dermal to fecal route      E. Waterborne mishaps  
C. Oral to fecal route      F. None of the Above
- When infected humans or animals pass the bacteria, viruses, and \_\_\_\_\_ in their stool, pathogens may get into water and spread disease.  
A. Fecal Coliform and E coli      D. Cryptosporidiosis  
B. Protozoa      E. Bioslime  
C. Macroorganisms      F. None of the Above
- For another person to become infected, he or she must take that pathogen in through the mouth.  
A. True      B. False
- Which 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
- 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

### Legionella

6. Legionnaire's disease, which causes a severe pneumonia, and the second, \_\_\_\_\_, which is a non-pneumonia illness; it's typically an influenza-like illness, and it's less severe.
- A. Campylobacter      D. Typhoid fever  
B. Pathogen            E. Shigella dysenteriae  
C. Pontiac fever      F. None of the Above
7. Which pathogen is naturally found in water, both natural and artificial water sources?
- A. Campylobacter      D. Typhoid fever  
B. Legionella          E. Hydrodysenteriae  
C. Pontiac fever      F. None of the Above
8. 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

### Pseudomonas

9. 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

### Norovirus

10. 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

### Cryptosporidium

11. Cryptosporidium causes diarrheal illness known as?
- A. Vomiting                D. Cryptosporidiosis  
B. Hemorrhagic colitis      E. Salmonellosis  
C. Diarrhea                F. None of the Above
12. 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

### Giardia

13. 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

### Schistosomatidae

14. 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

### Understanding Waterborne Viruses

15. 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
16. Which is the current method for culturing \_\_\_\_\_ under the ICR (U.S. Environmental Protection Agency, 1996c) is recognized as being difficult to implement.
- A. Protozoan pathogens
  - B. Indicators of fecal contamination
  - C. Enteric viruses
  - D. Viruses
  - E. Microorganisms
  - F. None of the Above
17. \_\_\_\_\_ 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
18. Which term represents coliphage - which 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

### Streamwater Sample Collection

19. 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
20. 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**

21. 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

### **Understanding Bacteriophage**

22. Bacteriophages may have a lytic cycle or a lysogenic cycle, such as the T4 phage, this missing term 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
23. \_\_\_\_\_ is an example of a virus that remains dormant until host conditions deteriorate, perhaps due to depletion of nutrients; then it becomes active?
- A. Lysogenic cycle
  - B. Endogenous phages
  - C. Vibrio cholerae
  - D. Phage virions
  - E. Myovirus bacteriophages
  - F. None of the Above
24. 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
25. Which of the following terms is an example is the conversion of a harmless strain of a phage that can cause cholera?
- A. Lysogenic cycle
  - B. The virus
  - C. Vibrio cholerae
  - D. Phage virions
  - E. Myovirus bacteriophages
  - F. None of the Above

### **E-Coli Section**

26. Escherichia coli. There are several pathogenic strains of Escherichia coli, which are classified under enterovirulent E. coli. They are enterohemorrhagic, enteroinvasive, enterotoxigenic, enteropathogenic, and enteroaggregative.
- A. True
  - B. False
27. Prevention strategies for E. coli O157:H7 include \_\_\_\_\_, halogenation of water, or boiling water for one minute.
- A. Primary protection
  - B. Source protection
  - C. Sodium chlorite
  - D. Eliminating snails with a molluscicide
  - E. Backflow prevention
  - F. None of the Above
28. What is the bacterial disease caused by the Salmonella species that causes diarrheal illness?
- A. Beaver fever
  - B. Escherichia coli O157:H7
  - C. Bacteria
  - D. Pseudomonas
  - E. Salmonellosis
  - F. None of the Above

### Repeat Sampling

29. 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

30. According to the text, whenever a Routine sample is total coliform or fecal coliform present, a set of repeat samples must be collected within \_\_\_\_\_ hours after being notified by the laboratory.

- A. 12
- B. 24
- C. 48
- D. 10
- E. 2
- F. None of the Above

31. The follow-up for repeat sampling is: If only one \_\_\_\_\_ per month or quarter is required, four (4) repeat samples must be collected.

- A. Routine sample
- B. Surface water sample
- C. Original sample
- D. Sample
- E. MCL sample
- F. None of the Above

32. For systems collecting two (2) or more routine samples per month, three (3) \_\_\_\_\_ must be collected.

- A. Routine samples
- B. Surface water samples
- C. Samplers
- D. Repeat samples
- E. MCL compliance calculations
- F. None of the Above

33. 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

34. 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

35. 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

36. 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

### Positive or Coliform Present Results

37. 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

38. Which of the following is very 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)

39. 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

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

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

41. Which 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

42. 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

43. 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

44. 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



### Spread Plate Method

45. During the Spread Plate Method, colonies can be transferred quickly, and \_\_\_\_\_ easily can be discerned and compared to published descriptions.
- A. Colonies grow
  - B. Surface growth
  - C. Low counts
  - D. Heterotrophic organisms will grow
  - E. Colony morphology
  - F. None of the Above

### Membrane Filter Method

46. This method permits testing large volumes of \_\_\_\_\_ and is the method of choice for low-count waters.
- A. Colonies
  - B. Surface water
  - C. Low-turbidity water
  - D. Heterotrophic organisms
  - E. MCL
  - F. None of the Above

### Heterotrophic Plate Count (Spread Plate Method)

47. After an incubation period, a bacteriological colony count provides an estimate of the concentration of heterotrophs in the sample of interest. The R2A agar provides a medium that will support a large variety of?
- A. Colonies
  - B. Bugs
  - C. Germs
  - D. Heterotrophic bacteria
  - E. MCL
  - F. None of the Above

### Total Coliforms

48. 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
49. For systems that 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
  - B. 10
  - C. 100
  - D. 200
  - E. 40
  - F. None of the Above

50. For systems that 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
  - B. 10
  - C. 100
  - D. 200
  - E. 40
  - F. None of the Above

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

51. A routine analysis shows total and \_\_\_\_\_ is followed by a repeat analysis which indicates total coliform present.
- A. Routine analysis
  - B. Drinking water violation
  - C. MCL violation
  - D. Human health violations
  - E. Fecal coliform or E. coli present
  - F. None of the Above

52. Which of the following terms requires the water system to provide public notice via radio and television stations in the area?

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

53. 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

54. 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

55. 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:

56. Which is violation of nitrate?

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

57. 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

58. 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

### What is Water?

59. Water is primarily a liquid under standard conditions, which is not predicted from its relationship to other analogous hydrides of the oxygen family in the periodic table, which are liquids such as sulfuric acid.

- A. True
- B. False

60. Water is the chemical substance with chemical formula H<sub>2</sub>O: one molecule of water has two hydrogen atoms covalently bonded to a single oxygen atom.

- A. True
- B. False

61. Water is a tasteless, odorless liquid at ambient temperature and pressure, and appears colorless in small quantities, although it has its own intrinsic very light blue hue. Ice also appears colorless, and water vapor is essentially invisible as a gas.

A. True      B. False

62. Oxygen attracts protons much more strongly than hydrogen, resulting in a net negative charge on the hydrogen atoms, and a net negative charge on the oxygen atom. The presence of a charge on each of these atoms gives each water molecule a net dipole moment.

A. True      B. False

63. Electrical attraction between water molecules due to this dipole pulls individual molecules closer together, making it more difficult to separate the molecules and therefore raising the boiling point.

A. True      B. False

### **Microbial Regulations**

64. 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

65. Which rule specifies treatment criteria to assure that these performance requirements are met; they include turbidity limits, disinfectant residual, and disinfectant contact time conditions?

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

66. \_\_\_\_\_ was established to maintain control of pathogens while systems lower disinfection byproduct levels to comply with the Stage 1 Disinfectants/Disinfection Byproducts Rule and to control Cryptosporidium?

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

67. 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 tightened turbidity standards back in December 2001.

A. True      B. False

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

A. True      B. False

69. 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

### Introduction to Chlorine (DDBP)

70. These term means that chlorine is present as Cl, 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

71. 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

72. While testing chlorine disinfection process, you will need to understand one especially important feature is the ease of overdosing to create a "missing term" 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

73. 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

74. Typically this chlorine residual is 2 ppm for \_\_\_\_\_.

- 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

75. The most common chlorination by-products found in U.S. drinking water supplies are?

- A. Chlorate and Chlorite
- B.  $\text{CO}_2$  and  $\text{H}_2\text{SO}_4$
- C. Trihalomethanes (THMs)
- D. Ammonia and THMS
- E. Chloramines
- F. None of the Above

### The Principal Trihalomethanes are:

76. Chloroform, bromodichloromethane, chlorodibromomethane, and bromoform. Other less common chlorination by-products include the haloacetic acids and haloacetonitriles. 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

77. 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

78. 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

79. 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

80. Many cities utilize the use of ozone to disinfect their source water and to reduce formation of this parameter?

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

81. \_\_\_\_\_ 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                      D. Chlorine Dioxide, Chlorine  
B. UV, Chlorine                          E. Chloramines, Chlorine  
C. Chlorite, Chlorine                      F. None of the Above

82. 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                                      D. Chlorine Dioxide  
B. UV    E. Chloramines  
C. Chlorite                                    F. None of the Above

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

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

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

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

85. 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 Rule Summary**

86. 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

87. Chlorine and chlorine-based compounds (halogens) react with organics in water causing the chlorine atom to substitute other atoms resulting in?  
A. Chlorine                      D. Halogenated by-products  
B. Organic sulfide(s)      E. HOCl  
C. Calcium carbonate      F. None of the Above

88. Oxidation reactions, where chlorine oxidizes \_\_\_\_\_ present in water.  
A. Carbon                      D. Chlorine and chlorine-based compounds (halogens)  
B. Surface water              E. Secondary by-products  
C. Compounds                  F. None of the Above

89. Which of the following rules requires systems using public water supplies from either surface water or groundwater under the direct influence of surface water to disinfect?  
A. TTHM and HAA5 Rule                      D. Disinfection byproducts (DBPs) Rule  
B. DBP MCLs Rule                              E. Surface Water Treatment Rule (SWTR)  
C. A community water system (CWS)      F. None of the Above

90. 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 MCLs Rule                              E. Total Trihalomethanes  
C. A community water system (CWS)      F. None of the Above

91. Which of the following 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 MCLs Rule                              E. Disinfectants and Disinfection Byproducts (DBP)  
C. A community water system              F. None of the Above

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

93. Which of the following rules 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 began 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

### Public Health Concerns

94. According to the text, because off the large population exposed, health risks associated with \_\_\_\_\_, even if small, need to be taken seriously.
- A. DBPs
  - B. Chlorine and chloramine
  - C. Stage 2 DBPR
  - D. Classes of DBPs
  - E. Ultraviolet light
  - F. None of the Above
95. Which of the following rules has been highly effective in protecting public health and has evolved to respond to new and emerging threats to safe drinking water?
- A. Stage 2 DBPR
  - B. DBP exposure
  - C. The Stage 2 DBP rule
  - D. Long Term 2 Enhanced Surface Water Treatment Rule
  - E. Safe Drinking Water Act (SDWA)
  - F. None of the Above
96. \_\_\_\_\_ is one of the major public health advances in the 20th century.
- A. Major public health advances
  - B. The Stage 2 DBPR
  - C. Disinfection of drinking water
  - D. Amendments to the SDWA in 1996
  - E. Primary or residual disinfectant
  - F. None of the Above

97. Water system managers may also consider switching from chlorine to alternative disinfectants to reduce formation of THMs and HAAs.
- A. True
  - B. False

### Water Chemistry- Halides

98. Halide ions combined with single hydrogen atoms form the hydrohalic acids (i.e., HF, HCl, HBr, HI), a series of particularly strong acids, one being?
- A. HCl
  - B. HOCl
  - C. Hydrastatic acid
  - D. Chlorine gas
  - E. The hypochlorite ion (OCl<sup>-</sup>)
  - F. None of the Above
99. Many synthetic organic compounds such as plastic polymers, and a few natural ones, contain halogen atoms; these are known as halogenated compounds or?
- A. Organic halides
  - B. Free radicals
  - C. Diatomic Compound
  - D. Many synthetic organic compounds
  - E. Neither fluorine nor bromine
  - F. None of the Above
100. What is the negative ion referred to as?
- A. Salts
  - B. A halide proton
  - C. A halide ion
  - D. Free radical
  - E. Diatomic Compound
  - F. None of the Above
101. Which of the following terms containing these ions are known as halides?
- A. Salts
  - B. CXT values
  - C. Primary disinfectant
  - D. Many synthetic organic compounds
  - E. Neither fluorine nor bromine
  - F. None of the Above

## Chlorine

102. This halogen is needed only in very small amounts for the production of thyroid hormones such as thyroxine?

- A. Chlorine
- B. Chlorine dioxide
- C. Iodine
- D. Halogen(s)
- E. Inhibitory transmitter GABA
- F. None of the Above

103. On the other hand, neither fluorine nor bromine are believed to be really essential for humans, although small amounts of \_\_\_\_\_ can make tooth enamel resistant to decay.

- A. Salts
- B. Iodine
- C. Chlorine
- D. Synthetic organic compounds
- E. Fluoride
- F. None of the Above

104. Which halogen is needed in relatively large amounts by humans?

- A. Chlorine
- B. Chlorine dioxide
- C. Iodine
- D. Halogen(s)
- E. Inhibitory transmitter GABA
- F. None of the Above

## Halogens

105. 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

## pH Section

106. 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

107. 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

108. 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

109. Because the pH scale is logarithmic, therefore pH is?

- A. Universal indicator
- B. A dimensionless quantity
- C. A Spectrophotometer
- D. Excess of Ion concentrations
- E. A set of non-linear equations
- F. None of the Above

110. Alkalinity is able to neutralize \_\_\_\_\_ and is measured in a quantitative capacity in an aqueous solution.

- A. Acid
- B. Base
- C. pH
- D. pH measurement(s)
- E. Bond formation
- F. None of the Above



111. 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

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

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

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

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

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

115. Calculations are not necessary except in extreme situations for strong acids and bases. The pH of a solution containing a weak acid requires?

- A. The concentration value      D. Visual comparison  
B. The solution of a quadratic equation      E. The solution of a cubic equation  
C. The Spectrophotometer      F. None of the Above

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

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

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

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

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

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

119. Sodium hydroxide, NaOH, is an example of \_\_\_\_\_.

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

120. 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

121. 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

122. 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

### Water Disinfection Methods Review

123. 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
124. 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
125. 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

126. 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

127. 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

128. 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

129. 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

### Chlorination and Dechlorination

130. \_\_\_\_\_ and some of its derivatives will continue as an integral part of the disinfection process in water and wastewater treatment.

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

131. The relationship between chlorine concentration (C, milligrams per liter) and contact time (T, minutes) required for a specific percentage destruction of microorganisms is expressed as a constant ( $CT = K$ ).

- A. True
- B. False

132. The proper use of this CT relationship to determine adequate water chlorination requirements has been emphasized as an approach to prevent and control waterborne diseases. Minimum CT values of 15-30 for systems using groundwater as a source and 100-150 for those using surface supplies have been recommended.

- A. True
- B. False

### Chlorine Dioxide Section

133.  $\text{ClO}_2$  generation uses \_\_\_\_\_ and chlorine gas.

- 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. Ozone
- F. None of the Above

134. Chlorine gas is educted into a motive water stream in a  $\text{ClO}_2$  generator forming?

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

135. This compound 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

136. \_\_\_\_\_ does not hydrolyze in water as chlorine does and with it. It remains fully active in a pH range far broader than chlorine or sodium hypochlorite.

- 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

137. 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

138. 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

139. Which of the following compound(s) tends to be much less, if not totally 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

140. Which of the following compound(s) is much less aggressive to traditional corrosion inhibitors?

- 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

141. \_\_\_\_\_ is heavily pH-dependent, because as system pH increases, there is a correspondingly rapid decrease in the concentration of the biocidally active species.

- 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

142. Which of the following compound(s) 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

143. \_\_\_\_\_ 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
144. Which of the following compound(s), 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
145. 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
146. \_\_\_\_\_ was 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
147. 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
148. 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
149. 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 mg/l to 1 mg/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
150. Which of the following compound(s) 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

151. The effects of \_\_\_\_\_ on hypochlorous acid and its reactivity with a variety of compounds both combine to vastly diminish its effectiveness in contaminated, high-pH cooling water systems. Conversely, chlorine dioxide remains completely pH-independent in the range where recirculating and once-through cooling systems are typically operated.

- A. THM precursor(s)
- B. Chlorine gas
- C. Chlorine dioxide
- D. pH
- E. THM formation
- F. None of the Above

### Ultraviolet Disinfection

152. 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

153. 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

154. 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

155. 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 will fail.

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

156. 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

157. 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

158. 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

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

160. 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

161. 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

162. 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

163. 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

164. 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

165. Each water has its own?

- 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

166. 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

167. 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

168. 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

169. 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

170. 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

171. Which 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

172. Ozone may also be used as \_\_\_\_\_ for removal of taste and odor, or may be applied as a pre-disinfectant.

- A. An oxidant
- B. Free and/or combined chlorine
- C. Residual levels
- D. System residual
- E. Strongest oxidizing agent
- F. None of the Above

### Chlorine Section

#### Chlorine's Appearance and Odor

173. 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



174. Prolonged exposures to chlorine gas may result in\_\_\_\_\_. Odor thresholds ranging from 0.08 to part per million (ppm) parts of air have been reported.

- A. Exposure to chlorine
- B. Odor thresholds
- C. A corrosive material
- D. Olfactory fatigue
- E. Moisture, steam, and water
- F. None of the Above

### Reactivity

175. 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

176. 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

177. 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

178. When there is a fire that involves chlorine, the firefight should be fought downwind from the minimum distance possible.

- A. True
- B. False

179. By dropping a few drops of hydrochloric acid onto a piece of manganese dioxide, Steele had discovered?

- A. Halogens
- B. Ammonia
- C. Chlorine
- D. Manganese dioxide
- E. H<sub>2</sub>SO<sub>4</sub>
- F. None of the Above

180. English chemist Sir Humphrey Davy discovered that chlorine gas was actually an element. Until that time, people were convinced that the gas was a?

- A. Chlorine chemistry
- B. Compound of oxygen
- C. Compound of ammonia
- D. Economical germ-killers
- E. Theory
- F. None of the Above

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

181. 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

182. 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

183. 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

184. 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

185. Because it is highly reactive, chlorine is usually found in nature bound with other elements like sodium, potassium, and magnesium.

- A. True      B. False

186. Chemical elements have their own set of unique properties and chlorine is known as \_\_\_\_\_--so reactive, in fact, that it is usually found combined with other elements in the form of compounds.

- A. Synthesizing organic compounds      D. Organic compounds  
B. A very reactive element      E. One of the most abundant chemical elements  
C. Chlorine compounds      F. None of the Above

187. Which substance is capable of removing a wide variety of disease-causing germs from drinking water and wastewater as well as from hospital and food production surfaces?

- A. Inorganic disinfectant      D. Useful chemical elements  
B. Chlorine-based disinfectants      E. Organic compounds  
C. Ancient seawater      F. None of the Above

188. Various states of chlorine includes when chlorine is isolated as a free element, chlorine is a greenish yellow gas, which is \_\_\_\_\_.

- 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

### Released From the Salt of the Earth

189. According to the text, because of the slow evaporation of \_\_\_\_\_, Chlorine is produced industrially from the compound sodium chloride.

- A. Water      D. Useful chemical elements  
B. Brine      E. Organic compounds  
C. Ancient seawater      F. None of the Above

### Chlorine Gas Section

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

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

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

- A. HCl
- B. HOCl
- C. High chlorine concentrations
- D. Alkalinity
- E. Hypochlorite ion (OCl<sup>-</sup>)
- F. None of the Above

192. According to the text, 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

193. 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 (OCl<sup>-</sup>)
- F. None of the Above

### Pathophysiology

194. 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
- B. Chlorine gas
- C. The gas
- D. The chemical species produced
- E. Plasma exudation
- F. None of the Above

### Mechanism of Activity

195. 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
- B. Chlorine acid
- C. Hydrochloric acid
- D. A caustic effect
- E. Hypochlorous and hydrochloric acid
- F. None of the Above

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

- A. True
- B. False

### Solubility Effects

197. Which of the following terms is highly soluble in water. The predominant targets of the acid are the epithelia of the ocular conjunctivae and upper respiratory mucus membranes.

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

### Early Response to Chlorine Gas

198. 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

### Immediate Effects

199. 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

200. According to the text, treatment plants use \_\_\_\_\_ to reduce water levels of microorganisms that can spread disease to humans.

- A. HCl
- B. HOCl
- C. High chlorine concentrations
- D. Chlorine
- E. The hypochlorite ion (OCl<sup>-</sup>)
- F. None of the Above

201. 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

### Chlorine's Effectiveness

202. The amount of chlorine required to achieve disinfection and that reacts with the other chemicals is the?

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

203. Which of the following terms 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

204. 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

205. 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

206. 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

207. Which term expresses a compound that 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

208. \_\_\_\_\_ expresses 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

209. Which term 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**

210. 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

211. All of the following play a role in the decision-making process: environmental and regulatory impact, \_\_\_\_\_, process contamination, and equipment capital and maintenance expense.

- A. As necessary
- B. Disinfection process
- C. System pH
- D. The primary methods used for the disinfection
- E. Economical and versatile chemicals
- F. None of the Above

212. The primary killing mechanism is oxidizing protein groups within a microorganism, these proteins are the basic components of \_\_\_\_\_ that are necessary for life-sustaining cellular processes such as respiration.

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

### **Chemistry of Chlorination**

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

- A. True
- B. False

214. 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

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

- A. True
- B. False

216. 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

217. 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

218. 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

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

- A. True
- B. False

### Types of Residual

220. Which of the following terms is all the 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

221. 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

222. 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

223. 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

224. Fill in the blank \_\_\_\_\_ = Concentration (mg/L) x Time (minutes)

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

225. The effective reduction in pathogens can be calculated by reference to standard tables of required?

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

226. The CT concept as developed by the United States Environmental Protection Agency (uses the combination of disinfectant residual concentration (mg/L) and the effective disinfection contact time (in minutes) to measure effective pathogen reduction.

- A. True
- B. False

### Calculation and Reporting of CT Data

227. The \_\_\_\_\_ 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

228. 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

### Chlorine Review

229. \_\_\_\_\_ 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

230. 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

231. Which 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

232. Which term describes the concentration of chlorine in the water after the chlorine demand has been satisfied?

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

233. Which term 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

234. \_\_\_\_\_ the residual chlorine existing in water in chemical combination with ammonia or organic amines which 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

235. 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

236. \_\_\_\_\_ 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

### Common Terms

237. 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
- B. Post-chlorination
- C. Chlorine Demand
- D. Demand
- E. Pre-chlorination
- F. None of the Above

238. \_\_\_\_\_ describes the sum of free and combined chlorine.

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



239. 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
- B. The amount of chlorine
- C. Chlorine Demand
- D. Total chlorine
- E. Free chlorine
- F. None of the Above

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

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

241. 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

242. 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

243. 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

244. 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

245. 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

246. \_\_\_\_\_ 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

247. 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

248. Which 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

249. If chloramines are present in the municipal water supply, then 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

250. 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

251. 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

### **Chlor-Alkali Membrane Process**

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

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

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

254. Which of the following terms passes across an ion selective membrane leaving the chlorine ion to combine with a second chlorine ion, which makes a chlorine gas bubble at the anode (electrode)?

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

255. The membrane in the cell keeps the two solutions separate; otherwise, the chlorine gas bubble would immediately combine with the caustic soda forming?

- A. Chlorination
- B. Caustic soda
- C. Chlorine ion
- D. Chlor-alkali membrane process
- E. Sodium hypochlorite, or bleach
- F. None of the Above

### Disinfection Summary

#### Wastewater Disinfection

256. According to the text, there are a number of chemicals and processes that will this missing term, but none are universally applicable.

- A. Limit the effects of organic material
- B. Numerous alternative disinfection processes
- C. Residual level of disinfection
- D. Disinfect wastewater
- E. Limit the travel of pathogens
- F. None of the Above

#### Water Disinfection

257. Disinfection is usually the final stage in the \_\_\_\_\_ in order to limit the effects of organic material, suspended solids and other contaminants.

- A. Limit the effects of organic material
- B. Numerous alternative disinfection processes
- C. Residual level of disinfection
- D. Water treatment process
- E. Limit the travel of pathogens
- F. None of the Above

258. \_\_\_\_\_ 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

259. 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

260. 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

261. According to the text, \_\_\_\_\_ and 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><sup>-</sup>
- D. Microbiological contamination
- E. Sodium chloride
- F. None of the Above

262. Chlorates were once widely used in \_\_\_\_\_ for this reason, though their use has fallen due to their instability. Most pyrotechnic applications which formerly used chlorates in the past now use the more stable perchlorates instead.

- A. Acid/base balance
- B. Stable perchlorates
- C. Formula  $\text{ClO}_3$
- D. Pyrotechnics
- E. Chemical formula  $\text{CaCl}_2$
- F. None of the Above

### Chloride Ion

263. The chloride ion is formed when the \_\_\_\_\_, a halogen, gains an electron to form an anion (negatively-charged ion)  $\text{Cl}^-$ .

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

264. The salts of hydrochloric acid contain chloride ions and can also be called chlorides. The chloride ion, and its salts such as sodium chloride, \_\_\_\_\_.

- A. Acid/base balance
- B. The stable perchlorates
- C. The formula  $\text{ClO}_3$
- D. Are very soluble in water
- E. The chemical formula  $\text{CaCl}_2$
- F. None of the Above

265. Methyl chloride, more commonly called chloromethane, ( $\text{CH}_3\text{Cl}$ ) 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

266. Other salts such as calcium chloride, magnesium chloride, potassium chloride have varied uses ranging from medical treatments to?

- A. Chemical formula  $\text{CaCl}_2$
- B. Cement formation
- C. Chlorite ion is  $\text{ClO}_2^-$ .
- D. Corresponding anions  $\text{Cl}^-$ ,  $\text{ClO}^-$ ,  $\text{ClO}_2^-$ ,  $\text{ClO}_3^-$ , or  $\text{ClO}_4^-$
- E. Chlorine dioxide
- F. None of the Above

267. Which of the following compounds is an example is table salt?

- A.  $\text{CaCl}_2$
- B.  $\text{NaCl}$
- C.  $\text{ClO}_2^-$ .
- D.  $\text{Cl}^-$ ,  $\text{ClO}^-$ ,  $\text{ClO}_2^-$ ,  $\text{ClO}_3^-$ , or  $\text{ClO}_4^-$
- E.  $\text{NaCl}_2$
- F. None of the Above

268. \_\_\_\_\_ is also the prosthetic group present in the amylase enzyme. Another example is calcium chloride with the chemical formula  $\text{CaCl}_2$ .

- A. Chemical formula  $\text{CaCl}_2$
- B. A chloride ion
- C. Chlorite ion is  $\text{ClO}_2^-$ .
- D. Corresponding anions  $\text{Cl}^-$ ,  $\text{ClO}^-$ ,  $\text{ClO}_2^-$ ,  $\text{ClO}_3^-$ , or  $\text{ClO}_4^-$
- E. Chlorine dioxide
- F. None of the Above

269. Which of the following compounds is used for maintaining unpaved roads and for sanite fortifying roadbases for new construction?

- A. Chemical formula  $\text{CaCl}_2$
- B. Calcium chloride
- C. Chlorite ion is  $\text{ClO}_2^-$ .
- D. Corresponding anions  $\text{Cl}^-$ ,  $\text{ClO}^-$ ,  $\text{ClO}_2^-$ ,  $\text{ClO}_3^-$ , or  $\text{ClO}_4^-$
- E. Chlorine dioxide
- F. None of the Above

270. Which of the following compounds are a closely monitored constituent of the mud system?  
A. Chemical formula  $\text{CaCl}_2$  D. Chlorides  
B. Chloride E. Chlorine dioxide  
C. Chlorite ion is  $\text{ClO}_2^-$  F. None of the Above

271. \_\_\_\_\_ is also a useful and reliable chemical indicator of river / groundwater fecal contamination, as chloride is a non-reactive solute and ubiquitous to sewage & potable water.  
A. Chemical formula  $\text{CaCl}_2$  D. Corresponding anions  $\text{Cl}^-$ ,  $\text{ClO}^-$ ,  $\text{ClO}_2^-$ ,  $\text{ClO}_3^-$ , or  $\text{ClO}_4^-$   
B. Chloride E. Chlorine dioxide  
C. Chlorite ion is  $\text{ClO}_2^-$  F. None of the Above

### Chlorite Ion

272. The chlorite ion is \_\_\_\_\_.  
A. Chemical formula  $\text{CaCl}_2$  D. Corresponding anions  $\text{Cl}^-$ ,  $\text{ClO}^-$ ,  $\text{ClO}_2^-$ ,  $\text{ClO}_3^-$ , or  $\text{ClO}_4^-$   
B. Chloride E. Chlorine dioxide  
C.  $\text{ClO}_2^-$  F. None of the Above

273. Chlorine can assume oxidation states of -1, +1, +3, +5, or +7 within the corresponding anions  $\text{Cl}^-$ ,  $\text{ClO}^-$ ,  $\text{ClO}_2^-$ ,  $\text{ClO}_3^-$ , or  $\text{ClO}_4^-$ , known commonly and respectively as \_\_\_\_\_.  
A. Chemical formula  $\text{CaCl}_2$  D. Chloride, hypochlorite, chlorite, chlorate, and perchlorate  
B. Chloride E. Chlorine dioxide  
C. Chlorite ion is  $\text{ClO}_2^-$  F. None of the Above

274. An additional oxidation state of +4 is seen in the neutral compound \_\_\_\_\_, which has a similar structure to chlorite  $\text{ClO}_2^-$  (oxidation state +3) and the cation chloryl ( $\text{ClO}_2^+$ ) (oxidation state +5).  
A. Chemical formula  $\text{CaCl}_2$  D. Corresponding anions  $\text{Cl}^-$ ,  $\text{ClO}^-$ ,  $\text{ClO}_2^-$ ,  $\text{ClO}_3^-$ , or  $\text{ClO}_4^-$   
B. Chloride E. Chlorine dioxide  $\text{ClO}_2$   
C. Chlorite ion is  $\text{ClO}_2^-$  F. None of the Above

### Chlorine Dioxide

275. Chlorine dioxide is a chemical compound with the formula?  
A. Chemical formula  $\text{CaCl}_2$  D. Corresponding anions  $\text{Cl}^-$ ,  $\text{ClO}^-$ ,  $\text{ClO}_2^-$ ,  $\text{ClO}_3^-$ , or  $\text{ClO}_4^-$   
B. Chloride E.  $\text{ClO}_2$   
C. Chlorite ion is  $\text{ClO}_2^-$  F. None of the Above

### Haloacetic Acids

276. 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 D. Carboxylic acids  
B. A single halogen E. Calcium hypochlorite  
C. Hypochlorite compounds F. None of the Above

### Contaminants in Drinking Water

277. \_\_\_\_\_ 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 D. Disinfection by-products  
B. A single halogen E. Calcium hypochlorite  
C. Hypochlorite compounds F. None of the Above

### Hypochlorites

278. 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

### Bromate

279. 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
- B. Bromide, Bromate, Ozone
- C. Bromate, Bromate, Bromate
- D. Hydrogen sulfide, Water, Nitrogen
- E. Bromate, Ozone, Bromide
- F. None of the Above

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

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

### Chlorite

281. 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
- B. 10 parts per billion
- C. 100 parts per billion
- D. 10 parts per million
- E. 500 parts per million
- F. None of the Above

### Disinfection Byproducts

282. Which 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

283. \_\_\_\_\_ 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)

284. Which term represents a group of four chemicals that are formed along with other disinfection byproducts when chlorine or other disinfectants used to control microbial contaminants in drinking water react with naturally occurring organic and inorganic matter in water?

- A. Disinfection byproducts
- B. Other disinfectants
- C. Naturally occurring bromide
- D. Occurring organic and inorganic matter in water
- E. Trihalomethanes (THM)
- F. None of the Above

285. \_\_\_\_\_ represents chloroform, bromodichloromethane, dibromochloromethane, and bromoform?
- A. Chlorine dioxide    D. Trihalomethanes, haloacetic acids, bromate, and chlorite  
B. HAA5                    E. Chloroform  
C. Trihalomethanes    F. None of the Above

### Haloacetic Acids (HAA5)

286. Which term represents substances in drinking water that reacts with naturally occurring organic and inorganic matter in water?

- A. Disinfection byproducts                    D. Occurring organic and inorganic matter in water  
B. Other disinfectants                        E. Microbial contaminants  
C. Naturally occurring bromide                F. None of the Above

287. \_\_\_\_\_ represents monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, and dibromoacetic acid.

- A. Chlorine dioxide    D. Trihalomethanes, haloacetic acids, bromate, and chlorite  
B. HAA5                    E. Chloroform  
C. Trihalomethanes    F. None of the Above

288. Bromate is a chemical that is formed when \_\_\_\_\_ is used to disinfect drinking water?

- A. Disinfection byproducts                    D. Occurring organic and inorganic matter in water  
B. Other disinfectants                        E. Ozone  
C. Naturally occurring bromide                F. None of the Above

289. Which term represents a byproduct formed when chlorine dioxide is used to disinfect water?

- A. Chlorite                    D. Trihalomethanes, haloacetic acids, bromate, and chlorite  
B. HAA5                        E. Chloroform  
C. Trihalomethanes    F. None of the Above

### Chloroform

290. Which is typically the most prevalent THM measured in chlorinated water, is probably the most thoroughly studied disinfection byproduct?

- A. Disinfection byproducts                    D. Occurring organic and inorganic matter in water  
B. Other disinfectants                        E. Chloroform  
C. Naturally occurring bromide                F. None of the Above

### Sodium Chlorate

291. Sodium chlorate can also be synthesized by passing \_\_\_\_\_ into a hot sodium hydroxide solution. It is then purified by crystallization.

- A. Chlorate                    D. Sodium metaborate or ammonium phosphates  
B. Oxygen                     E. The free acid, chlorous acid,  $\text{HClO}_2$   
C. Chlorine gas                F. None of the Above

## Hypochlorites and Chloramines

### Chloramine Disadvantages

292. Which residual in tap water can pass through membranes in dialysis machines and directly induce oxidant damage to red blood cells?

- A. Free chlorine
- B. Chloramine
- C. Dichloramine
- D. Monochloramine
- E. Ammonia and chlorine compounds
- F. None of the Above

### Chloramine Section

293. \_\_\_\_\_:  $\text{NH}_3 + \text{HOCl} \rightarrow \text{NH}_2\text{Cl} + \text{H}_2\text{O}$

- A. Free chlorine
- B. Trichloramine
- C. Dichloramine
- D. Monochloramine
- E. Ammonia and chlorine compounds
- F. None of the Above

294. Free chlorine reacts with the chloramine to produce hydrogen ion, water, and \_\_\_\_\_ which will come out of solution. In the case of the monochloramine, the following reaction occurs:  $2\text{NH}_2\text{Cl} + \text{HOCl} \rightarrow \text{N}_2 + 6\text{HCl} + \text{H}_2\text{O}$

- A. Free chlorine
- B. Chloramine(s)
- C. Dichloramine
- D. Nitrogen gas
- E. Ammonia and chlorine compounds
- F. None of the Above

295. Which of the following terms are formed in the pH range of 4.5 to 8.5, however, monochloramine is most common when the pH is above 8. When the pH of the water is below 4.5, the most common form of chloramine is trichloramine which produces a very foul odor.

- A. Free chlorine
- B. Chloramine(s)
- C. Dichloramine
- D. Monochloramine and dichloramine
- E. Ammonia and chlorine compounds
- F. None of the Above

### Post Chlorination

296. Post chlorination is almost always done in water treatment, but can be replaced with chlorine dioxide or chloramines. In this stage, chlorine is fed to the drinking water stream which is then sent to the chlorine contact basin to allow the chlorine a long enough detention time to kill all viruses, bacteria, and protozoa that were not removed and rendered inactive in the prior stages of treatment.

- A. True
- B. False

### Exposure

297. After prolonged exposure, the skin can become sensitive. Sodium hypochlorite is poisonous for water organisms. It is mutagenic and very toxic when it comes in contact with Ammonium salts.

- A. True
- B. False

### Routes of Exposure

#### Inhalation

298. Chlorine is lighter than air and may cause asphyxiation in poorly ventilated, enclosed, or high-lying areas.

- A. True
- B. False



### Ingestion

299. Metabolic acidosis is rare, but has been reported following the ingestion of \_\_\_\_\_. Pulmonary complications resulting from aspiration may also be seen after ingestion.

- A. Hypochlorous Acid (HOCl)
- B. Residual disinfectant
- C. Higher levels of chlorine
- D. Sodium and calcium
- E. Household bleach
- F. None of the Above

### Sources/Uses

300. According to the text, these compounds are manufactured by the chlorination of sodium hydroxide or lime.

- A. Sodium hypochlorite
- B. Chlorine gas
- C. Sodium and calcium hypochlorite
- D. Hypochlorous acid
- E. Hypochlorite solutions, powder, or concentrated vapor
- F. None of the Above

### Routes of Exposure

#### Calcium Hypochlorite: Powder and Tablets

301. Which of the following substances comes in two forms: powder and tablets?

- A. Calcium hypochlorite
- B. Hypochlorous Acid (HOCl)
- C. Sodium hypochlorite
- D. Chlorine
- E. Hypochlorite
- F. None of the Above

302. 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

303. 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

### Accuracy

304. According to the text, this answer is an accurate dose, always yielding the stated level of available chlorine in water or very slightly over, never under.

- A. Chlorine tablet(s)
- B. Household bleach
- C. Hypochlorous Acid (HOCl)
- D. Sodium hypochlorite
- E. Calcium hypochlorite
- F. None of the Above

### Effectiveness

305. Liquid Sodium hypochlorite and chlorine tablets produce Hypochlorous Acid (HOCl) and?

- A. Calcium hypochlorite
- B. Hydrochlorous Acid (HOCl)
- C. Oxygen
- D. Hypochlorite ion (OCI-) in solution
- E. Hypochlorite ion
- F. None of the Above

### **Safety**

306. Which of the following can affect eyes, skin and mucous membranes; it is easily splashed and rots clothing?

- A. Chlorine tablet(s)
- B. Hypochlorite
- C. Chloramine
- D. Sodium dichloroisocyanurate (NaDCC)
- E. Liquid chlorine
- F. None of the Above

### **Corrosion**

307. Which of the following are much less corrosive than liquid chlorine, which is highly corrosive to most metals?

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

### **Comparison**

308. Which substance is comparable to Sodium dichloroisocyanurate (NaDCC) is their neutralization by organic matter.

- A. Chlorine tablet(s)
- B. Hypochlorite
- C. Chloramine
- D. Sodium hypochlorite (NaOCl)
- E. Hypochlorous Acid
- F. None of the Above

### **Health Effects**

309. Which substance produces tissue injury by liquefaction necrosis. Systemic toxicity is rare, but metabolic acidosis may occur after ingestion.

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

### **Acute Exposure**

310. According to the text, the toxic effects of this compound are primarily due to the corrosive properties of the hypochlorite moiety.

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

### **Sodium Hypochlorite Solutions**

311. Sodium hypochlorite solutions liberate the Toxic gases chlorine or chloramine if mixed with acid or ammonia (this can occur when bleach is mixed with another cleaning product). Thus, exposure to hypochlorite may involve exposure to these gases.

- A. True
- B. False

### **Potential Sequelae**

312. Exposure to toxic gases generated from hypochlorite solutions can lead to reactive airways dysfunction syndrome (RADS), a chemical irritant-induced type of asthma. Chronic complications following ingestion of hypochlorite include esophageal obstruction, pyloric stenosis, squamous cell carcinoma of the esophagus, and vocal cord paralysis with consequent airway obstruction.

- A. True
- B. False

### Chronic Exposure

313. Because chronic dermal can cause dermal irritation due to exposure to this substance.

- A. Chlorine tablet(s)
- B. Hypochlorite
- C. Chloramine
- D. Sodium dichloroisocyanurate (NaDCC)
- E. Hypochlorous Acid
- F. None of the Above

### Summary

#### Chloramines

314. 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

315. \_\_\_\_\_ 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

316. Which 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

317. 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

318. In solution, Chlorine dioxide 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

319. Which of the following terms does chlorine dioxide produce?

- A. CO<sub>2</sub> and H<sub>2</sub>SO<sub>4</sub>
- B. Sodium hypochlorite
- C. Bromate
- D. Trihalomethanes, haloacetic acids, bromate, and chlorite
- E. A residual it is only rarely used for this purpose
- F. None of the Above

#### Chlorination Safety and Equipment Section- Chlorine Health Hazard Section

320. 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

321. \_\_\_\_\_ 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

322. 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

323. 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

324. 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

### Eye

325. If you get chlorine in the eye, pour a gentle stream of \_\_\_\_\_ through the affected eye for at least 15 minutes. Contact the poison control center, emergency room or physician right away as further treatment will be necessary.

- A. Liquid
- B. Warm water
- C. Milk
- D. Salt water
- E. Cold water
- F. None of the Above

### Skin

326. If you get chlorine on the skin, run \_\_\_\_\_ over the affected area for 15 minutes.

- A. A gentle stream of water
- B. Warm water
- C. Milk
- D. Salt water
- E. Cold water
- F. None of the Above

### Chronic

327. Repeated exposures to chlorine gas can result in a loss of ability to detect the odor of chlorine. Long term exposures may cause damage to teeth and inflammation or?

- A. Chlorine gas toxicity
- B. Plasma exudation
- C. Pulmonary edema
- D. Ulceration of the nasal passages
- E. Noncardiogenic pulmonary edema
- F. None of the Above

### Pre-hospital Management

328. 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

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

- A. True      B. False

330. 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

331. 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

332. 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

333. 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

334. 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

335. 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

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

### Decontamination Zone

337. Victims may be transferred immediately to the?
- A. Support Zone
  - B. Patient Zone
  - C. Chemical free zone
  - D. Decontamination area
  - E. Hot Zone to the Decontamination Zone
  - F. None of the Above

### Rescuer Protection

338. 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
  - B. Patient Zone
  - C. Chemical free zone
  - D. Decontamination area
  - E. Hot Zone
  - F. None of the Above

### ABC Reminders

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

### Basic Decontamination

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

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

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

342. During a chlorine leak, consider appropriate \_\_\_\_\_ of chemically contaminated children at the exposure site. Provide reassurance to the child during decontamination, especially if separation from a parent occurs.

- A. Decontamination
- B. Hot Zone
- C. Chemical-protective clothing
- D. Management
- E. Hot Zone to the Decontamination Zone
- F. None of the Above

### Equipment Requirements

343. Chlorine gas under pressure shall not be permitted outside the chlorine room. A chlorine room is where chlorine gas cylinders and/or ton containers are \_\_\_\_\_.

- A. Under pressure
- B. In this stage
- C. Stored
- D. At the point of solution application
- E. Dosing enough chlorine
- F. None of the Above

344. Which is the mechanical gas proportioning equipment that may or may not be located inside the chlorine room?

- A. Gas vacuum line
- B. Vacuum regulators
- C. Manual chlorine feed systems
- D. The chlorinator
- E. Injectors
- F. None of the Above

345. \_\_\_\_\_ shall be included in the gas vacuum line between the vacuum regulator(s) and the chlorinator(s) to ensure that pressurized chlorine gas does not enter the gas vacuum lines leaving the chlorine room?

- A. Gas vacuum line
- B. A gas pressure relief system
- C. Manual chlorine feed systems
- D. Mechanical gas proportioning equipment
- E. Post chlorination
- F. None of the Above

### Capacity

346. 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

347. 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

348. 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

349. 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

350. 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

351. 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**

352. 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**

353. 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**

354. Which of the following related chlorine alarm equipment shall be installed at all water treatment plants using chlorine gas? Leak detection shall be provided for the chlorine rooms.

- 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

355. 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

356. 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

357. 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

358. Consideration should 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

359. 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



360. 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

361. 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

362. The chlorinator may or may not be located inside?

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

### Ventilation

363. Which chlorine safety related equipment term shall have entirely separate exhaust ventilation systems capable of delivering one (1) complete air change per minute during periods of chlorine room occupancy only?

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

364. Which chlorine safety related equipment term 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

365. 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

366. Chlorine rooms shall have \_\_\_\_\_, if a forced air system is used to heat the building.

- A. Gas chlorine room            D. Automatic chlorine leak detection  
B. Separate heating systems            E. Chlorine room ventilation system  
C. The room            F. None of the Above

367. Which chlorine safety related equipment term 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

368. Which of the following terms may be provided to simply store the chlorine gas cylinders, with no connection to the line?

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

369. Which chlorine safety related equipment term shall have provision for ventilation at thirty air changes per hour?

- 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

370. Sometimes entry in very large facilities, may be through a vestibule from outside in to?

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

### Scrubbers

371. 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

372. Which term must be satisfied before chlorine becomes available to accomplish disinfection?

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

373. Which term means the amount of chlorine required to produce a residual of 0.1 mg/l after a contact time of fifteen minutes as measured by Iodometric method of a sample at a temperature of twenty degrees in conformance with Standard methods?

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

### Respiratory Protection Section

374. This definition means a respiratory device that is designed for use only during escape 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

375. \_\_\_\_\_ means a system that warns the respirator user of the approach of the end of adequate respiratory protection; for example, that the sorbent is approaching saturation or is no longer effective.

- 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

376. 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

377. \_\_\_\_\_ 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

378. 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

379. This definition means a component used in respirators to remove solid or liquid aerosols from the inspired air.

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

380. \_\_\_\_\_ means a particulate respirator with a filter as an integral part of the facepiece or with the entire facepiece composed of the filtering medium.

- A. Canister or Cartridge
- B. Air-Purifying Respirator
- C. Filtering Facepiece
- D. Disposable Respirators
- E. Demand Respirator
- F. None of the Above

381. This definition means a negative pressure particulate respirator with a filter as an integral part of the facepiece or with the entire facepiece composed of the filtering medium.

- A. Canister or Cartridge
- B. Air-Purifying Respirator
- C. Filtering Facepiece
- D. Disposable Respirators
- E. Demand Respirator
- F. None of the Above

382. \_\_\_\_\_ means a container with a filter, sorbent, or catalyst, or a combination of these items, which removes specific contaminants from the air passed through the container.

- A. Canister or Cartridge
- B. Air-Purifying Respirator
- C. Filtering Facepiece
- D. Disposable Respirators
- E. Demand Respirator
- F. None of the Above

383. 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

384. This definition 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

385. \_\_\_\_\_ 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

386. This definition means a respirator that is discarded after the end of its recommended period of use, after excessive resistance or physical damage, or when odor breakthrough or other warning indicators render the respirator unsuitable for further use.

- A. Canister or Cartridge
- B. Air-Purifying Respirator
- C. Filtering Facepiece
- D. Disposable Respirators
- E. Demand Respirator
- F. None of the Above

387. 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

388. The Employee is required to retain written information regarding medical evaluations, fit testing, and the respirator program.

- A. True
- B. False

389. Training will be provided prior to requiring the employee to use a respirator in the workplace.

- A. True
- B. False

**The training shall ensure that each employee can demonstrate knowledge of at least the following:**

390. Why the respirator is necessary and how to obtain an improper fit, usage, or maintenance can compromise the protective effect of the respirator.

- A. True
- B. False

391. Limitations and capabilities of OSHA.

- A. True
- B. False

**Retraining shall be conducted annually and when:**

392. Changes in the workplace or the type of respirator render previous training obsolete.

- A. True
- B. False

## Laboratory Analysis

### Bacteriological Sample Processing Procedures

393. 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

## Summary

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

394. Which of the following terms is multiplied by minimum contact time (minutes), offer water operator's guidance in computing an effective combination of chlorine concentration and chlorine contact time required to achieve disinfection of water at a given temperature?

- A. CXT concept
- B. CXT values
- C. CXT formula
- D. Pound per day
- E. Contact concept
- F. None of the Above

395. \_\_\_\_\_ demonstrates that if an operator chooses to decrease the chlorine concentration, the required contact time must be lengthened.

- A. CXT concept
- B. CXT values
- C. CXT formula
- D. Contact concept
- E. Pound per day
- F. None of the Above

396. When free available chlorine residuals are desired, the characteristics of the water will determine how this will be accomplished. This may have to be considered:

If the water contains no ammonia or this missing term, any application of chlorine will yield a free residual once it has reacted with any bacteria, virus and other microorganisms present in the water.

- A. Other nitrogen compounds
- B. More chlorine
- C. Taste and odor
- D. Amount of chlorine
- E. Iron, manganese, organic matter
- F. None of the Above

397. 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

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

A. True B. False

399. Which term 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

400. 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