

**Registration form**

**Chlorination 404 CEU Training Course \$200.00  
48 HOUR RUSH ORDER PROCESSING FEE ADDITIONAL \$50.00**

Start and Finish Dates: \_\_\_\_\_ *You will have 90 days from this date in order to complete this course*

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

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

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

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

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

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

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

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

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

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

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

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

If you've paid on the Internet, please write your Customer# \_\_\_\_\_

Please invoice me, my PO# \_\_\_\_\_

**Please pay with your credit card on our website under Bookstore or Buy Now. Or call us and provide your credit card information.**

***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 fully understand that this type of study program deals with dangerous, changing conditions and various laws and that I will not hold Technical Learning College, Technical Learning Consultants, Inc. (TLC) liable in any fashion for any errors, omissions, advice, suggestions or neglect contained in this CEU education training course or for any violation or injury, death, neglect, damage or loss of your license or certification caused in any fashion by this CEU education training or course material suggestion or error or my lack of submitting paperwork. It is my responsibility to 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. It is my responsibility to ensure all information is correct and to abide with all rules and regulations.

**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.

**Do not solely depend on TLC's Approval list for it may be outdated.**

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

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

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

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

# Chlorination 404 CEU Course Answer Key

Name \_\_\_\_\_ Telephone # \_\_\_\_\_

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

It is your sole responsibility to ensure this course is accepted for credit in your State. No refunds. Did you check with your State agency to ensure this course is accepted for credit?

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

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

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

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

*Please circle, underline, bold or X only one correct answer*

- |                 |                 |                 |
|-----------------|-----------------|-----------------|
| 1. A B C D E F  | 19. A B C D E F | 37. A B C D E F |
| 2. A B C D E F  | 20. A B C D E F | 38. A B C D E F |
| 3. A B C D E F  | 21. A B C D E F | 39. A B C D E F |
| 4. A B C D E F  | 22. A B C D E F | 40. A B C D E F |
| 5. A B C D E F  | 23. A B C D E F | 41. A B C D E F |
| 6. A B C D E F  | 24. A B C D E F | 42. A B C D E F |
| 7. A B C D E F  | 25. A B C D E F | 43. A B C D E F |
| 8. A B C D E F  | 26. A B C D E F | 44. A B C D E F |
| 9. A B C D E F  | 27. A B C D E F | 45. A B C D E F |
| 10. A B C D E F | 28. A B C D E F | 46. A B C D E F |
| 11. A B C D E F | 29. A B C D E F | 47. A B C D E F |
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| 13. A B C D E F | 31. A B C D E F | 49. A B C D E F |
| 14. A B C D E F | 32. A B C D E F | 50. A B C D E F |
| 15. A B C D E F | 33. A B C D E F | 51. A B C D E F |
| 16. A B C D E F | 34. A B C D E F | 52. A B C D E F |
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55. A B C D E F      86. A B C D E F      117. A B C D E F  
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57. A B C D E F      88. A B C D E F      119. A B C D E F  
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63. A B C D E F      94. A B C D E F      125. A B C D E F  
64. A B C D E F      95. A B C D E F      126. A B C D E F  
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66. A B C D E F      97. A B C D E F      128. A B C D E F  
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72. A B C D E F      103. A B C D E F      134. A B C D E F  
73. A B C D E F      104. A B C D E F      135. A B C D E F  
74. A B C D E F      105. A B C D E F      136. A B C D E F  
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446. A B C D E F      472. A B C D E F      498. A B C D E F  
447. A B C D E F      473. A B C D E F      499. A B C D E F  
448. A B C D E F      474. A B C D E F      500. A B C D E F  
449. A B C D E F  
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451. A B C D E F  
452. A B C D E F

**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**

**CHLORINATION 404 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.**

Please rate the difficulty of your course.

Very Easy 0 1 2 3 4 5 Very Difficult

Please rate the difficulty of the testing process.

Very Easy 0 1 2 3 4 5 Very Difficult

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

Very Similar 0 1 2 3 4 5 Very Different

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

What would you do to improve the Course?

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Any other concerns or comments.

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*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 and do not follow this course for proper compliance.*



## Chlorination 404 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.**

### pH Section

- According to the manual, \_\_\_\_\_ determine a parameter using a concentration cell with transference by measuring the potential difference.  
A. Primary pH standard values      D. pH measurement(s)  
B. Alkalinity      E. Measurement of pH  
C. pH      F. None of the Above
- Mathematically speaking, pH is the negative logarithm of the activity of the (solvated) hydronium ion, often expressed as the measurement of \_\_\_\_\_.  
A. Electrons      D. Cation measurement(s)  
B. Alkalinity      E. Ions  
C. Hydronium ion concentration      F. None of the Above
- What is the theory that states that an acid is a substance that produces hydronium ions when dissolved in water, and a base is one that produces hydroxide ions when dissolved in water?  
A. Newton's      D. Amadeus  
B. Alkalinity      E. Arrhenius  
C. Lord Calvin's      F. None of the Above
- What is the term associated with a charged species, an atom or a molecule, that has lost or gained one or more electrons?  
A. A proton      D. An electron  
B. Ion      E. A cation  
C. Anti-matter      F. None of the Above
- What is a substance that has the ability to reduce other substances and is reductive in nature?  
A. Protons      D. Electrons  
B. An electron donor      E. Cations  
C. Anti-matter      F. None of the Above
- Pure water has a pH very close to?  
A. 5      D. 7.7  
B. 6      E. 7.5  
C. 7      F. None of the Above

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

A. True      B. False

8. 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      D. Brønsted–Lowry acid–base theory

B. Ion-selective electrode(s)      E. Acid-base behavior

C. (Solvated) hydronium ion      F. None of the Above

9. With respect to standard buffer values, when more than two buffer solutions are used the electrode can be calibrated by fitting observed pH values to a straight line.

A. True      B. False

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

A. Universal indicator

D. Spectrophotometer Example

B. Colorwheel measurement

E. Lab test

C. Nearest whole number

F. None of the Above

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

A. Universal indicator

D. Excess of alkaline earth metal concentrations

B. Colorimeter of spectrophotometer      E. A set of non-linear simultaneous equations

C. Spectrophotometer

F. None of the Above

12. A(n) \_\_\_\_\_ is an example of a mathematical procedure for calculating the concentrations of all chemical species that are present in the solution.

A. Universal indicator

D. A chemical speciation calculation

B. pH log

E. A set of non-linear simultaneous equations

C. A set of linear equations      F. None of the Above

13. The pH is then equal to minus the logarithm of?

A. The concentration value

D. End-point pH

B. The pH

E. A set of non-linear simultaneous equations

C. The Spectrophotometer

F. None of the Above

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

A. Acid

D. pH measurement(s)

B. Alkalinity      E. End-point pH

C. pH

F. None of the Above

15. 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

16. 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
17. 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
18. Commercial standard buffer solutions usually comes with information about value and a correction factor to be applied for what temperatures?
- A. 4 °C                      D. 10 °C  
 B. 25 °C                      E. 70 °F  
 C. 39 °F                      F. None of the Above
19. Because the pH scale is logarithmic, therefore pH is?
- A. Universal indicator                      D. Excess of Ion concentrations  
 B. A dimensionless quantity                      E. A set of non-linear equations  
 C. A Spectrophotometer                      F. None of the Above
20. What is the new pH scale is referred to as \_\_\_\_\_ .
- A. Total scale                      D. Ph<sub>3</sub>  
 B. POH                      E. POE  
 C. P3H                      F. None of the Above
21. Alkalinity is able to neutralize \_\_\_\_\_ and is measured in a quantitative capacity in an aqueous solution.
- A. Acid                      D. pH measurement(s)  
 B. Base                      E. Bond formation  
 C. pH                      F. None of the Above
22. 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
23. 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
24. What factor is key in in determining the suitability of water for irrigation?
- A. pH of 8                      D. Alkaline earth metal concentrations  
 B. pH of 7                      E. Borates, phosphates, silicates  
 C. pH of 3                      F. None of the Above

25. The calculation of the pH of a solution containing acids and/or bases is an example of a \_\_\_\_\_ calculation, that is, a mathematical procedure for calculating the concentrations of all chemical species that are present in the solution

- A. Universal indicator
- B. Colorwheel measurement
- C. Spectrophotometer
- D. Visual comparison
- E. Chemical speciation
- F. None of the Above

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

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

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

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

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

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

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

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

30. 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

### Potent Germicide

31. Chlorine disinfectants can reduce the level of \_\_\_\_\_ in drinking water to almost immeasurable levels.

- A. Cryptosporidium parvum and Giardia lamblia
- B. Many disease-causing microorganisms
- C. Nitrogenous compounds
- D. Sodium hypochlorite solution
- E. Chlorine disinfectants
- F. None of the Above

32. Chlorine is added to drinking water to destroy pathogenic (disease-causing) organisms. It can be applied in several forms: \_\_\_\_\_, sodium hypochlorite solution (bleach) and dry calcium hypochlorite.

- A. Cryptosporidium parvum and Giardia lamblia
- B. Many disease-causing microorganisms
- C. Elemental chlorine (chlorine gas)
- D. Sodium hypochlorite solution
- E. Chlorine disinfectants
- F. None of the Above

33. One pound of elemental chlorine provides approximately as much \_\_\_\_\_ as one gallon of sodium hypochlorite (12.5% solution) or approximately 1.5 pounds of calcium hypochlorite (65% strength).

- A. Free available chlorine
- B. Many disease-causing microorganisms
- C. Nitrogenous compounds
- D. Sodium hypochlorite solution
- E. Chlorine disinfectants
- F. None of the Above

34. While any of these forms of chlorine can effectively disinfect drinking water, each has distinct advantages and limitations for \_\_\_\_\_. Almost all water systems that disinfect their water use some type of chlorine-based process, either alone or in combination with other disinfectants.

- A. Cryptosporidium parvum and Giardia lamblia
- B. Many disease-causing microorganisms
- C. Particular applications
- D. Sodium hypochlorite solution
- E. Chlorine disinfectants
- F. None of the Above

### **Taste and Odor Control**

35. Chlorine disinfectants reduce many disagreeable tastes and odors. Chlorine oxidizes many naturally occurring substances such as \_\_\_\_\_, sulfides and odors from decaying vegetation.

- A. Cryptosporidium parvum and Giardia lamblia
- B. Many disease-causing microorganisms
- C. Nitrogenous compounds
- D. Sodium hypochlorite solution
- E. Foul-smelling algae secretions
- F. None of the Above

### **Biological Growth Control**

36. Chlorine disinfectants eliminate \_\_\_\_\_ that commonly grow in water supply reservoirs, on the walls of water mains and in storage tanks.

- A. Cryptosporidium parvum and Giardia lamblia
- B. Many disease-causing microorganisms
- C. Nitrogenous compounds
- D. Slime bacteria, molds and algae
- E. Chlorine disinfectants
- F. None of the Above

### **Chemical Control**

37. Chlorine disinfectants destroy \_\_\_\_\_ (which has a rotten egg odor) and remove ammonia and other nitrogenous compounds that have unpleasant tastes and hinder disinfection. They also help to remove iron and manganese from raw water.

- A. Cryptosporidium parvum and Giardia lamblia
- B. Many disease-causing microorganisms
- C. Nitrogenous compounds
- D. Hydrogen sulfide
- E. Chlorine disinfectants
- F. None of the Above

### **Water Treatment**

38. Every day, approximately 170,000 \_\_\_\_\_ treat and convey billions of gallons of water through approximately 880,000 miles of distribution system piping to U.S. homes, farms and businesses.

- A. Chlorine residual
- B. Public water systems
- C. Chemical or biological contamination
- D. Low levels of color and turbidity (cloudiness)
- E. Distribution system piping
- F. None of the Above

39. Broadly speaking, water is treated to render it suitable for human use and consumption. While the primary goal is to produce a biologically (disinfected) and chemically safe product, other objectives also must be met, including: no objectionable taste or odor; \_\_\_\_\_ and chemical stability.

- A. Chlorine residual
- B. Sediments
- C. Chemical or biological contamination
- D. Low levels of color and turbidity
- E. Distribution system piping
- F. None of the Above

40. Surface water usually presents a greater treatment challenge than groundwater, which is naturally filtered as it percolates through?

- A. Chlorine residual
- B. Sediments
- C. Chemical or biological contamination
- D. Low levels of color and turbidity (cloudiness)
- E. Distribution system piping
- F. None of the Above

41. Surface water is laden with organic and mineral particulate matter, and may harbor protozoan parasites such as?

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

### Water Distribution

42. Among \_\_\_\_\_, chlorination is unique in that a pre-determined chlorine concentration may be designed to remain in treated water as a measure of protection against harmful microbes encountered after leaving the treatment facility.

- A. Microbial contamination
- B. Potential threats
- C. Critical assets
- D. Disinfection techniques
- E. Cost-effective methods
- F. None of the Above

43. In the event of a significant intrusion of pathogens resulting, for example, from a broken water main, the level of the average “\_\_\_\_\_” will be insufficient to disinfect contaminated water. In such cases, it is the monitoring of the sudden drop in the chlorine residual that provides the critical indication to water system operators that there is a source of contamination in the system.

- A. Chlorine residual
- B. Potential threats
- C. Chemical or biological contamination
- D. Low levels of color and turbidity (cloudiness)
- E. Distribution system piping
- F. None of the Above

### The Challenge of Disinfection Byproducts

44. Which of the following terms - when chlorine and other disinfectants react with natural organic matter in water?

- A. Microbial contamination
- B. Potential threats
- C. Critical assets
- D. Chemical compounds formed unintentionally
- E. Cost-effective methods
- F. None of the Above

45. While the available evidence does not prove that \_\_\_\_\_ in drinking water cause adverse health effects in humans, high levels of these chemicals are certainly undesirable. Cost-effective methods to reduce DBP formation are available and should be adopted where possible.

- A. Microbial contamination
- B. Potential threats
- C. Critical assets
- D. Vulnerability assessments
- E. DBPs
- F. None of the Above

### Chlorine and Water System Security

46. The prospect of a terrorist attack has forced all water systems, large and small, to re-evaluate and upgrade?

- A. Chlorine residual
- B. Existing security measures
- C. Chemical or biological contamination
- D. Low levels of color and turbidity (cloudiness)
- E. Vulnerability assessments
- F. None of the Above

47. With passage of the Public Health Security and Bioterrorism Response Act of 2002, Congress required community water systems to assess their vulnerability to a terrorist attack and other intentional acts. As part of these vulnerability assessments, systems assess?

- A. Microbial contamination
- B. Potential threats
- C. Critical assets
- D. The transportation, storage and use of treatment chemicals
- E. Cost-effective methods
- F. None of the Above

48. These chemicals are both critical assets and \_\_\_\_\_ .

- A. Microbial contamination
- B. Potential threats
- C. Critical assets
- D. Vulnerability assessments
- E. Potential vulnerabilities
- F. None of the Above

49. Water systems using elemental chlorine, in particular, must determine whether existing protection systems are adequate. If not, they must consider additional measures to reduce the likelihood of an attack or to mitigate the?

- A. Microbial contamination
- B. Potential threats
- C. Critical assets
- D. Vulnerability assessments
- E. Potential consequences
- F. None of the Above

50. Which of the following terms - in no way guarantee safety from biological attacks?

- A. Microbial contamination
- B. Potential threats
- C. Conventional treatment barriers
- D. Vulnerability assessments
- E. Cost-effective methods
- F. None of the Above

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

51. 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

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

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

53. 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

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

- A. True
- B. False

### **Disinfectant Qualities**

55. 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

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

- A. True      B. False

57. In studying and \_\_\_\_\_ -- compounds that have at least one atom of the element carbon in their molecular structure. All living organisms, including humans, are composed of organic compounds.

- A. Synthesizing organic compounds      D. Organic compounds  
B. Chlorine disinfection compounds      E. Abundant chemical elements  
C. Chlorine inorganic compounds      F. None of the Above

58. This is a huge reservoir of dissolved chlorine weathered from the continents and transported to the oceans by Earth's rivers.

- A. Brine      D. Useful chemical elements  
B. Sodium chloride      E. Seawater  
C. Ancient seawater      F. None of the Above

59. 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

60. This substance 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

61. Various states of chlorine includes when chlorine is isolated as a free element, chlorine is a greenish yellow gas, which is \_\_\_\_\_. It turns to a liquid state at  $-34^{\circ}\text{C}$  ( $-29^{\circ}\text{F}$ ), and it becomes a yellowish crystalline solid at  $-103^{\circ}\text{C}$  ( $-153^{\circ}\text{F}$ ).

- A. 2.5 times heavier than water      D. 2.5 times heavier than air  
B. 2.5 times lighter than air      E. 25 times heavier than air  
C. 10 times heavier than air      F. None of the Above

## Chlorine Gas Introduction

62. 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

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

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

64. In alkaline conditions, \_\_\_\_\_ becomes the predominant species and lacks the biocidal efficacy of the non-dissociated form.

- A. Chlorine
- B. Sodium hypochlorite
- C.  $\text{OCl}^-$
- D. Chlorine gas
- E. Hypochlorous acid ( $\text{HOCl}$ ), and hydrochloric acid ( $\text{HCl}$ )
- F. None of the Above

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

- A.  $\text{HCl}$
- B.  $\text{HOCl}$
- C. High chlorine concentrations
- D. Alkalinity
- E. Hypochlorite ion ( $\text{OCl}^-$ )
- F. None of the Above

66. 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  $\text{HOCl}$ .

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

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

- A. Chlorine demand
- B.  $\text{HOCl}$
- C. High chlorine concentration
- D. Total residual
- E. The hypochlorite ion ( $\text{OCl}^-$ )
- F. None of the Above

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

- A. True
- B. False

69. \_\_\_\_\_ removes alkalinity, pH depression and system corrosion could occur.

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

70. Which of the following terms can damage or penetrate the passive oxide layer, leading to localized damage of the metal surface?

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

71. High chlorine concentrations have also been shown to directly attack traditional organic-based corrosion inhibitors. When these inhibitors are "deactivated," the metal surface would then be susceptible to corrosion. Process Safety Management (PSM) guidelines dictated by the U.S. Occupational Safety and Health Administration (OSHA), discharge problems related to Chlorinated organic compounds such as trihalomethane (THM), dezincification of admiralty brass and delignification of cooling tower wood are other significant concerns associated with the use of chlorine.

- A. True
- B. False

### Pathophysiology

72. As far as chlorine safety and respiratory protection, the intermediate \_\_\_\_\_ of chlorine accounts for its effect on the upper airway and the lower respiratory tract.

- A. Generation of free oxygen radicals
- B. Vapor from Chlorine gas
- C. Effects of Hydrochloric acid
- D. Water solubility
- E. The odor threshold for chlorine
- F. None of the Above

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

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

### Mechanism of Activity

74. 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

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

- A. True
- B. False

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

- A. True
- B. False

### Solubility Effects

77. Which of the following terms is highly soluble in water?

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

78. Because it is highly water soluble, Hypochlorous acid has an injury pattern similar to?

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

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

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

### Early Response to Chlorine Gas

80. 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

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

### Immediate Effects

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

### Pathological Findings

83. Chlorine is a highly reactive gas.

- A. True      B. False

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

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

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

- A. True      B. False

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

- A. True      B. False

87. 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 Gas Appearance and Odor

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

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

89. 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**

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

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

91. Incompatibilities: \_\_\_\_\_ is formed when chlorine is in contact with combustible substances (such as gasoline and petroleum products, hydrocarbons, turpentine, alcohols, acetylene, hydrogen, ammonia, and sulfur), reducing agents, and finely divided metals.

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

92. 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

93. 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

94. 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

**Disinfection Essentials**

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

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

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

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

97. Environmental/Adverse Effects. Some systems may need to have additional treatment of the disinfected effluent in order to render it benign when released, while other systems may provide a net-positive environmental benefit through increased?

- A. Operating costs
- B. Other than chlorine
- C. Safeguards
- D. Breathing apparatus and protective clothing
- E. Oxygenation of the receiving waters
- F. None of the Above

98. Flow and Water Characteristics. If your system cannot adjust for dry or wet weather flow rates of the receiving water body, \_\_\_\_\_ may also affect the system's appropriateness for your application.

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

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

- A. True
- B. False

100. One decision to install a system could be the result of local concerns and potential to mitigate health risks, as well as?

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

### Chlorine's Effectiveness

101. There are several factors when considering chlorine residual. The effectiveness of chlorination depends on the \_\_\_\_\_ of the water, the concentration of the chlorine solution added, the time that chlorine is in contact with the organism, and water quality.

- A. Chlorine residual
- B. Color change
- C. Chlorine demand
- D. Chlorination
- E. Required contact time
- F. None of the Above

102. Sometimes chlorine is not available for disinfection because \_\_\_\_\_ in the water (like iron, manganese, hydrogen sulfide, and ammonia).

- A. pH increases
- B. Chlorine level and water quality
- C. Free chlorine residual
- D. Required contact time
- E. Part of it combines with other chemicals
- F. None of the Above

103. 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

104. \_\_\_\_\_ is used 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

105. Chlorination is more effective as?

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

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

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

107. 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

108. 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

### Chlorination Equipment Requirements

109. 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

110. Which of the following shall also be located inside the chlorine room?

- A. Gas vacuum line
- B. Vacuum regulators
- C. Manual chlorine feed systems
- D. Mechanical gas proportioning equipment
- E. Injectors
- F. None of the Above

111. Which of the following, which is the mechanical gas proportioning equipment, 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

112. Which of the following should be located to minimize the length of pressurized chlorine solution lines?

- A. Gas vacuum line
- B. Vacuum regulators
- C. Manual chlorine feed systems
- D. Mechanical gas proportioning equipment
- E. Injectors
- F. None of the Above

113. \_\_\_\_\_ 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

114. Which of the following shall have positive shutdown in the event of a break in the downstream vacuum lines?

- A. Gas vacuum line
- B. A gas pressure relief system
- C. Manual chlorine feed systems
- D. Mechanical gas proportioning equipment
- E. The vacuum regulating valve(s)
- F. None of the Above

115. Anti-siphon valves shall be incorporated in the \_\_\_\_\_ or in the discharge piping.

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

### Capacity

116. 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

117. 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

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

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

119. Which piece if 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

120. Which piece if 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

121. 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

122. 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

123. 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

124. 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

125. 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

126. 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

127. 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

128. 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

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

- A. True
- B. False

130. 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

131. 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

132. 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
- B. Corrosion resistant
- C. Securely positioned
- D. Automatic chlorine leak detection
- E. Chlorine room ventilation system
- F. None of the Above

133. The chlorinator may or may not be located inside \_\_\_\_\_ .

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

134. \_\_\_\_\_ 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
- B. The chlorine room
- C. The room
- D. Automatic chlorine leak detection
- E. Chlorine room ventilation system
- F. None of the Above

135. 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
- B. The chlorine room
- C. Air inlets
- D. Automatic chlorine leak detection
- E. Chlorine room ventilation system
- F. None of the Above

136. Which chlorine safety related equipment term should be outside the room at all entrance or viewing points, and a clear wire-reinforced glass window shall be installed in such a manner as to allow the operator to inspect from the outside of The room.

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

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

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

138. 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
- B. Corrosion resistant
- C. Securely positioned
- D. Automatic chlorine leak detection
- E. Chlorine room ventilation system
- F. None of the Above

### Storage of Chlorine Cylinders

139. If necessary, \_\_\_\_\_ may be provided to simply store the chlorine gas cylinders, with no connection to the line. The chlorine cylinder storage room shall have access either to the chlorine room or from the plant exterior, and arranged to prevent the uncontrolled release of spilled gas.

- 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

140. 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

141. 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

142. 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

143. Chlorine combines with a wide variety of materials. These side reactions complicate the use of chlorine for disinfecting purposes. Their \_\_\_\_\_ 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

144. 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

### Chlorine Health Hazard Section

145. 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

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

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

### Inhalation

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

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

148. 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

149. 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

150. 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

151. 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

152. 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

153. 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

154. 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

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

- A. True
- B. False

156. 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**

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

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

**Rescuer Protection**

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

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

159. 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)
- B. Hypochlorite
- C. Chlorine gas
- D. Solid hypochlorite or concentrated solutions
- E. Hypochlorous Acid
- F. None of the Above

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

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

**ABC Reminders**

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

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

**Victim Removal**

162. 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

163. Victims may be transferred immediately to the \_\_\_\_\_. All others require decontamination.

- 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

## Understanding Water Disinfection

### Wastewater Disinfection

164. According to the text, there are a number of chemicals and processes that will \_\_\_\_\_, 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

165. 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

### Chlorate Ion

166. 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>
- D. Trigonal pyramidal structures
- E. Chemical formula CaCl<sub>2</sub>
- F. None of the Above

167. \_\_\_\_\_ 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>
- D. Microbiological contamination
- E. Sodium chloride
- F. None of the Above

168. 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 ClO<sub>3</sub>
- D. Pyrotechnics
- E. Chemical formula CaCl<sub>2</sub>
- F. None of the Above

### Chloride Ion

169. The chloride ion is formed when the \_\_\_\_\_, a halogen, gains an electron to form an anion (negatively-charged ion) Cl<sup>-</sup>.

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

170. 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 ClO<sub>3</sub>
- D. Are very soluble in water
- E. The chemical formula CaCl<sub>2</sub>
- F. None of the Above

171. 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

172. Which of the following compounds is an example of table salt, which is sodium chloride with the chemical formula?

- A. Chemical formula  $\text{CaCl}_2$
- B.  $\text{NaCl}$
- 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

173. Which of the following compounds or element is also the prosthetic group present in the amylase enzyme. Another example is calcium chloride with the chemical formula  $\text{CaCl}_2$ .

- 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

174. 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

175. Which of the following compounds are a closely monitored constituent of the mud system?

- A. Chemical formula  $\text{CaCl}_2$
- B. Chloride
- C. Chlorite ion is  $\text{ClO}_2^-$ .
- D. Chlorides
- E. Chlorine dioxide
- F. None of the Above

176. \_\_\_\_\_ 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  $\text{CaCl}_2$
- B. 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

### Chlorite Ion

177. The chlorite ion is \_\_\_\_\_.

- A. Chemical formula  $\text{CaCl}_2$
- B. Chloride
- C.  $\text{ClO}_2^-$
- 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

178. 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  $\text{CaCl}_2$
- B. Chloride
- C. Chlorite ion is  $\text{ClO}_2^-$ .
- D. Chloride, hypochlorite, chlorite, chlorate, and perchlorate
- E. Chlorine dioxide
- F. None of the Above

179. An additional oxidation state of +4 is seen in the neutral compound \_\_\_\_\_, which has a similar structure to chlorite  $\text{ClO}_2^-$  and the cation chloryl.

- A. Chemical formula  $\text{CaCl}_2$
- B. 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  $\text{ClO}_2$
- F. None of the Above

### Chlorine Dioxide

180. Chlorine dioxide is a chemical compound with the formula?

- A. Chemical formula  $\text{CaCl}_2$
- B. 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.  $\text{ClO}_2$
- F. None of the Above

### Haloacetic Acids

181. What type of substances are Haloacetic acids in which a halogen atom takes the place of a hydrogen atom in acetic acid?

- A. An anti-bonding orbital
- B. A single halogen
- C. Hypochlorite compounds
- D. Carboxylic acids
- E. Calcium hypochlorite
- F. None of the Above

182. The inductive effect caused by the \_\_\_\_\_ often result in the higher acidity of these compounds by stabilizing the negative charge of the conjugate base.

- A. High-test calcium hypochlorite(s)
- B. Calcium hypochlorite tablets
- C. Hypochlorous acid
- D. Electronegative halogens
- E. Chlorine dioxide
- F. None of the Above

### Contaminants in Drinking Water

183. Which of the following terms expresses an exposure to such substances in drinking water has been associated with a number of health outcomes by epidemiological studies, although the putative agent in such studies has not been identified?

- A. An anti-bonding orbital
- B. A single halogen
- C. Hypochlorite compounds
- D. Disinfection by-products
- E. Calcium hypochlorite
- F. None of the Above

### Hypochlorites

184. 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

185. Hypochlorite compounds contain an excess of \_\_\_\_\_ and tend to raise the pH of the water.

- A. An anti-bonding orbital
- B. Alkali
- C. Hypochlorite compounds
- D. A common undesirable by-product
- E. Calcium hypochlorite
- F. None of the Above

186. Calcium hypochlorite tablets are the predominant form in use in the United States for swimming pools. \_\_\_\_\_ is the only liquid hypochlorite disinfectant in current use. There are several grades and proprietary forms available.

- A. High-test calcium hypochlorite(s)
- B. Calcium hypochlorite tablets
- C. Hypochlorous acid
- D. Sodium hypochlorite
- E. Chlorine dioxide
- F. None of the Above

### Disinfection Byproducts

187. This term represents when disinfectants used in water treatment plants react with bromide and/or natural organic matter present in the source water. Different disinfectants produce different types or amounts of disinfection byproducts.

- 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

188. This term represents which regulations have been established have been identified in drinking water, including trihalomethanes, haloacetic acids, bromate, and chlorite.

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

### Trihalomethanes (THM)

189. This 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

190. This term represents are chloroform, bromodichloromethane, dibromochloromethane, and bromoform.

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

### Haloacetic Acids (HAA5)

191. This term represents substances 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. Microbial contaminants
- F. None of the Above

192. This term represents monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, and dibromoacetic acid.

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

193. Bromate is a chemical that is formed when this term is used to disinfect drinking water reacts with naturally occurring bromide found in source water?

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

194. This term represents a byproduct formed when chlorine dioxide is used to disinfect water.

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

### Chloroform

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

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

### Sodium Chlorate

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

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

### Microbial Regulations

197. 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

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

199. Which rule 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

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

### Understanding Cryptosporidiosis

201. Cryptosporidium is \_\_\_\_\_ because its transmission has increased dramatically over the past two decades.  
A. Cryptosporidium      D. An emerging parasitic protozoan pathogen  
B. Chlorine-based disinfectants      E. Emerging waterborne pathogen  
C. Giardia lamblia      F. None of the Above

### Understanding Giardia lamblia

202. Which of the following terms was discovered approximately 20 years ago, is another emerging waterborne pathogen?  
A. Cryptosporidium      D. An emerging parasitic protozoan pathogen  
B. Chlorine-based disinfectants      E. Emerging waterborne pathogen  
C. Giardia lamblia      F. None of the Above

### Chlorine (DDBP) Summary

203. These term means that chlorine is present as Cl, HOCl, and OCl<sup>-</sup> is called \_\_\_\_\_, and that which is bound but still effective is \_\_\_\_\_.  
A. Free available chlorine and Total      D. Free available chlorine - Combined Chlorine  
B. Free and Residual      E. Combined chlorine - readily available  
C. Break point and Free      F. None of the Above

204. Chloramines are formed by reactions with \_\_\_\_\_ .  
A. Acid and Cl<sub>2</sub>      D. Folic Acid and Cl<sub>2</sub>  
B. Ammonia and Cl<sub>2</sub>      E. THMs and Haploidic acid  
C. THMS and Cl<sub>2</sub>      F. None of the Above

205. While testing chlorine disinfection process, you will need to understand one especially important feature is the ease of overdosing to create a " \_\_\_\_\_ " concentration.  
A. Free available chlorine and Total      D. Free available chlorine and Combined Chlorine  
B. Residual      E. Combined chlorine and readily available  
C. Break point and Free      F. None of the Above

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

207. A typical chlorine residual is 2 ppm for this type of chlorine residual?  
A. Free available chlorine and Total      D. Combined Chlorine  
B. Residual      E. Combined chlorine and readily available  
C. Break point and Free      F. None of the Above

### Chlorine By-Products

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

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

### The Principal Trihalomethanes are:

209. 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

210. 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

### Health Effects

211. 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

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

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

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

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

214. 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.

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

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

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

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

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

217. 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

### Chlorine Chemistry Review

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

- A. True
- B. False

219. 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

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

- A. True
- B. False

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

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

222. 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

223. 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

224. All three forms of chlorine produce sodium hypochlorite when added to water.

- A. True
- B. False

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

- A. True
- B. False

### Types of Residual

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

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

227. In water, there are always other substances (interfering agents) such as iron, manganese, turbidity, etc., which will combine chemically with the chlorine, these are called the?

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

228. According to the text, once chlorine molecules are combined with these interfering agents, they are not capable of disinfection. \_\_\_\_\_ is much more effective as a disinfecting agent.

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

229. Either a total or a \_\_\_\_\_ can be read when a chlorine residual test is taken,

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

230. \_\_\_\_\_ is a much stronger disinfecting agent, therefore, most water regulating agencies will require that your daily chlorine residual readings be of free chlorine residual.

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

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

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

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

233. \_\_\_\_\_ = Concentration (mg/L) x Time (minutes)

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

234. 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

235. 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

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

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

237. Which of the following terms 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

238. 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

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

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

### Chlorine Review

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

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

241. 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

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

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

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

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

244. What 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

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

246. Which of the following term 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

247. \_\_\_\_\_ 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

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

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

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

- A. True
- B. False

250. When changing the  $\text{Cl}_2$  cylinder, clean with wire brush if necessary. If the valve face is smooth, clean proceed with hooking up the cylinder. Check the inlet face of the \_\_\_\_\_ and clean if necessary.

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

251. 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

252. \_\_\_\_\_ 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

253. 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

254. 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

255. Ammonia is sometimes deliberately added to chlorinated public water supplies to provide \_\_\_\_\_.

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

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

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

257. \_\_\_\_\_ describes the minimum amount of chlorine needed to react in a water purification system; used as a monitoring measurement by system operators.

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

258. 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

259. \_\_\_\_\_ 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

260. 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

261. 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

262. Which of the following term reacts with bacteria as if it was very corrosive and burns the skin or covering killing the bacteria?

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

### Chlorine Exposure Limits

263. OSHA PEL?

- A. 10 PPM
- B. 1 PPM
- C. 00.1 PPM
- D. 1,000 PPM
- E. 100 PPM
- F. None of the Above

264. Physical and chemical properties of \_\_\_\_\_: A yellowish green, nonflammable and liquefied gas with an unpleasant and irritating smell.

- A. Cl<sub>3</sub>
- B. Chlorine
- C. HOCl and OCl-
- D. Combined Available Chlorine
- E. Monochloramine
- F. None of the Above

265. This can be readily compressed into a clear, amber-colored liquid, a \_\_\_\_\_, and a strong oxidizer.

- A. Cl<sub>2</sub>
- B. Cl
- C. HOCl and OCl-
- D. Combined Available Chlorine
- E. Noncombustible gas
- F. None of the Above

266. Solid chlorine is about \_\_\_\_\_ times heavier than water and gaseous chlorine is about 2.5 times heavier than air.

- A. 1.5
- B. 1.0
- C. 0.5
- D. 2.5
- E. 3.0
- F. None of the Above

267. Cl<sub>2</sub> IDLH?

- A. 10 PPM
- B. 1 PPM
- C. 00.1 PPM
- D. 1,000 PPM
- E. 100 PPM
- F. None of the Above

268. Cl<sub>2</sub> Fatal Exposure Limit?

- A. 10 PPM
- B. 1 PPM
- C. 00.1 PPM
- D. 1,000 PPM
- E. 100 PPM
- F. None of the Above

269. The current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for chlorine is 10 PPM (3 milligrams per cubic meter (mg/m<sup>3</sup>)) as a ceiling limit. A worker's exposure to chlorine shall at no time exceed this ceiling level.

- A. True
- B. False

270. When using chlorine gas: In addition to protective clothing and goggles, chlorine gas should be used only in a well-ventilated area so that \_\_\_\_\_ cannot concentrate.

- A. Chlorine exposure
- B. Connection
- C. Leak area
- D. Any leaking gas
- E. Several safety precautions
- F. None of the Above

271. HOCl and OCl<sup>-</sup>: The OCl<sup>-</sup> is the hypochlorite ion and both of these species are known as free available chlorine, they are the two main chemical species formed by chlorine in water and they are known collectively as \_\_\_\_\_ and the \_\_\_\_\_.

- A. Hypochlorous acid, Cl<sub>2</sub>
- B. Hypochlorous acid, Hypochlorite ion
- C. HOCl<sub>2</sub> and OCl<sub>2</sub>
- D. Combined Available Chlorine, Total
- E. Monochloramine, Cl<sub>2</sub>
- F. None of the Above

272. Which of the following terms when added to water, rapidly hydrolyzes, the chemical equations best describe this reaction is Cl<sub>2</sub> + H<sub>2</sub>O → H<sup>+</sup> + Cl<sup>-</sup> + HOCl?

- A. Chlorine gas
- B. Cl
- C. HOCl and OCl<sup>-</sup>
- D. Combined Available Chlorine
- E. Monochloramine
- F. None of the Above

273. Which of the following substances is the most germicidal of the chlorine compounds with the possible exception of chlorine dioxide?

- A. Hydrochlorous acid
- B. Sulfuric acid
- C. Hypochlorous acid
- D. Combined Available Chlorine
- E. Monochloramine
- F. None of the Above

274. Yoke-type connectors should be used on a \_\_\_\_\_ assuming that the threads on the valve may be worn.

- A. Chlorine regulator
- B. Connection
- C. Leak area
- D. Protective bonnet
- E. Chlorine cylinder's valve
- F. None of the Above

275. What is the Atomic number of chlorine?

- A. 17.7
- B. 17
- C. 0.17
- D. 17 PPM
- E. 23
- F. None of the Above

276. \_\_\_\_\_ is the elemental symbol and \_\_\_\_\_ is the chemical formula.

- A. Cl, Cl<sub>2</sub>
- B. Cl<sub>2</sub>, Cl
- C. HOCl and OCl<sup>-</sup>
- D. Chlorine, Cl<sub>2</sub>
- E. Cl<sub>2</sub>, ClH<sub>4</sub>
- F. None of the Above

277. Monochloramine, \_\_\_\_\_, and trichloramine are known as Combined Available Chlorine. Cl<sub>2</sub> + NH<sub>4</sub>.

- A. Cl<sub>2</sub>
- B. Dichloramine
- C. HOCl and OCl<sup>-</sup>
- D. Combined Available Chlorine
- E. Monochloramine
- F. None of the Above

### Halogens - Halides

278. What is the negative ion often referred to as \_\_\_\_\_ .

- A. Salts
- B. A halide proton
- C. A halide ion
- D. Free radical
- E. Diatomic Compound
- F. None of the Above

279. Which of the following terms contains ions 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

280. 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

281. 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

### Chlorine

282. Only halogen is needed in relatively large amounts (as chloride ions) by humans?

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

283. 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

284. 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

### Halogens

285. 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

### Disinfection Rules - Disinfection Byproduct Regulations

#### Bromate

286. The EPA has established the Stage 1 Disinfectants/Disinfection Byproducts Rule to regulate \_\_\_\_\_ at annual average of 10 parts per billion in drinking water.

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

287. This standard became effective for large **public water systems** by December 2001 and for small surface water and \_\_\_\_\_ back in December 2003.

- A. Waterborne disease outbreaks
- B. Diagnosed cases of waterborne illness
- C. Treatment measures
- D. Amounts of disinfection byproducts
- E. All ground public water systems
- F. None of the Above

### Detailed Disinfection Supplement Section

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

288. CXT values [ final free chlorine concentration (mg/L) multiplied by minimum contact time (minutes)], offer water operators guidance in computing an effective combination of chlorine concentration and chlorine contact time required to achieve disinfection of water at a given temperature.

- A. True
- B. False

289. The CXT formula demonstrates that if an operator chooses to decrease the chlorine concentration, the required contact time must be lengthened. Similarly, as higher strength chlorine solutions are used, contact times may be reduced.

- A. True
- B. False

### Chloramines

290. 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

291. This term 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

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

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

### Chlorine Dioxide

293. This 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 chlorine dioxide.

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

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

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

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

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

### Chlorine Dioxide

296. This 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 chlorine dioxide.

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

297. Which of the following 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

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

298. Which of the following terms is multiplied by minimum contact time (minutes)], offer water operators 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

299. This term 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

300. 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 \_\_\_\_\_, 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

301. 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

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

- A. True
- B. False

303. This 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

304. 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

### EPA's Drinking Water Regulations for Disinfectants

305. 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

306. All disinfectants form DBPs in one of two reactions: Chlorine and chlorine-based compounds (halogens) react with organics in water causing the chlorine atom to substitute other atoms resulting in?
- A. Chlorine
  - B. Organic sulfide(s)
  - C. Calcium carbonate
  - D. Halogenated by-products
  - E. HOCl
  - F. None of the Above
307. Oxidation reactions, where chlorine oxidizes \_\_\_\_\_ present in water.
- A. Carbon
  - B. Surface water
  - C. Compounds
  - D. Chlorine and chlorine-based compounds (halogens)
  - E. Secondary by-products
  - F. None of the Above
308. 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
  - B. DBP MCLs Rule
  - C. A community water system (CWS)
  - D. Disinfection byproducts (DBPs) Rule
  - E. Surface Water Treatment Rule (SWTR)
  - F. None of the Above
309. The maximum contaminant level for the SWTR disinfection set by EPA. At this time, an MCL is set for only \_\_\_\_\_, and proposed for additional disinfection byproducts.
- A. TTHM and HAA5 Rule
  - B. DBP MCLs Rule
  - C. A community water system (CWS)
  - D. Disinfection byproducts (DBPs) Rule
  - E. Total Trihalomethanes
  - F. None of the Above
310. 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
  - B. DBP MCLs Rule
  - C. A community water system (CWS)
  - D. Disinfection byproducts (DBPs) Rule
  - E. Disinfectants and Disinfection Byproducts (DBP)
  - F. None of the Above
311. The Long Term 2 Enhanced Surface Water Treatment Rule (LT2) rule applies to all water systems using \_\_\_\_\_ under the influence of a surface water, as well as groundwater/surface water blends.
- A. Surface water, groundwater
  - B. DBP MCLs Rule
  - C. A community water system (CWS)
  - D. Disinfection byproducts (DBPs) Rule
  - E. Total Trihalomethanes
  - F. None of the Above
312. Which of the following rules began in 2006 with the characterization of raw water Cryptosporidium and E. coli levels?
- 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
313. Which of the following rules applies to all public water systems using groundwater?
- A. Groundwater Rule (GWR)
  - B. Compliance
  - C. SDWA in 1996
  - D. Long Term 2 Enhanced Surface Water Treatment Rule (LT2)
  - E. Interim Enhanced Surface Water Treatment Rule
  - F. None of the Above

314. Which of the following rules require EPA to develop rules to balance the risks between microbial pathogens and disinfection byproducts?
- A. Amendments to the SDWA in 1996
  - B. Disinfectants
  - C. SDWA in 1996
  - D. Stage 1 Disinfectant and Disinfection Byproduct Rule
  - E. The LT2 requirements
  - F. None of the Above

**Public Health Concerns**

315. Which of the following rules and Disinfection Byproducts Rule applies to all community and nontransient non-community water systems that treat their water with a chemical disinfectant?
- A. Groundwater Rule (GWR)
  - B. The Stage 1 Disinfectants
  - C. SDWA in 1996
  - D. Long Term 2 Enhanced Surface Water Treatment Rule
  - E. Interim Enhanced Surface Water Treatment Rule
  - F. None of the Above

316. Which of the following rules and Disinfection Byproduct Rule updates and supersedes the 1979 regulations for total trihalomethanes?
- A. DBPs
  - B. The Stage 1 Disinfectant
  - C. SDWA in 1996
  - D. Stage 1 Disinfectant and Disinfection Byproduct Rule
  - E. The LT2 requirements
  - F. None of the Above

**Stage 2 DBP Rule Federal Register Notices**

317. Which of the following rules is part of the Microbial and Disinfection Byproducts Rules, which are a set of interrelated regulations that address risks from microbial pathogens and disinfectants/disinfection byproducts?
- A. Groundwater Rule (GWR)
  - B. Compliance
  - C. The Stage 2 DBP rule
  - D. Long Term 2 Enhanced Surface Water Treatment Rule (LT2)
  - E. Interim Enhanced Surface Water Treatment Rule
  - F. None of the Above

318. Which Rule will reduce potential cancer and reproductive and developmental health risks from disinfection byproducts (DBPs) in drinking water, which form when disinfectants are used to control microbial pathogens?
- A. Stage 3 DBPR
  - B. DBP exposure
  - C. Stage 2 Disinfection Byproducts
  - D. Long Term 2 Enhanced Surface Water
  - E. Traditional disinfection practices
  - F. None of the Above

319. This rule will apply to all community water systems and nontransient non-community water systems that add a primary or residual disinfectant other than \_\_\_\_\_ or deliver water that has been disinfected by a primary or residual disinfectant other than UV.
- A. Ultraviolet (UV) light
  - B. The open-channel system
  - C. UV rather than ozone
  - D. UV source
  - E. UV radiation
  - F. None of the Above

320. Which of the following rules has been highly effective in protecting public health and has also 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

321. Which of the following terms is one of the major public health advances in the 20th century?
- A. Major public health advances      D. Amendments to the SDWA in 1996  
 B. The Stage 2 DBPR                      E. Primary or residual disinfectant  
 C. Disinfection of drinking water      F. None of the Above
322. There are specific microbial pathogens, such as \_\_\_\_\_, which can cause illness, and are highly resistant to traditional disinfection practices.
- A. Enteric virus(es)      D. C. perfringens  
 B. Oocyst(s)              E. E. coli host culture  
 C. Cryptosporidium      F. None of the Above
323. The Stage 1 Disinfectants and Disinfection Byproducts Rule and \_\_\_\_\_, promulgated in December 1998.
- A. Major public health advances      D. Amendments to the SDWA in 1996  
 B. The Stage 2 DBPR                      E. Interim Enhanced Surface Water Treatment Rule  
 C. This final rule                          F. None of the Above
324. The Stage 2 Disinfectants and Disinfection Byproducts Rule builds upon the \_\_\_\_\_ to address higher risk public water systems for protection measures beyond those required for existing regulations.
- A. Stage 2 DBPR      D. Long Term 2 Enhanced Surface Water Treatment Rule  
 B. DBP exposure      E. Traditional disinfection practices  
 C. Stage 1 DBPR      F. None of the Above
325. Which of the following rules and the Long Term 2 Enhanced Surface Water Treatment Rule are the second phase of rules required by Congress?
- A. Major public health advances      D. Amendments to the SDWA in 1996  
 B. The Stage 2 DBPR                      E. Primary or residual disinfectant  
 C. This final rule                          F. None of the Above
326. Which of the following rules will reduce potential cancer and reproductive and developmental health risks from disinfection byproducts?
- A. Stage 1 DBPR                              D. Long Term 2 Enhanced Surface Water Rule  
 B. DBP exposure                              E. Traditional disinfection practices  
 C. Stage 2 Disinfection Byproducts Rule      F. None of the Above
327. \_\_\_\_\_ strengthens public health protection for customers by tightening compliance monitoring requirements for two groups of DBPs, trihalomethanes and haloacetic acids.
- A. Major public health advances      D. Amendments to the SDWA in 1996  
 B. The Stage 3 DBPR                      E. Primary or residual disinfectant  
 C. This final rule                          F. None of the Above
328. Which of the following rules targets systems with the greatest risk and builds incrementally on existing rules?
- A. Stage 2 DBPR                              D. Long Term 2 Enhanced Surface Water Treatment Rule  
 B. The rule                                      E. Traditional disinfection practices  
 C. The Stage 1 DBP rule                      F. None of the Above

**What are Disinfection Byproducts (DBPs)?**

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

- A. TTHM and HAA5
- B. DBP MCLs
- C. DBPs from chlorination
- D. Disinfection byproducts (DBPs)
- E. Trihalomethanes and haloacetic acids
- F. None of the Above

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

- A. Sodium Thiosulfate
- B. Chlorine and chloramine
- C. Stage 2 DBPR
- D. Classes of DBPs
- E. Trihalomethanes and haloacetic acids
- F. None of the Above

331. \_\_\_\_\_ in drinking water can change from day to day, depending on the season, water temperature, amount of disinfectant added, the amount of plant material in the water, and a variety of other factors.

- A. Thiols
- B. Chlorine and chloramine
- C. Stage 2 DBPR
- D. Classes of DBPs
- E. Trihalomethanes and haloacetic acids
- F. None of the Above

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

332. Which of the following terms typically occur at higher levels than other known and unknown DBPs?

- A. TTHM and HAAs
- B. DBP MCLs
- C. Classes of DBPs
- D. Disinfection byproducts (DBPs)
- E. Trihalomethanes and haloacetic acids
- F. None of the Above

333. The presence of \_\_\_\_\_ is representative of the occurrence of many other chlorination DBPs; thus, a reduction in the TTHM and HAA5 generally indicates a reduction of DBPs from chlorination.

- A. DBPs from chlorination
- B. Chlorine and chloramine
- C. Stage 2 DBPR
- D. Classes of DBPs
- E. TTHM and HAA5
- F. None of the Above

**Chlor-Alkali Membrane Process**

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

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

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

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

336. Which of the following terms is used to keep the two different solutions from mixing?

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

337. When a low voltage direct current (DC) power supply is applied to the electrodes in the cell, the \_\_\_\_\_ in the brine are attracted in opposite directions to the polarized electrodes.

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

338. \_\_\_\_\_ 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.

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

339. When the sodium crosses the membrane, it combines with a hydroxyl ion at the cathode (electrode) making sodium hydroxide, or caustic soda (NaOH). The hydroxyl ion originates from the dissolution of water at the cathode where \_\_\_\_\_ also develops.

- A. Hydrogen gas
- B. Chlorination
- C. Sodium
- D. Caustic soda
- E. Sodium and chlorine ions
- F. None of the Above

340. 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

### Chlorine's Effectiveness

341. 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

342. Which of the following terms 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

343. Which of the following terms is less effective as the water's pH increases?

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

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

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

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

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

346. If the concentration of the \_\_\_\_\_ increases, the required contact time to disinfect decreases.

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

347. Which of the following terms is more effective as water temperature increases?

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

### **Sodium Hypochlorite Exposure**

348. There is no threshold value for to sodium hypochlorite exposure. Various health effects occur after exposure to sodium hypochlorite. People are exposed to sodium hypochlorite by inhalation of aerosols. This causes coughing and a sore throat. After swallowing sodium hypochlorite, the effects are stomach ache, a burning sensation, coughing, diarrhea, a sore throat and vomiting. Sodium hypochlorite on skin or eyes causes redness and pain.

- A. True
- B. False

349. 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**

350. \_\_\_\_\_ can liberate toxic gases such as chlorine.

- A. Air
- B. Hypochlorite solutions
- C. Higher levels of chlorine
- D. Ammonia
- E. Household bleach
- F. None of the Above

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

- A. True
- B. False

#### **Ingestion**

352. Metabolic acidosis is rare, but has been reported following the ingestion of?

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

353. 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

354. These compounds are used primarily as oxidizing and bleaching agents or disinfectants. They are components of commercial bleaches, cleaning solutions, and disinfectants for drinking water and waste water purification systems and swimming pools.

- A. Sodium hypochlorite
- B. Chlorine gas
- C. Sodium and calcium hypochlorite
- D. Sodium hydroxide or lime
- E. Hypochlorite solutions
- F. None of the Above

### Calcium Hypochlorite Section

355. 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

356. Which of the following substances is generally available as a white powder, pellets, or flat plates; sodium hypochlorite is usually a greenish yellow, aqueous solution. Although not flammable, they may react explosively.

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

357. 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

358. 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

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

- A. True
- B. False

360. Which of the following answers is not flammable, but it acts as an oxidizer with combustible material and may react explosively with ammonia, amines, or organic sulfides.

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

### Accuracy

361. 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

362. Which compound's strengths vary so widely and are mostly unknown (the container usually says "less than 5%") that it is impossible to make up accurate in-use solutions without access to laboratory equipment?

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

### Effectiveness

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

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

364. The ratio of hypochlorous acid to \_\_\_\_\_ increases with acidity.

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

365. 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

366. 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. Hydrochlorite
- F. None of the Above

### Comparison

367. 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

368. If there is a high concentration of organic material present, NaDCC will be very much more effective than?

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

369. Hypochlorite powder, solutions, and vapor are irritating and corrosive to the eyes, skin, and respiratory tract. Ingestion and skin contact produces injury to any exposed tissues. Exposure to gases released from \_\_\_\_\_ may cause burning of the eyes, nose, and throat; cough as well as constriction and edema of the airway and lungs can occur.

- A. Hypochlorite
- B. Hypochlorous Acid (HOCl)
- C. Oxygen and chlorine
- D. Sodium dichloroisocyanurate (NaDCC)
- E. Hydrochlorite ion
- F. None of the Above

370. 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

371. 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

372. This material causes tissue damage by liquefaction necrosis.

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

373. Calcium hypochlorite decomposes in water releasing?

- A. Chlorine gas
- B. Hypochlorous Acid (HOCl)
- C. Fulmic acid
- D. THM
- E. Hypochlorite ion
- F. None of the Above

### Sodium Hypochlorite Solutions

374. 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

375. 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

376. 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

### Chlorine-Based Disinfectants Chloramines

#### Chloramine Disadvantages

377. 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

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

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

379. \_\_\_\_\_:  $\text{NHCl}_2 + 3\text{HOCl} \rightarrow \text{NHCl}_3 + 3\text{H}_2\text{O}$

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

380. 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

381. \_\_\_\_\_:  $\text{NH}_2\text{Cl} + 2\text{HOCl} \rightarrow \text{NHCl}_2 + 2\text{H}_2\text{O}$

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

382. 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?

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

### Post Chlorination

383. Post chlorination is usually done in Water treatment, but can be replaced with chlorine dioxide or chloramines. In this stage, chlorine is fed to the drinking water stream that 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

384. Drinking water requires a large addition of chlorine because there must be a residual amount of chlorine in the water that will carry through the system until it reaches the tap of the user. After Post chlorination, the water is retained in a clear well prior to distribution.

- A. True
- B. False

### Chlorine Dioxide Section

385.  $\text{ClO}_2$  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

386. Chlorine gas is educted into a motive water stream in a  $\text{ClO}_2$  generator forming?  
 A. Hypochlorous acid                      D. Sodium chlorate ( $\text{NaClO}_3$ ) and sulfuric acid  
 B. HOCl and HCl                              E. Sodium thiosulfate  
 C. Chlorine dioxide                          F. None of the Above
387. This compound is pumped into the stream and allowed to react in a generating column to produce  $\text{ClO}_2$ ?  
 A. Hypochlorous acid                      D. Sodium chlorite  
 B. HOCl and HCl                              E. Sodium thiosulfate  
 C. Chlorine dioxide                          F. None of the Above
388. Which of the following compound(s) does not hydrolyze in water as chlorine does and with it, no dissociation of  $\text{ClO}_2$ ?  
 A. Sodium chlorite ( $\text{NaClO}_2$ )                      D. Sodium chlorate ( $\text{NaClO}_3$ )  
 B. Chlorine gas                                  E. NaOCl and HCl  
 C. Chlorine dioxide or  $\text{ClO}_2$                       F. None of the Above
389. Which of the following compound(s) remains a gas in water, it does not have the corrosive tendencies of chlorine gas?  
 A. Sodium chlorite ( $\text{NaClO}_2$ )                      D. Sodium chlorate ( $\text{NaClO}_3$ )  
 B. Chlorine gas                                  E. NaOCl and HCl  
 C. Chlorine dioxide or  $\text{ClO}_2$                       F. None of the Above
390. \_\_\_\_\_ is a dissolved gas in water; there is no mineral acid or caustic soda formation as happens when using HOCl.  
 A.  $\text{ClO}_2$     D. NaOCl and HCl in place of chlorine gas  
 B. Sodium chlorite ( $\text{NaClO}_2$ )                      E. Heavily pH-dependent  
 C. Hypochlorous acid                              F. None of the Above
391. Which of the following compound(s) tends to be much less, if not totally non-reactive, with many organic and inorganic compounds?  
 A.  $\text{ClO}_2$     D. NaOCl and HCl in place of chlorine gas  
 B. Sodium chlorite ( $\text{NaClO}_2$ )                      E. Heavily pH-dependent  
 C. Hypochlorous acid                              F. None of the Above
392. Which of the following compound(s) is much less aggressive to traditional corrosion inhibitors?  
 A. Sodium chlorite ( $\text{NaClO}_2$ )                      D. Sodium chlorate ( $\text{NaClO}_3$ )  
 B. Chlorine gas                                      E. NaOCl and HCl  
 C. Chlorine dioxide or  $\text{ClO}_2$                       F. None of the Above
393. Which compound is a yellow-green gas with an irritating odor not unlike Chlorine?  
 A. Sodium thiosulfate                      D. Sodium chlorate ( $\text{NaClO}_3$ ) and sulfuric acid  
 B. Chlorine    E. Ozone  
 C. Chlorine dioxide                          F. None of the Above
394. Which compound cannot be compressed and shipped in a container, so it must be generated on site?  
 A. Sodium thiosulfate                      D. Sodium chlorate ( $\text{NaClO}_3$ ) and sulfuric acid  
 B. Chlorine    E. Ozone  
 C. Chlorine dioxide                          F. None of the Above

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

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

396. 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

397. 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

### Common Water Disinfection Alternative Methods

#### Ultraviolet Disinfection

398. 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

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

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

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

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

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

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

402. 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      D. UV reactor  
 B. UV rays            E. Electromagnetic energy  
 C. UV disinfection    F. None of the Above
403. 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                    D. UV reactor  
 B. Contact              E. Ballasts and shields  
 C. Channel              F. None of the Above
404. Heat is generated by the electric components of the UV system, adequate ventilation and cooling must be applied to the \_\_\_\_\_ to reduce heat build-up, otherwise the ballasts could fail.
- A. UV arrays            D. UV reactor  
 B. UV rays              E. Electromagnetic energy  
 C. UV disinfection    F. None of the Above
405. 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        D. UV reactor  
 B. UV Flux              E. Ballasts and shields  
 C. UV disinfection    F. None of the Above
406. The germicidal effect of UV is thought to be associated with its reduction by various inorganic components essential to the cell's functioning.
- A. True                  B. False
407. Which term represents the transfer of electromagnetic energy from a mercury arc lamp to a pathogen's DNA material, thus affecting its ability to replicate itself.
- A. UV radiation        D. UV reactor  
 B. UV rays              E. Electromagnetic energy  
 C. UV disinfection    F. None of the Above
408. Which term represents the intensity being emitted, the length of time that the wastewater comes in contact with the UV radiation, and the arrangement of the UV reactor?
- A. UV radiation        D. UV reactor  
 B. UV arayment        E. Electromagnetic energy  
 C. UV disinfection    F. None of the Above
409. The contact time for the wastewater with the UV source is the shortest of any of the disinfectant strategies, lasting no longer than 20 to 30 seconds.
- A. True                  B. False
410. 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

411. 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**

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

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

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

414. 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      D. Oxygen and nascent oxygen  
B. THMs      E. Strongest oxidizing agent  
C. Light blue gas      F. None of the Above

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

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

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

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

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

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

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

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

## Alternate Disinfectants Section Summary

### Chloramines

419. 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

420. 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

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

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

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

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

423. 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

424. 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

425. 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

426. \_\_\_\_\_ 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
427. Ozone does not provide a \_\_\_\_\_ and should be used as a primary disinfectant only in conjunction with free and/or combined chlorine.
- A. Ozone CT
  - B. Free and/or combined chlorine
  - C. Residual level(s)
  - D. System residual
  - E. Risk
  - F. None of the Above
428. Ozone does not produce this term but it may cause an increase in such byproduct formation if it is fed ahead of free chlorine; ozone may also produce its own oxygenated byproducts such as aldehydes, ketones, or carboxylic acids.
- A. Carcinogens
  - B. Organics
  - C. Carboxylic acids
  - D. Oxygen and nascent oxygen
  - E. Chlorinated byproducts
  - F. None of the Above
429. 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

## Protozoan Caused Diseases

430. Which of the following bugs is larger than bacteria and viruses but still microscopic; they invade and inhabit the gastrointestinal tract?
- A. HIV infections
  - B. Symptoms
  - C. Giardiasis
  - D. Hepatitis A
  - E. Protozoan pathogens
  - F. None of the Above
431. A few of the parasites enter the environment in a dormant form, with a protective cell wall, called a \_\_\_\_\_.
- A. Lamblia
  - B. Shell
  - C. Case
  - D. Cyst
  - E. Infection
  - F. None of the Above
432. Which of the following terms can survive in the environment for long periods of time and is extremely resistant to conventional disinfectants such as chlorine?
- A. HIV
  - B. Symptoms
  - C. Infection
  - D. Hepatitis A cyst
  - E. Cyst
  - F. None of the Above

433. Which of the following terms is a commonly reported protozoan-caused disease, it has also been referred to as backpacker's disease?

- A. Giardia lamblia
- B. Giardiasis
- C. Malaise
- D. Cryptosporidiosis
- E. Anti-water Infection
- F. None of the Above

434. The backpacker's disease incubation period is 5-25 days or longer, with an average of 7-10 days, many infections are?

- A. Total
- B. Weak
- C. Strong
- D. Asymptomatic
- E. Unisymptomatic
- F. None of the Above

435. Which of the following bugs/disease terms occurs worldwide primarily because customers are receiving their drinking water from streams or rivers without adequate disinfection or a filtration system?

- A. HIV infections
- B. Symptoms
- C. Giardiasis
- D. Hepatitis A symptoms
- E. Cryptosporidiosis symptoms
- F. None of the Above

### **Giardia lamblia**

436. \_\_\_\_\_ has been responsible for more community-wide outbreaks of disease in the U.S. than any other, drug treatment is not 100% effective.

- A. HIV infection
- B. Giardia lamblia
- C. Giardiasis
- D. Hepatitis A
- E. Cryptosporidiosis
- F. None of the Above

### **Cryptosporidiosis**

437. The mode of transmission of this bug is fecal-oral, either by person-to-person or animal-to-person, there is no specific treatment.

- A. HIV infection
- B. Giardia lamblia
- C. Giardiasis
- D. Hepatitis A
- E. Cryptosporidiosis
- F. None of the Above

438. All of these diseases, with the exception of this bug, have one symptom in common: diarrhea. They also have the same mode of transmission, fecal-oral, whether through person-to-person or animal-to-person contact.

- A. HIV infection
- B. Giardia lamblia
- C. Giardiasis
- D. Hepatitis A
- E. Cryptosporidiosis
- F. None of the Above

439. Which of the following is an example of a protozoan disease that is common worldwide, but was only recently recognized as causing human disease?

- A. HIV infection
- B. Giardia lamblia symptom
- C. Giardiasis
- D. Hepatitis A
- E. Cryptosporidiosis
- F. None of the Above

440. Which of the following usually come and go, and end in fewer than 30 days in most cases, the incubation period is 1-12 days, with an average of about seven days?

- A. HIV infections
- B. Symptoms
- C. Giardiasis
- D. Hepatitis A
- E. Cryptosporidiosis
- F. None of the Above

## Sampling Procedures

### Streamwater Sample Collection

441. 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

442. 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

443. 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

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

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

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

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

### Understanding Bacteriophage

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

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

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

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

448. 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

449. 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

### **Safe Drinking Water Act (SDWA) Review**

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

- A. True
- B. False

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

- A. True
- B. False

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

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

- A. True
- B. False

453. Issue regulations requiring monitoring of all regulated and certain unregulated contaminants, depending on the number of people served by the system, the source of the water supply, and the contaminants likely to be found;

- A. True
- B. False

454. Set criteria under which systems are obligated to filter water from surface water sources; it must also develop procedures for states to determine which systems have to filter.

- A. True
- B. False

455. Through the Surface Water Treatment Rule (SWTR), EPA has set treatment requirements to control microbiological contaminants in public water systems using surface water sources (and ground-water sources under the direct influence of surface water).

- A. True
- B. False

### **Bacteriological Monitoring Section**

456. Which of the following are usually harmless, occur in high densities in their natural environment and are easily cultured in relatively simple bacteriological media?

- A. Indicator bacteria
- B. Bacteria tests
- C. Contaminate
- D. Microbiological analysis
- E. Presence of an indicator
- F. None of the Above

457. Indicators in common use today for routine monitoring of drinking water include total coliforms, fecal coliforms, and?

- A. Sample container
- B. Bacteria tests
- C. Coliform bacteria
- D. Escherichia coli (E. coli)
- E. Iron bacteria
- F. None of the Above

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

- A. Indicator bacteria
- B. Bacteria tests
- C. Contamination
- D. Coliform bacteria
- E. Presence of an indicator
- F. None of the Above

459. \_\_\_\_\_ is used as an indicator organism to determine the biological quality of your water.

- A. Microbiological analysis
- B. Bac-T
- C. Coliform bacteria
- D. Escherichia coli (E. coli)
- E. Presence of an indicator
- F. None of the Above

460. The presence of an indicator or \_\_\_\_\_ in your drinking water is an important health concern.

- A. Indicator bacteria
- B. Pathogenic bacteria
- C. Contaminate
- D. Microbiological analysis
- E. Presence of an indicator
- F. None of the Above

461. Which of the following terms is used to signal possible fecal contamination, and therefore, the potential presence of pathogens?

- A. Indicator bacteria
- B. Pathogenic bacteria
- C. Contaminate
- D. Microbiological analysis
- E. Presence of an indicator
- F. None of the Above

### **Bacteria Sampling**

462. Water samples for this process must always be collected in a sterile container.

- A. Indicator
- B. Bacteria tests
- C. Contamination
- D. pH analysis
- E. Presence of an indicator
- F. None of the Above

463. Refrigerate the sample and transport it to the testing laboratory within eight hours (in an ice chest). Many labs will accept bacteria samples on Friday. Mailing Indicator bacteria is not recommended because laboratory analysis results are not as reliable.

- A. True
- B. False

464. Which bug forms an obvious slime on the inside of pipes and fixtures? A water test is not needed for identification. Check for a reddish-brown slime inside a toilet tank or where water stands for several days.

- A. Colonies
- B. Algae
- C. Coliform bacteria
- D. Escherichia coli (E. coli)
- E. Iron bacteria
- F. None of the Above

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

- A. Diseases
- B. Germs
- C. Coliform bacteria
- D. Escherichia coli (E. coli)
- E. Iron bacteria
- F. None of the Above

**Laboratory Procedures**

466. The laboratory may perform the \_\_\_\_\_ in one of four methods approved by the U.S. EPA and your local environmental or health division.

- A. Colilert
- B. Coliform
- C. Sample time
- D. Total coliform analysis
- E. Pathogen test
- F. None of the Above

**Methods**

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

- A. Colilert
- B. Coliform
- C. Sample stuff
- D. Total coliform analysis
- E. Pathogen media
- F. None of the Above

468. If coliforms are present, the laboratory will analyze the sample further to determine if these are \_\_\_\_\_ and \_\_\_\_\_ and report their presence or absence.

- A. Colilert, E. coli
- B. Coliforms, E. coli
- C. Fecal coliforms, E. coli
- D. Total coliform analysis, Pathogens
- E. Pathogens, Total coliform analysis
- F. None of the Above

**Types of Water Samples**

469. It is important to identify the type of \_\_\_\_\_ you are collecting.

- A. Colilert
- B. Coliforms
- C. Sample
- D. Total coliform analysis
- E. Pathogens
- F. None of the Above

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

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

- A. Repeat
- B. Special
- C. QA QC
- D. Total coliform analysis
- E. Routine
- F. None of the Above

471. What type of samples can be collected for other reasons? Examples would be a sample collected after repairs to the system.

- A. Repeat
- B. Special
- C. Sample
- D. Total coliform analysis
- E. Routine
- F. None of the Above

472. What type of samples can be collected on a routine basis to monitor for contamination? Collection should be in accordance with an approved sampling plan.

- A. Repeat
- B. Special
- C. Sample
- D. Total coliform analysis
- E. Routine
- F. None of the Above

**Repeat Sampling**

473. Which of the following terms is total coliform or fecal coliform present, a set of repeat samples must be collected within 24 hours after being notified by the laboratory?

- A. MCL compliance
- B. Distribution system
- C. Routine sample
- D. Original sampling location
- E. Repeat sample(s)
- F. None of the Above

**The follow-up for repeat sampling is:**

474. If only one \_\_\_\_\_ per month or quarter is required, four (4) repeat samples must be collected.

- A. Special Sample
- B. Routine sample
- C. Repeat sample(s)
- D. Coliform present
- E. Original sampling location
- F. None of the Above

**Sampling Procedures**

475. \_\_\_\_\_ must be followed and all operating staff must be clear on how to follow the sampling plan.

- A. Seal individual samples
- B. Chain of custody
- C. Distribution system
- D. Sample siting plan
- E. Positive for total coliform
- F. None of the Above

**Maximum Contaminant Levels (MCLs)**

476. 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

**Chain of Custody Procedures**

477. Which of the following terms begins when the sample containers are obtained from the laboratory? From this point on, a chain of custody record will accompany the sample containers.

- A. Multiple sources
- B. Sample siting plan
- C. Total coliform
- D. Chain of custody record
- E. Sampling containers
- F. None of the Above

478. Each custody sample requires a \_\_\_\_\_ record and may require a seal. If you do not seal individual samples, then seal the containers in which the samples are shipped.

- A. Seal individual samples
- B. Chain of custody
- C. Distribution system
- D. Sample siting plan
- E. Positive for total coliform
- F. None of the Above

479. 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

480. 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

### **Total Coliforms**

481. 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

### **HazCom Rule**

#### **3.1.4 Oxidizing Gases**

482. Which of the following terms - means any gas which may, generally by providing oxygen, cause or contribute to the combustion of other material more than air does?

- A. Aerosols
- B. Single hazard category
- C. Flammable gas
- D. Ignition
- E. Oxidizing gas
- F. None of the Above

483. Which of the following terms - of this hazard class are assigned to a single hazard category on the basis that, generally by providing oxygen, they cause or contribute to the combustion of other material more than air does?

- A. Aerosols
- B. Single hazard category
- C. Flammable gas means a gas
- D. Substances and mixtures
- E. Oxidizers
- F. None of the Above

#### **3.1.5 Gases under Pressure**

484. Which of the following terms under pressure are gases that are contained in a receptacle at a pressure not less than 280 Pa at 20°C or as a refrigerated liquid?

- A. Flammable solids
- B. Substances and mixtures
- C. Gases
- D. Physical state or compressed gases
- E. Substances and mixtures of this hazard class
- F. None of the Above

#### **3.1.8 Self-Reactive Substances**

485. Which of the following terms are thermally unstable liquids or solids liable to undergo a strongly exothermic thermal decomposition even without participation of oxygen?

- A. Combustion of other material
- B. Readily combustible solids
- C. Basis of the flash point
- D. Explosive, organic peroxides or as oxidizing
- E. Self-reactive substances
- F. None of the Above

### 3.1.13 Oxidizing Liquids

486. Which of the following terms - is a liquid which, while in itself not necessarily combustible, may, generally by yielding oxygen, cause or contribute to the combustion of other material?

- A. Combustible liquid
- B. Readily combustible liquid
- C. Basis of the flash point
- D. Explosive liquid
- E. An oxidizing liquid
- F. None of the Above

487. Substances and mixtures of this hazard class are assigned to one of three hazard categories on the basis of test results which measure ignition or pressure rise time compared to?

- A. Flammable solids
- B. Substances and mixtures
- C. Ignition
- D. Physical state or compressed gases
- E. Substances and mixtures of this hazard class
- F. None of the Above

### 3.1.14 Oxidizing Solids

488. An oxidizing solid is a solid which, while in itself not necessarily combustible, may, generally by yielding oxygen, cause or contribute to the?

- A. Combustion of other material
- B. Readily combustible solids
- C. Basis of the flash point
- D. Explosive, organic peroxides or as oxidizing
- E. Critical temperature
- F. None of the Above

### 3.1.15 Organic Peroxides

489. The term also includes organic peroxide formulations, such substances and mixtures may: be liable to- this missing term -; burn rapidly; be sensitive to impact or friction; react dangerously with other substances.

- A. Melt
- B. Decompose
- C. Corrode
- D. Explosive decomposition
- E. Burn
- F. None of the Above

### 3.1.16 Substances Corrosive to Metal

490. A substance or a mixture that by- this missing term - will materially damage, or even destroy, metals is termed 'corrosive to metal'.

- A. Substances and mixtures
- B. Harmonized approach
- C. Chemical action
- D. Structure/activity or structure property
- E. Organic radicals
- F. None of the Above

### 3.2.2 Skin Corrosion

491. Which of the following terms - means the production of irreversible damage to the skin following the application of a test substance for up to 4 hours?

- A. Skin corrosion
- B. Harmonized approach
- C. Chemical action
- D. Structure/activity or structure property
- E. Organic radicals
- F. None of the Above

### 3.2.3 Skin Irritation

492. Which of the following terms - means the production of reversible damage to the skin following the application of a test substance for up to 4 hours?

- A. Chemical action
- B. Analysis of existing
- C. Corrosive
- D. Health and environmental criteria
- E. Skin irritation
- F. None of the Above

### 3.2.4 Eye Effects

493. Which of the following terms should be considered in determining the serious eye damage or eye irritation potential before testing is initiated?

- A. Several factors
- B. pH extremes
- C. Contact sensitizer
- D. Substances and mixtures in this hazard class
- E. Hypersensitivity
- F. None of the Above

494. Structure/activity or structure property relationship to a - this missing term - already classified; pH extremes like  $\leq 2$  and  $\geq 11.5$  that may produce serious eye damage.

- A. Test substance
- B. pH extreme
- C. Contact sensitizer
- D. Substance or mixture
- E. Hypersensitivity
- F. None of the Above

### 3.2.5 Sensitization

495. Which of the following terms means a substance that induces hypersensitivity of the airways following inhalation of the substance?

- A. Several factors
- B. pH extremes
- C. Contact sensitizer
- D. Respiratory sensitizer
- E. Hypersensitivity
- F. None of the Above

496. Substances and mixtures in this hazard class are assigned to?

- A. Several factors
- B. pH extremes
- C. Contact sensitizer
- D. One hazard category
- E. Hypersensitivity
- F. None of the Above

497. Skin sensitizer means a substance that will induce an allergic response following skin contact. The definition for "skin sensitizer" is equivalent to?

- A. Contact sensitizer
- B. An irritant
- C. Skin sensitizer
- D. Reproductive and developmental effects
- E. Serious physical decay
- F. None of the Above

## 3.3 Environmental Hazards

### 3.3.1 Hazardous to the Aquatic Environment

498. The harmonized criteria are - this missing term - for packaged goods in both supply and use in multi-modal transport schemes.

- A. Considered suitable
- B. A single exposure
- C. Known or presumed
- D. Only in animal studies
- E. Complex substance
- F. None of the Above

## 4.0 Hazard Communication

499. As in existing systems, labels and - this missing term - are the main tools for chemical hazard communication. They identify the hazardous properties of chemicals that may pose a health, physical or environmental hazard during normal handling or use.

- A. GHS
- B. Environmental hazards
- C. Chemical products
- D. Safety Data Sheets
- E. Hazardous properties of chemicals
- F. None of the Above

### **Transport and Emergency Responders**

500. For hazardous products being transported, outer containers have required label elements, product identifier and hazard symbols \_\_\_\_\_ are in addition to workplace or end use label requirements.

- A. Transportation requirements
- B. Environmental hazards
- C. Chemical products
- D. Safety Data Sheets
- E. Hazardous properties of chemicals
- F. None of the Above