

Registration form

**Chlorine & Disinfection CEU Training Course \$200.00
48 HOUR RUSH ORDER PROCESSING FEE ADDITIONAL \$50.00**

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

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

Name _____ Signature _____
I have read and understood the disclaimer notice on page 2. Digitally signature XXX is Permissible

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**

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 also understand that this type of study program deals with dangerous conditions and that I will not hold Technical Learning College, Technical Learning Consultants, Inc. (TLC) liable for any errors or omissions or advice contained in this CEU education training course or for any violation or injury caused by this CEU education training course material.

I will call or contact TLC if I need help or assistance and double-check to ensure my registration page and assignment has been received and graded.

State Approval Listing Link, check to see if your State accepts or has pre-approved this course. Not all States are listed. Not all courses are listed. Do not solely trust our list for it may be outdated. It is your sole responsibility to ensure this course is accepted for credit.

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

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.

Additional certificate for another Agency – additional fee \$50

All downloads are electronically tracked and monitored for security purposes.

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

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

For Texas TCEQ Wastewater Licensed Operators

Wastewater/Collections Rule Changes

Rule Changes and Updates for Domestic Wastewater Systems

On Nov. 4, 2014, TCEQ commissioners adopted revisions to 30 Texas Administrative Code (TAC), Chapter 217, Design Criteria for Domestic Wastewater Systems, and “re-adopted” previously repealed rules in 30 TAC, Chapter 317, Design Criteria Prior to 2008.

Some of the changes to Chapter 217 include:

- Adding new definitions and clarifying existing definitions;
- Adding design criteria and approval requirements for rehabilitation of existing infrastructure;
- Adding design criteria for new technologies, including cloth filters and air lift pumps;
- Making changes to reflect modern practices, standards and trends;
- Modifying rule language to improve readability and enforceability; and
- Modifying the design organic loadings and flows for a new wastewater treatment facility.

SUBCHAPTER A: ADMINISTRATIVE REQUIREMENTS §§217.1 - 217.18

Effective December 4, 2015 §217.1. Applicability. (a) Applicability. (1) This chapter applies to the design, operation, and maintenance of: (A) domestic wastewater treatment facilities that are constructed with plans and specifications received and approved by the executive director after the effective date of the amendments to this chapter; (B) treatment units that are altered, constructed, or re-rated with plans and specifications received and approved by the executive director after the effective date of the amendments to this chapter; (C) collection systems that are constructed with plans and specifications received and approved by the executive director after the effective date of the amendments to this chapter; (D) collection system units that are altered, constructed, or re-rated with plans and specifications received and approved by the executive director after the effective date of the amendments to this chapter; (E) existing domestic wastewater treatment facilities that do not have a current Texas Pollutant Discharge Elimination System permit or a Texas Land Application Permit and are required to have an active wastewater permit; (F) existing wastewater treatment facilities and collection systems that never received approval for plans and specifications from the executive director; and (G) collection system rehabilitation projects covered in §217.56(c) and §217.69 of this title (relating to Trenchless Pipe Installation; and Maintenance, Inspection, and Rehabilitation of the Collection System). (2) Domestic wastewater treatment facilities, treatment units, collection systems, and collection system units with plans and specifications approved by the executive director that were received on or after August 28, 2008 and before the effective date of this chapter must comply with the rules in this chapter, as they existed immediately before the effective date of the amendments to this chapter.

The rules in Texas Commission on Environmental Quality Page 2 Chapter 217 - Design Criteria for Domestic Wastewater Systems effect immediately before the effective date of the amendments to this chapter are continued in effect for that purpose. (3) This chapter does not apply to: (A) the design, installation, operation, or maintenance of domestic wastewater treatment facilities, treatment units, collection systems, or collection system units with plans and specifications that were approved by the executive director on or before August 27, 2008, which are governed by Chapter 317 of this title (relating to Design Criteria Prior to 2008) or design criteria that preceded Chapter 317 of this title; and (B) systems regulated by Chapter 285 of this title (relating to On-Site Sewage Facilities); or collection systems or wastewater treatment facilities that collect, transport, treat, or dispose of wastewater that

does not have the characteristics of domestic wastewater, although the wastewater may contain domestic wastewater.

(b) The executive director may grant variances from new requirements added by the amendments of this chapter to a person who proposes to construct, alter, or re-rate a collection system or wastewater treatment facility if the plans and specifications for the project are submitted within 180 days after the date the amendments to this chapter are effective, provided the plans and specifications comply with the rules in effect immediately prior to the amendment. Adopted November 4, 2015 Effective December 4, 2015

The link to the rules is available on the TCEQ website at <https://www.tceq.texas.gov/rules/indxpdf.html>

For Texas Students Only....

Please sign and date this notice

Printed Name

Signature

Date

Texas Students Only
Acknowledgement of Notice of Potential Ineligibility for License
You are required to sign and return to TLC or your credit will not be reported.

Name: _____

Date of Birth: _____

Email Address: _____

By signing this form, I acknowledge that Technical Learning College notified me of the following:

- the potential ineligibility of an individual who has been convicted of an offense to be issued an occupational license by the Texas Commission on Environmental Quality (TCEQ) upon completion of the educational program;
- the current TCEQ Criminal Conviction Guidelines for Occupational Licensing, which describes the process by which the TCEQ's Executive Director determines whether a criminal conviction:
 - renders a prospective applicant an unsuitable candidate for an occupational license;
 - warrants the denial of a renewal application for an existing license; or
 - warrants revocation or suspension of a license previously granted.
- the right to request a criminal history evaluation from the TCEQ under Texas Occupations Code Section 53.102; and
- that the TCEQ may consider an individual to have been convicted of an offense for the purpose of denying, suspending or revoking a license under circumstances described in Title 30 Texas Administrative Code Section 30.33.

Enrollee Signature: _____ Date: _____

Name of Training Provider/Organization: Technical Learning College

Contact Person: Melissa Durbin Role/Title: Dean

Chlorine and Disinfection CEU Course Answer Key

Name _____ Telephone # _____

You are solely responsible to ensure that your State will accept this course for credit. Did you check with your State agency to ensure this course is accepted for credit?

*Method of Course acceptance confirmation. Please fill this section
Some States and Employers require proctoring.*

Website ___ Telephone Call ___ Email ___ Spoke to _____

Did you receive the approval number, if applicable? _____

What is the course approval number, if applicable? _____

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

You are responsible to ensure that TLC receives the Assignment and Registration Key. Please call us to ensure that we received it. No refunds. States and many employers require the final exam to be proctored. You can use Adobe Acrobat DC Program to complete the assignment.

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

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

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

**CHLORINE & DISINFECTION CEU TRAINING COURSE
CUSTOMER SERVICE RESPONSE CARD**

NAME: _____

E-MAIL _____ PHONE _____

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

1. Please rate the difficulty of your course.

Very Easy 0 1 2 3 4 5 Very Difficult

2. Please rate the difficulty of the testing process.

Very Easy 0 1 2 3 4 5 Very Difficult

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

Very Similar 0 1 2 3 4 5 Very Different

4. How did you hear about this Course? _____

5. What would you do to improve the Course?

How about the price of the course? Poor ___ Fair___ Average___ Good ___ Great ___

How was your customer service? Poor ___ Fair___ Average___ Good ___ Great ___

Any other concerns or comments.

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

Chlorine and Disinfection CEU Course Assignment

The Assignment (Exam) is also available in Word on the Internet for your Convenience, please visit www.ABCTLIC.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.

We would prefer that you utilize the enclosed answer sheet in the front, but if you are unable to do so, type out your own answer key. Please include your name and address on your Answer Key and make copy for yourself. You can e-mail or fax your Answer Key along with the Registration Form to TLC. **(S) Means answer may be plural or singular. Multiple Choice Section, One answer per question and please use the answer key.**

Waterborne Pathogens Chapter 1 100 Questions

Disinfection Essentials

1. Selecting the right _____ requires understanding several factors governing the particular site and the water or wastewater to be treated.
A. Operating costs D. Operating method
B. Disinfection weapon E. Net-positive environmental benefit
C. UV device F. None of the Above
2. If the disinfection system is complex it may require additional staff time to ensure that it operates within the?
A. Disinfectant system D. Net-positive environmental benefit
B. Narrow tolerance E. Acceptable standards
C. Desired parameters F. None of the Above
3. 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 D. Breathing apparatus and protective clothing
B. Other than chlorine E. Oxygenation of the receiving waters
C. Safeguards F. None of the Above
4. Safety: A system will often require significant safety protection—such as use of breathing apparatus and protective clothing—as well as high levels of operator training, it may be advisable to explore other, _____.
A. Disinfectant systems D. Less intensive systems
B. Narrow tolerance E. Acceptable standards
C. Desired parameters F. None of the Above

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

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

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

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

7. 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

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

- A. True
- B. False

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

Waterborne Pathogens Section

The reason we disinfect.

10. Pathogens are bacteria, viruses and protozoans that cause disease.

- A. True
- B. False

11. Pathogens _____ and affect people in a relatively short amount of time.

- A. Limits the treatment process
- B. Are mild in nature
- C. Cause intestinal illness
- D. Will cause fatalities
- E. Limit the travel of pathogens
- F. None of the Above

How Diseases are Transmitted.

12. How are waterborne pathogens spread?

- A. Fecal-oral, or feces-to-mouth, route
- B. Dermal to fecal route
- C. Oral to fecal route
- D. Influenza route
- E. Waterborne mishaps
- F. None of the Above

13. A source of waterborne pathogens is the stool of infected humans or animals. The stool contains the disease-causing bacteria, viruses, and _____.

- A. Fecal Coliform and E coli
- B. Protozoa
- C. Macroorganisms
- D. Cryptosporidiosis
- E. Bioslime
- F. None of the Above

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

- A. True
- B. False

15. _____ are different from the pathogens that cause influenza or the bacteria that cause tuberculosis.

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

Safe Drinking Water Act (SDWA) Review

16. 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

17. 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:

18. 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

19. 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

20. 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

21. Treatment must remove or inactivate at least 99.9% of Giardia lamblia cysts and 99.99% of viruses.

- A. True
- B. False

22. 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

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

- A. True B. False

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

- A. True B. False

Microbes

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

- A. True B. False

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

- A. True B. False

27. _____ in human or animal wastes can cause diarrhea, cramps, nausea, headaches, or other symptoms.

- | | |
|--------------------|----------------------|
| A. Microbes | D. Cryptosporidiosis |
| B. Giardia lamblia | E. Coliform bacteria |
| C. Microorganisms | F. None of the Above |

28. The presence of _____ bacteria indicates that the water may be contaminated with fecal matter from humans or animals.

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

29. _____ is a parasite that enters drinking water sources through sewage and animal waste. This parasite causes cryptosporidiosis.

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

30. Giardia lamblia is a parasite that enters drinking water sources through sewage and animal waste. This parasite causes _____.

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

Conclusion

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

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

32. Water authorities are reassessing the adequacy of current water-quality regulations because of outbreaks of chlorine resistant?

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

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

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

34. Many different areas need to be investigated and understood to afford the water quality safeguards are not taken for granted. Areas of concern include life cycles, mechanisms of infection, protective or dormant states, emergence of disinfection resistant variants, _____, regrowth in distribution lines.

- A. Optimal pathogen removal techniques
- B. Disinfection process
- C. Environmental and regulatory impact
- D. Primary methods used for the disinfection
- E. Extensive waterborne disease research
- F. None of the Above

Salmonella Typhi

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

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

36. Salmonella typhi. Prevention strategies for this pathogen include source protection, halogenation of water, and _____.

- A. Adding chlorine
- B. Adding sodium chlorite
- C. Adding KNO₄
- D. Adding NH₄
- E. Boiling water for one minute
- F. None of the Above

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

- A. True
- B. False

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

- A. True
- B. False

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

- A. True
- B. False

40. Legionnaire's disease, which causes a severe pneumonia, and the second, _____, which is a nonpneumonia illness; it's typically an influenza-like illness, and it's less severe.
- A. Campylobacter D. Typhoid fever
 B. Pathogen E. Shigella dysenteriae
 C. Pontiac fever F. None of the Above
41. Which pathogen is naturally found in water, both natural and artificial water sources?
- A. Campylobacter D. Typhoid fever
 B. Legionella E. Hydrodysenteriae
 C. Pontiac fever F. None of the Above
42. Legionella, prevention. Legionella in water systems. Hot water in tanks should be maintained between _____ degrees Centigrade.
- A. 81 to 100 D. 71 and 77
 B. 110 to 210 E. 75 and 85
 C. 75 – 212 F. None of the Above
43. Pseudomonas, the basics. It's a protozoon. It is caused by visual contact with water. It can cause dermatitis, which is an inflammation of the skin, or it can cause otitis, which is an infection of the ear.
- A. True B. False
44. Which of the following terms is typically associated with soil and water?
- A. Hepatitis A virus D. Pseudomonas
 B. Diarrheal illness E. Waterborne outbreaks
 C. Cryptosporidium F. None of the Above
45. Pseudomonas prevention. Proper maintenance and disinfection of recreational water systems is important in preventing?
- A. Pathogen D. Pseudomonas
 B. Cryptosporidium E. Salmonellosis
 C. Hepatitis A virus F. None of the Above
46. Hepatitis A, the basics. It's a virus. It causes inflammation of the liver, and the reservoir for _____ is humans.
- A. Hepatitis A virus D. Hepatitis B
 B. Diarrheal illness E. Waterborne outbreaks
 C. Cryptosporidium F. None of the Above
47. Hepatitis A virus is resistant to combined chlorines, so it is important to have an adequate free chlorine residual. Fecal matter can shield _____ from chlorine.
- A. Hepatitis A virus D. Hepatitis B
 B. Diarrheal illness E. Waterborne outbreaks
 C. Cryptosporidium F. None of the Above
48. Humans are the reservoir for the Norovirus. Prevention strategies for this pathogen include?
- A. Maintaining water systems D. Containment protection
 B. Source protection E. Internal protection
 C. Chlorine monoxide F. None of the Above

49. Cryptosporidium causes diarrheal illness known as?
 A. Vomiting D. Cryptosporidiosis
 B. Hemorrhagic colitis E. Salmonellosis
 C. Diarrhea F. None of the Above
50. Cryptosporidium is typically associated with animals and humans, and it can be acquired through consuming fecally contaminated food, contact with fecally contaminated soil and water.
 A. True B. False
51. CT equals a concentration, in parts per million, while time equals a contact time in minutes. _____ can also be prevented or eliminated by boiling water for one minute.
 A. Hemorrhagic colitis D. Pseudomonas
 B. Diarrheal illness E. Waterborne outbreaks
 C. Cryptosporidium F. None of the Above
52. Filtration with an "absolute" pore size of one micron or smaller can eliminate? And reverse osmosis is known to be effective as well.
 A. Pathogen D. Pseudomonas
 B. Cryptosporidium E. Salmonellosis
 C. Hepatitis A virus F. None of the Above
53. Giardia prevention strategies for this pathogen include _____; filtration, coagulation, and halogenation of drinking water.
 A. Maintaining hot water systems D. Primary protection
 B. Source protection E. Secondary measurements
 C. Sulfur dioxide F. None of the Above
54. Schistosomatidae, the basics. It is a parasite. It is acquired through dermal contact, cercarial dermatitis. It is commonly known as _____.
 A. Swimmer's itch D. Pseudomonas
 B. Beaver fever E. Salmonellosis
 C. Hemorrhagic colitis F. None of the Above

E-Coli Section

55. Escherichia coli. There are several pathogenic strains of Escherichia coli, which are classified under enterovirulent E. coli. They are enterohemorrhagic, enteroinvasive, enterotoxigenic, enteropathogenic, and enteroaggregative.
 A. True B. False
56. Escherichia coli. In its most severe form, it can cause?
 A. Hemorrhagic colitis D. Pseudomonas
 B. Escherichia coli O157:H7 E. Salmonellosis
 C. Beaver fever F. None of the Above
57. What is the bacterial disease caused by the Salmonella species that causes diarrheal illness?
 A. Beaver fever D. Pseudomonas
 B. Escherichia coli O157:H7 E. Salmonellosis
 C. Bacteria F. None of the Above

58. Prevention strategies for Salmonella include source protection, halogenation of water and also?

- A. KNMO4
- B. Source protection
- C. Chlorine dioxide
- D. Eliminating snails with a molluscicide
- E. Boiling water for one minute
- F. None of the Above

59. Repeat sampling replaces the old check sampling with a more comprehensive procedure to try to _____ areas in the system.

- A. Double check the routine sample
- B. Identify problem
- C. Originate the sampling location
- D. Sample
- E. Calculate MCL compliance
- F. None of the Above

60. According to the text, whenever a Routine Sample is total coliform or fecal coliform present, a set of repeat samples must be collected within how many hours after being notified by the laboratory.

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

61. The follow-up for repeat sampling is: If a system collects only one _____ per month or quarter, it must collect four (4) repeat samples.

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

62. If a system collects two (2) or more routine samples per month, it must collect three (3) _____.

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

63. Repeat samples must be collected from:

The original sampling location of the?

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

64. One of the repeat samples must be collected from within five (5) service connections upstream from the _____.

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

65. One of the repeat samples must be collected from within five (5) service connections downstream from the _____.

- A. Routine sample site
- B. Surface water location
- C. Original sampling location
- D. Sample area
- E. MCL compliance area
- F. None of the Above

66. Samples should be taken elsewhere in the _____ or at the wellhead, if necessary.
- A. Sewage system
 - B. Surface system
 - C. Sampling location
 - D. Distribution system
 - E. MCL compliance calculation
 - F. None of the Above

Positive or Coliform Present Results

67. 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

68. Ideally speaking, your Drinking Water Program Agency should contract with health departments to provide _____ to water systems.

- A. Assistance
- B. Harassment
- C. Hostility
- D. Sample help
- E. Compliance calculation
- F. None of the Above

69. Hopefully after you have contacted an agency for assistance, you will be instructed as to the proper repeat sampling procedures and possible corrective measures for solving the problem. It is very important to initiate the _____ as the corrective measures will be based on those results.

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

Some examples of typical corrective measures to coliform problems are:

70. Shocking the system should be done anytime the bell is opened for repair (pump replacement, etc.). If you plan to _____, calculate the total gallonage of storage and distribution.

- A. Shock the entire system
- B. Repeat sampling immediately
- C. Drink the water
- D. Perform routine cleaning
- E. Perform corrective measures
- F. None of the Above

71. Which of the following terms to meet current construction standards as set by your state environmental or health agency?

- A. Install storage tanks
- B. Repeat sampling immediately
- C. Upgrade the wellhead area
- D. Perform routine cleaning
- E. Install air gaps
- F. None of the Above

72. If you _____, review your operation and be sure to maintain a detectable residual (0.2 mg/l free chlorine) at all times in the distribution system.

- A. Break out
- B. Repeat sampling
- C. Upgrade the wellhead area
- D. Continuously chlorinate
- E. Corrective measures
- F. None of the Above

73. Conduct _____ by installing blowoffs on all dead end lines.

- A. Storage and distribution procedures
- B. Repeat sampling immediately
- C. Procedures
- D. Perform routine cleaning procedures
- E. Routine distribution line flushing
- F. None of the Above

74. Conduct a cross connection program to _____ with non-potable water sources.

- A. Correct
- B. Identify all connections
- C. Upgrade the wellhead area
- D. Perform routine cleaning
- E. Corrective measures
- F. None of the Above

75. Which of the following terms or provide approved backflow prevention devices?

- A. Install storage tanks
- B. Repeat sampling immediately
- C. Install air gaps
- D. Perform routine cleaning
- E. Eliminate all of these connections
- F. None of the Above

76. Operators need to ensure the tanks are clean and _____ of the storage system.

- A. Storage and distribution
- B. Repeat sampling immediately
- C. Perform upgrade
- D. Perform routine cleaning
- E. Corrective measures
- F. None of the Above

Maximum Contaminant Levels (MCLs)

77. 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

Heterotrophic Plate Count HPC

78. Heterotrophic Plate Count (HPC) is a procedure for estimating the number of live heterotrophic bacteria and measuring changes during water treatment and distribution.

- A. True
- B. False

79. The term " _____ " refers to the chains, clusters, or single cells that form colonies of bacteria.

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

Spread Plate Method

80. During the Spread Plate Method, all colonies are on the _____ where they can be distinguished readily from particles and bubbles.

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

81. During the Spread Plate Method, _____ can easily be discerned and compared to published descriptions.

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

Membrane Filter Method

82. Large volumes of _____ can be tested by the Membrane Filter Method, and this method is preferred for low-count waters.

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

Heterotrophic Plate Count (Spread Plate Method)

83. _____ use inorganic carbon sources as their substrate. The Heterotrophic Plate Count provides a technique to quantify the bacteriological activity of a sample.

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

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

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

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

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

Total Coliforms

86. 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

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

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

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

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

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

89. Which of the following terms to human health violation occurs if either one of the following happens?

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

90. If a routine analysis shows total coliform present, and a follow-up repeat analysis indicates fecal coliform or E. coli present, _____ has occurred.

- A. A routine analysis violation
- B. A drinking violation
- C. A water penalty
- D. An acute risk to human health violation
- E. Fecal coliform or E. coli present
- F. None of the Above

91. If routine analysis shows _____, and a follow-up repeat analysis indicates total coliform present, an acute risk to human health violation has occurred.

- A. A routine analysis violation
- B. A drinking violation
- C. A MCL violation
- D. Presence of bacteria
- E. Total and fecal coliform or E. coli present
- F. None of the Above

92. A water system is required to provide public notice via radio and television stations in the area when _____ occurs.

- A. A routine analysis violation
- B. A drinking water rule violation
- C. A MCL violation
- D. A human health violation
- E. An acute health risk violation
- F. None of the Above

93. A public notice for an acute health risk violation must be given as soon as possible, but no later than 24 hours after notification from the laboratory of the test results.

- A. True
- B. False

Public Notice

94. A public notice must be issued by a water system whenever it fails to comply with an applicable MCL or _____.

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

95. Whenever a water system fails to comply with its monitoring and/or reporting requirements, a _____ is required.

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

96. Each public notice must be issued properly and in a timely manner, and must contain certain information and _____.

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

97. The timing and place of posting of the public notice will depend on whether _____ is present to water users.

- A. A routine analysis
- B. A drinking water rule
- C. An acute risk
- D. Legal analysis
- E. Fecal coliform or E. coli
- F. None of the Above

The following are acute violations:

98. Violation of the _____ for nitrate is an acute violation.

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

99. Any violation of the _____ for total coliforms, when fecal coliforms or E. coli are present, is an acute violation.

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

100. Any outbreak of _____ is an acute violation.

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

Disinfection Rules Chapter 2 25 Questions

Microbial Regulations

101. The Surface Water Treatment Rule was implemented by USEPA to counter pathogens in drinking water.

- A. True
- B. False

102. The _____ specifies treatment criteria that include turbidity limits, disinfectant residual, and disinfectant contact time conditions.

- A. Long Term 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

103. The Total Coliform Rule (TCR) of 1989 and the _____ regulate microbial contamination of drinking water sources. The SWTR covers all water systems that use surface water or groundwater under the direct influence of surface water.

- 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

104. 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

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

- A. True
- B. False

106. The SWTR provides protection against Giardia intestinalis, viruses, and Legionella that can be present in surface water sources. The _____ provides additional protection against Cryptosporidium in surface water sources.

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

Bromate

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

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

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

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

Chlorite

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

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

What is in Water?

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

- A. True
- B. False

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

- A. True
- B. False

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

- A. True
- B. False

Introduction to Chlorine (DDBP)

113. These term means that chlorine is present as Cl , HOCl , and OCl^- is called _____, and that which is bound but still effective is _____.

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

114. Chloramines are formed by reactions with?

- A. Acid and Cl_2
- B. Ammonia and Cl_2
- C. THMS and Cl_2
- D. Folic Acid and Cl_2
- E. THMs and Haploidic acid
- F. None of the Above

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

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

116. According to the text, this type of chlorine residual concentration residual is from 0.1 to 0.5 ppm.

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

117. A typical chlorine residual is 2 ppm for this type of chlorine residual?

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

Chlorine By-Products

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

- A. Chlorate and Chlorite
- B. CO_2 and H_2SO_4
- C. Trihalomethanes (THMs)
- D. Ammonia and THMS
- E. Chloramines
- F. None of the Above

The Principal Trihalomethanes are:

119. 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

120. 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

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

- A. True B. False

Risks and Benefits of Chlorine

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

- A. Chlorate and Chlorite D. Ammonia and THMS
B. CO₂ and H₂SO₄ E. Chloramines
C. Trihalomethanes (THMs) F. None of the Above

Disinfection Byproduct Regulations Summary

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

- A. True B. False

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

- A. True B. False

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

- A. True B. False

Halogen Chapter Chapter 3 75 Questions

Halides

126. What is the negative ion often referred to as?

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

127. _____ containing these ions are known as halides.

- A. Salts D. Many synthetic organic compounds
B. CXT values E. Neither fluorine nor bromine
C. Primary disinfectant F. None of the Above

128. 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 D. Chlorine gas
B. HOCl E. The hypochlorite ion (OCI⁻)
C. Hydrastatic acid F. None of the Above

129. 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

130. 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

131. 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

132. 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

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

- A. True
- B. False

Principles of Modern Chemistry

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

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

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

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

136. _____ is a transformation of some substances into one or more different substances.

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

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

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

138. The number of atoms on the left and the right in the equation for a _____ is equal.

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

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

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

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

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

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

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

Matter

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

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

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

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

144. According to the text, Matter can be a pure chemical substance or _____.

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

Atom

145. What is the smallest entity that can be envisaged to retain the chemical properties of the element, such as electronegativity, ionization potential, preferred oxidation state(s), coordination number, and preferred types of bonds to form (e.g., metallic, ionic, covalent)?

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

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

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

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

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

Element

148. The standard presentation of the _____ is in the periodic table, which orders elements by atomic number.

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

Compound

149. The properties of a compound bear little similarity to those of its _____.

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

Chemical Compounds

150. This term means represents substances, but not all substances are compounds.

- A. Bulk chemical(s)
- B. Chemical(s)
- C. Mechanical processe(s)
- D. Compound(s)
- E. A pure chemical compound
- F. None of the Above

Substances versus Mixtures

151. All matter consists of various elements and _____, but these are often intimately mixed together.

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

Chemicals versus Chemical Substances

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

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

Molecule

153. A molecule is the smallest indivisible portion of a pure chemical substance that has its unique set of chemical properties, that is, its potential to undergo a certain set of _____ with other substances.

- A. Tetra atomic molecule(s)
- B. Ions
- C. Chemical reactions
- D. Existence of identifiable molecule(s)
- E. Isolated chemical element(s)
- F. None of the Above

154. _____ residing in solids (for example, common sulfate or nitrate ions) are generally not considered "molecules" in chemistry.

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

Substance and Mixture

155. _____ is a kind of matter with a definite composition and set of properties. A collection of substances is called a mixture. Examples of mixtures are air and alloys.

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

Mole and Amount of Substance

156. The mole is a unit of measurement that denotes an amount of substance (also called _____).

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

Phase

157. Sometimes the distinction between phases can be continuous instead of having a discrete boundary, in this case the matter is considered to be in _____.

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

158. The most familiar examples of phases are solids, liquids, and gases. Many substances exhibit multiple solid phases. There are three phases of solid iron (alpha, gamma, and delta) that vary based on _____.

- A. An ionic bond
- B. Another atom
- C. Multiple solid phases
- D. Phase transition
- E. Temperature and pressure
- F. None of the Above

159. In addition to the specific chemical properties that distinguish different chemical classifications, chemicals can exist in several phases. For the most part, the chemical classifications are independent of these _____ classifications; however, some more exotic phases are incompatible with certain chemical properties.

- A. An ionic bond
- B. Another atom
- C. Multiple solid phases
- D. Phase transition
- E. Bulk phase
- F. None of the Above

160. _____ of a chemical system that have similar bulk structural properties, over a range of conditions, such as pressure or temperature.

- A. An amount of substance
- B. A triple point
- C. Crystal structure
- D. A phase is a set of states
- E. Multipole balance
- F. None of the Above

161. The phase of matter is defined by _____, which is when energy put into or taken out of the system goes into rearranging the structure of the system, instead of changing the bulk conditions.

- A. An ionic bond
- B. Another atom
- C. Multiple solid phases
- D. The phase transition
- E. Bulk phase
- F. None of the Above

162. Another phase commonly encountered in the study of chemistry is the _____, which is the state of substances dissolved in aqueous solution (that is, in water).

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

163. Less familiar phases include plasmas, _____ condensates and fermionic condensates and the paramagnetic and ferromagnetic phases of magnetic materials. While most familiar phases deal with three-dimensional systems, it is also possible to define analogs in two-dimensional systems, which has received attention for its relevance to systems in biology.

- A. Bose–Einstein
- B. Another atom
- C. Multiple solid phases
- D. Phase transition
- E. Bulk phase
- F. None of the Above

Bonding

164. Atoms sticking together in _____ are said to be bonded with one another. A chemical bond may be visualized as the multipole balance between the positive charges in the nuclei and the negative charges oscillating about them.

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

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

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

166. _____ is formed when a metal loses one or more of its electrons, becoming a positively charged cation, and the electrons are then gained by the non-metal atom, becoming a negatively charged anion.

- A. An ionic bond
- B. Another atom
- C. Multiple solid phases
- D. Phase transition
- E. Bulk phase
- F. None of the Above

Energy

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

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

pH Section

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

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

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

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

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

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

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

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

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

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

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

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

174. 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

175. 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

176. 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

177. 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

178. 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

179. What is the new pH scale is referred to as?

- A. Total scale D. Ph_3
B. POH E. POE
C. P3H F. None of the Above

180. 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

181. 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

182. According to the manual, this device/method/calculation consists of a mixture of indicators that 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

183. 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
- B. pH log
- C. A set of linear equations
- D. A chemical speciation calculation
- E. A set of non-linear simultaneous equations
- F. None of the Above

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

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

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

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

186. 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

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

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

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

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

189. Because alkalinity is significant in many uses and treatments of natural waters and wastewaters. The measured values also may include contributions from _____ or other bases if these are present.

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

190. 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
- B. The solution of a quadratic equation
- C. The Spectrophotometer
- D. Visual comparison
- E. The solution of a cubic equation
- F. None of the Above

191. What factor is key in determining the suitability of water for irrigation.

- A. pH of 8
- B. pH of 7
- C. pH of 3
- D. Alkaline earth metal concentrations
- E. Borates, phosphates, silicates
- F. None of the Above

192. 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

193. 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

194. According to the manual, which 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

195. 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

196. 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

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

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

Hard Water Section

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

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

Occurrence of Hard Water

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

- A. Water hardness
- B. Metallic cations
- C. Carbon dioxide (CO₂)
- D. Calcium (Ca) and magnesium (Mg)
- E. Noncarbonate hardness
- F. None of the Above

Chlorine Section Chapter 4 225 Questions

Chlorine's Appearance and Odor (QA/QC)

200. Chlorine is a greenish-yellow gas it will condense to an amber liquid at approximately _____F or at high pressures.

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

201. 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

202. 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

203. Incompatibilities: What 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

204. 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

205. 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

206. 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

Chlorine Basics

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

- A. Halogens
- B. Ammonia
- C. Chlorine
- D. Manganese dioxide
- E. H₂SO₄
- F. None of the Above

208. It was Davy who gave the element its name on the basis of the Greek word khloros, for _____ . In 1810 he suggested the name "chloric gas" or "chlorine."

- A. Time
- B. Green gas
- C. Greenish-yellow
- D. Swamp gas
- E. Heavy gas
- F. None of the Above

What Happens to Chlorine When it Enters the Environment?

209. 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

210. 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

211. 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

212. 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

213. 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

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

- A. True
- B. False

215. 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
- B. Chlorine disinfection compounds
- C. Chlorine inorganic compounds
- D. Organic compounds
- E. Abundant chemical elements
- F. None of the Above

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

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

217. 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
- B. A very reactive element
- C. Chlorine compounds
- D. Organic compounds
- E. One of the most abundant chemical elements
- F. None of the Above

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

219. Various states of chlorine includes when chlorine is isolated as a free element, chlorine is a greenish yellow gas, which is _____.

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

Chlorine's Effectiveness

220. According to the text, 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

221. 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

222. 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

223. The _____ to disinfect decreases, as the concentration of the chlorine increases.

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

224. 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

225. 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

226. 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

227. By adding a little more chlorine to what is already sufficient, this action will generally result in _____that can be measured easily.
- A. pH increases
 - B. Chlorine level and water quality
 - C. Chlorine demand
 - D. Required contact time
 - E. A free chlorine residual
 - F. None of the Above

Chemistry of Chlorination

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

229. 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

230. Under normal water conditions, hypochlorous acid will also chemically react and break down into the hypochlorite ion.
- A. True
 - B. False

231. 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

232. 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

233. The disassociation of chlorine gas
(OCI -): HOCl H⁺ + OCl⁻ Also expressed HOCl → H⁺ + OCl⁻
(hypochlorous acid) (hydrogen) (hypochlorite ion)
- A. True
 - B. False

(S) Means the answer can be plural or singular

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

- A. True B. False

235. 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

236. _____ is all chlorine that is available for disinfection.

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

237. 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

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

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

239. 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

240. 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

241. _____ 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

242. _____ 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

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

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

244. _____ = Concentration (mg/L) x Time (minutes)

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

245. 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

246. 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

247. 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

248. The _____ must be greater than 1.0 to be acceptable.

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

249. 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

250. Which missing 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

251. 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

252. 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

253. What term describes the concentration of residual chlorine in water present as dissolved gas (Cl_2), hypochlorous acid (HOCl), and/or hypochlorite ion (OCl^-).

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

254. 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

255. 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

256. What term 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

257. _____ 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

258. What term describes the total of free residual and combined residual chlorine in a water purification system; 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

259. 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

260. 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

Common Terms

261. 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

262. What term best 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

263. 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

264. 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

265. 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

266. What term best describes the concentration of residual chlorine in water present as dissolved gas (Cl_2), hypochlorous acid (HOCl), and/or hypochlorite ion (OCl^-)?

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

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

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

268. 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

269. 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

270. 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 Cl₂ is the chemical formula.

- A. True
- B. False

271. _____ 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

272. Fusible plug is a safety device that melts. If the temperature of a full Cl₂ cylinder is increased by 50° F or 30° C, a rupture may occur. It will melt at 158 to 165 degrees F. It is found on the side of a 1-ton container and on top of the 150-pound cylinder and is located in the valve below the Valve seat.

- A. True
- B. False

273. What term best describes the addition of Cl₂ to the water until the Cl₂ demand is satisfied. Until all the microorganisms are killed?

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

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

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

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

- A. True B. False

276. What term best describes the total of free residual and combined residual chlorine in a water purification system; used as a monitoring measurement by system operators?

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

277. If chloramines are present in the municipal water supply, then total chlorine should be higher than _____.

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

278. What term best describes the method of water disinfection where gaseous, liquid, or dissolved chlorine is added to a water supply system? Water which has been treated with chlorine is effective in preventing the spread of disease.

- A. Chlorination D. Sterilization
B. Disinfection E. Free chlorine
C. Chlorine Demand F. None of the Above

279. What term best describes the killing of everything?

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

280. Physical and chemical properties of chlorine: A yellowish green, nonflammable and liquefied gas with an unpleasant and irritating smell. It can be readily compressed into a clear, amber-colored liquid, a noncombustible gas, and is a strong oxidizer.

- A. True B. False

281. Hook up the chlorinator to the container or cylinder with the chlorine valve turned off. Use the _____ not the liquid if using a 1-ton container.

- A. Cylinder valve outlet cap D. Safety device
B. Cylinder valve E. Gas side
C. Yoke F. None of the Above

282. Check the valve face for damage after removing the _____ and. Clean with wire brush if necessary. If the valve face is smooth, clean proceed with hooking up the cylinder.

- A. Cylinder valve outlet cap D. Safety device
B. Cylinder valve E. Lead gasket
C. Yoke F. None of the Above

283. According to the text, always check the _____ of the chlorinator and clean if necessary.

- A. Cylinder valve outlet cap
- B. Cylinder valve
- C. Yoke
- D. Inlet face
- E. Gasket
- F. None of the Above

284. Tighten the _____, compressing the gasket one-half to three quarters turn, do not over tighten. Replace the lead gasket with every change out.

- A. Cylinder valve outlet cap
- B. Cylinder valve
- C. Yoke
- D. Safety device
- E. Lead gasket
- F. None of the Above

Chlor-Alkali Membrane Process

285. 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

286. _____ passes across an ion selective membrane leaving the chlorine ion to combine with a second chlorine ion, which makes a chlorine gas bubble at the anode (electrode).

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

287. 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

288. 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

289. 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

290. _____ 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

291. _____ is less effective as the water's pH increases (becomes more alkaline).

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

292. 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

293. 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

294. 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

295. _____ is more effective as water temperature increases.

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

Oxidation Chemistry

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

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

297. One oxidant is chlorine dioxide, which destroys these proteins depriving the cell of its ability to carry out _____ and quickly kills it.

- A. Effects of life
- B. Numerous processes
- C. Functionality
- D. Operations of Cellular amino acids
- E. Fundamental life functions
- F. None of the Above

Chlorine Gas Section

298. When chlorine is added into the water stream, chlorine hydrolyzes into _____.

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

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

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

300. In alkaline conditions, this term becomes the predominant species and lacks the biocidal efficacy of the non-dissociated form.

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

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

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

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

- A. True
- B. False

303. Since this term removes alkalinity, pH depression and system corrosion could occur. In low pH water, the passive metal oxide layers protecting the metal may resolubilize, exposing the surface to corrosion.

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

304. It has been found that. Increased chloride may also have a negative impact on system corrosion. _____ 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 (Cl⁻)
- D. Chlorine gas
- E. Hypochlorous acid (HOCl), and hydrochloric acid (HCl)
- F. None of the Above

305. 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

306. 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

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

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

308. Because chlorine gas is so dangerous, the odor threshold for chlorine is approximately _____; however, distinguishing toxic air levels from permissible air levels may be difficult until irritative symptoms are present.

- 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

309. 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

310. 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

Solubility Effects

311. _____ is highly soluble in water. The predominant targets of the acid are the epithelia of the ocular conjunctivae and upper respiratory mucus membranes.

- A. Hydrochloric acid
- B. H₂SO₄
- C. Hypchloric acid
- D. Sodium hypochlorite solution
- E. Sulfuric Acid
- F. None of the Above

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

- A. Hydrochloric acid
- B. H₂SO₄
- C. Hypchloric acid
- D. Sodium hypochlorite solution
- E. Sulfuric Acid
- F. None of the Above

313. _____ may account for the toxicity of elemental chlorine and hydrochloric acid to the human body.

- A. Hydrochloric acid
- B. H₂SO₄
- C. Hypchloric acid
- D. Hypochlorous acid
- E. Sulfuric Acid
- F. None of the Above

Early Response to Chlorine Gas

314. 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

315. 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

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

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

Pathological Findings

317. Chlorine is a highly reactive gas.

- A. True
- B. False

318. According to the text, treatment plants use _____ to reduce water levels of microorganisms that can spread disease to humans.

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

319. 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

320. 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

321. 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

Exposure

322. There is no threshold value for 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

323. 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

324. Which of the following can liberate toxic gases such as chlorine?

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

Ingestion

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

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

Sources/Uses

326. According to the text, _____ are manufactured by the chlorination of sodium hydroxide or lime.

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

327. Which 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 wastewater purification systems and swimming pools.

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

Calcium Hypochlorite Section

328. 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

329. 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?

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

Description

330. 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.

- A. True
- B. False

331. 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

332. According to the text, _____ 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

333. Which compound's strengths vary so widely and are mostly unknown 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

334. Liquid Sodium hypochlorite and chlorine tablets produce Hypochlorous Acid (HOCl) and _____.

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

Safety

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

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

Corrosion

336. 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

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

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

Health Effects

338. 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

339. 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

340. 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

341. 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

342. 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

343. Sodium hypochlorite solutions liberate toxic gases chlorine or chloramine if mixed with acid or ammonia. Thus, exposure to hypochlorite may involve exposure to these gases.

- A. True
- B. False

Potential Sequelae

344. Exposure to toxic gases generated from hypochlorite solutions can lead to reactive airways dysfunction syndrome (RADS), a chemical irritant-induced type of asthma.

- A. True B. False

Chronic Exposure

345. Chronic dermal can cause dermal irritation due to exposure to this substance.

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

Chlorine-Based Disinfectants Chloramines

Chloramine Disadvantages

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

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

Chloramine Section

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

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

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

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

349. _____ are an effective disinfectant against bacteria but not against viruses. As a result, it is necessary to add more chlorine to the wastewater to prevent the formation of chloramines and form other stronger forms of disinfectants.

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

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

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

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

352. The most common chloramines are _____, dichloramine, and trichloramine.
- A. Free chlorine
 - B. Bichloramine
 - C. Chloramine
 - D. Monochloramine
 - E. Ammonia and chlorine compounds
 - F. None of the Above

Post Chlorination

353. 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

354. 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

Chlorination Equipment Requirement Section

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

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

356. 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

357. Which 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

358. 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

359. Which of the following 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

360. 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

361. 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

362. 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

363. 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

364. 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

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

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

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

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

Standby Provision

367. 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

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

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

Weigh Scales

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

- A. True
- B. False

Securing Cylinders

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

- A. True
- B. False

Chlorine Leak Detection

371. 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

372. 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

373. 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

374. 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

375. 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

376. Chlorine leak detection equipment may not be required for very small chlorine rooms with an exterior door (e.g., floor area less than 3m²).

- A. True B. False

377. You can use a spray solution of ammonia or a rag soaked with sulfur dioxide to detect a small Cl₂ 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

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

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

379. The chlorinator may or may not be located inside _____.

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

Ventilation

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

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

381. Which chlorine safety related equipment term should be louvered near the ceiling, the air being of such temperature as to not adversely affect the chlorination equipment?

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

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

Heating

383. 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

384. 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

385. 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

386. 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

387. 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

388. 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

389. 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

390. 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

391. 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

392. 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

393. 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

394. 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

395. 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

Chlorine Dioxide Section

396. Chlorine gas is educted into a motive water stream in a ClO₂ generator forming?

- A. Hypochlorous acid
- B. HOCl and HCl
- C. Chlorine dioxide
- D. Sodium chlorate (NaClO₃) and sulfuric acid
- E. Sodium thiosulfate
- F. None of the Above

397. Which compound is pumped into the stream and allowed to react in a generating column to produce ClO₂?

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

398. Which of the following compound(s) does not hydrolyze in water as does with chlorine and there is no dissociation of ClO_2 ? This remains fully active in a pH range far broader than chlorine or sodium hypochlorite.

- A. Sodium chlorite (NaClO_2)
- B. Chlorine gas
- C. Chlorine dioxide or ClO_2
- D. Sodium chlorate (NaClO_3)
- E. NaOCl and HCl
- F. None of the Above

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

- A. Sodium chlorite (NaClO_2)
- B. Chlorine gas
- C. Chlorine dioxide or ClO_2
- D. Sodium chlorate (NaClO_3)
- E. NaOCl and HCl
- F. None of the Above

400. Which of the following compound(s) is a dissolved gas in water; there is no mineral acid or caustic soda formation as happens when using HOCl ?

- A. ClO_2
- B. Sodium chlorite (NaClO_2)
- C. Hypochlorous acid
- D. NaOCl and HCl in place of chlorine gas
- E. Heavily pH-dependent
- F. None of the Above

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

- A. ClO_2
- B. Sodium chlorite (NaClO_2)
- C. Hypochlorous acid
- D. NaOCl and HCl in place of chlorine gas
- E. Heavily pH-dependent
- F. None of the Above

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

- A. Sodium chlorite (NaClO_2)
- B. Chlorine gas
- C. Chlorine dioxide or ClO_2
- D. Sodium chlorate (NaClO_3)
- E. NaOCl and HCl
- F. None of the Above

403. Other common methods of generation use _____ in place of chlorine gas..

- A. Chlorine dioxide (ClO_2)
- B. Sodium chlorite (NaClO_2)
- C. Hypochlorous acid
- D. NaOCl and HCl
- E. HOCl and HCl
- F. None of the Above

404. Another and, more recent method of generation uses sulfuric acid and?

- A. Sodium chlorite (NaClO_2)
- B. Chlorine gas
- C. Chlorine dioxide
- D. Sodium chlorate (NaClO_3)
- E. NaOCl and HCl
- F. None of the Above

405. Which of the following compound(s) holds many advantages over chlorine in cooling water systems?

- A. ClO_2
- B. Sodium chlorite (NaClO_2)
- C. Hypochlorous acid
- D. NaOCl and HCl in place of chlorine gas
- E. Sodium chlorate (NaClO_3) and sulfuric acid
- F. None of the Above

406. Which of the following compound(s) is heavily pH-dependent, because as system pH increases, there is a correspondingly rapid decrease in the concentration of the biocidally active species?

- A. Chlorine dioxide (ClO_2)
- B. Sodium chlorite (NaClO_2)
- C. Hypochlorous acid
- D. NaOCl and HCl in place of chlorine gas
- E. Sodium chlorate (NaClO_3) and sulfuric acid
- F. None of the Above

407. Which of the following compound(s) is a non-specific oxidant that readily reacts with various organic and inorganic compounds that may be present in a cooling water system?

- A. Chlorine dioxide (ClO_2)
- B. Sodium chlorite (NaClO_2)
- C. Hypochlorous acid
- D. NaOCl and HCl in place of chlorine gas
- E. Sodium chlorate (NaClO_3) and sulfuric acid
- F. None of the Above

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

- A. ClO_2
- B. Sodium chlorite (NaClO_2)
- C. Hypochlorous acid
- D. NaOCl and HCl in place of chlorine gas
- E. Sodium chlorate (NaClO_3) and sulfuric acid
- F. None of the Above

409. Which of the following compound(s), can be in fact, and be two-and-one-half times more reactive than chlorine?

- A. ClO_2
- B. Sodium chlorite (NaClO_2)
- C. Hypochlorous acid
- D. NaOCl and HCl in place of chlorine gas
- E. Sodium chlorate (NaClO_3) and sulfuric acid
- F. None of the Above

410. _____ as a water disinfectant increased in the 1970s when it was discovered that it did not promote THM formation.

- A. Sulfur Dioxide
- B. Chlorine gas
- C. Chlorine dioxide
- D. Sodium chlorate (NaClO_3) and sulfuric acid
- E. UV
- F. None of the Above

411. Which compound was used in the paper industry, has been an acceptable and effective alternative to chlorination in cooling systems?

- A. Chlorine dioxide (ClO_2)
- B. Sodium chlorite (NaClO_2)
- C. Hypochlorous acid
- D. NaOCl and HCl in place of chlorine gas
- E. Sodium thiosulfate
- F. None of the Above

412. Which compound is a yellow-green gas with an irritating odor not unlike Chlorine?

- A. Sodium thiosulfate
- B. Chlorine
- C. Chlorine dioxide
- D. Sodium chlorate (NaClO_3) and sulfuric acid
- E. Ozone
- F. None of the Above

413. Which compound cannot be compressed and shipped in a container, so it must be generated on site?

- A. Sodium thiosulfate
- B. Chlorine
- C. Chlorine dioxide
- D. Sodium chlorate (NaClO_3) and sulfuric acid
- E. Ozone
- F. None of the Above

414. Which of the following compound(s) under efficient generation, THMs are not formed and THM precursor(s) are reduced?

- A. ClO_2
- B. Sodium chlorite (NaClO_2)
- C. Hypochlorous acid
- D. NaOCl and HCl in place of chlorine gas
- E. Sodium chlorate (NaClO_3) and sulfuric acid
- F. None of the Above

415. 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

416. 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.

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

Water Disinfection Methods Review

417. Water systems add _____ to destroy microorganisms that can cause disease in humans.

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

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

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

419. The following primary methods of disinfection are chlorination, chloramines, ozone, and ultraviolet light. Other disinfection methods include chlorine dioxide, _____.

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

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

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

Physical Methods

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

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

Chemical Methods

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

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

Chlorination and Dechlorination

423. Which of the following compound(s) and some of its derivatives will continue as an integral part of the disinfection process in water and wastewater treatment?

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

pH Scale

424. Alkalinity is the capacity of water to increase acids. This increase is caused by the water's content of carbonate, bicarbonate, hydroxide and occasionally borate, silicate and phosphate.

- A. True
- B. False

Disinfection Rule Review

425. These compounds are called disinfection by-products (DBPs). 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

Alternative Disinfectants Chapter 5 25 Questions

Ultraviolet Disinfection

426. 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

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

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

428. 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

429. 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

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

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

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

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

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

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

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

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

434. 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

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

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

436. 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
- B. UV arayment
- C. UV disinfection
- D. UV reactor
- E. Electromagnetic energy
- F. None of the Above

437. 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

Strongest Oxidizing Agent

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

- A. Chloriamine
- B. Liquid Ozone
- C. Ozone
- D. Oxygen and nascent oxygen
- E. O₂
- F. None of the Above

439. Which compound is a light blue gas at room temperature?

- A. Chloriamine
- B. Liquid Ozone
- C. Ozone
- D. Oxygen and nascent oxygen
- E. O₂
- F. None of the Above

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

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

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

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

442. Ozone falls into the same category as other disinfectants in that it can produce _____.

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

443. Which compound is very unstable and can readily explode?

- A. Chloriamine
- B. Liquid Ozone
- C. Ozone
- D. Oxygen and nascent oxygen
- E. O₂
- F. None of the Above

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

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

Alternate Disinfectants Section Summary

Chloramines

445. Which 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

Chlorine Dioxide

446. Chlorine dioxide may be used for either taste and odor control or as _____.

- A. Post disinfectant
- B. ClO_2 /chlorite/chlorate
- C. An oxidant
- D. Total residual oxidants
- E. A pre-disinfectant
- F. None of the Above

Ozone

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

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

448. 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

449. Ozone does not produce _____ 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

450. 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

Respiratory Protection Section Chapter 6 25 Questions

451. Which definition means a situation that requires the use of respirators due to the unplanned generation of a hazardous atmosphere caused by an accident, mechanical failure, or other means and that requires evacuation of personnel or immediate entry for rescue or corrective action?

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

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

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

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

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

454. Which definition means a filter that is at least 99.97% efficient in removing monodisperse particles of 0.3 micrometers in diameter?

- A. Immediately Dangerous to Life or Health
- B. Interior Structural Firefighting
- C. Hood
- D. Loose-Fitting Facepiece
- E. High-Efficiency Particulate Air (Hepa) Filter
- F. None of the Above

455. Which definition means a respiratory device that is designed for use only during escape from hazardous atmospheres?

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

456. Which definition means a system that warns the respirator user of the approach of the end of adequate respiratory protection; for example, that the sorbent is approaching saturation or is no longer effective?

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

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

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

458. Which definition means a solid, mechanically produced particle with a size ranging from submicroscopic to macroscopic?

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

459. Which definition means a respirator intended to be used only for emergency exit?

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

460. Which definition means a component used in respirators to remove solid or liquid aerosols from the inspired air?

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

461. Which definition means a particulate respirator with a filter as an integral part of the facepiece or with the entire facepiece composed of the filtering medium?

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

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

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

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

- A. True
- B. False

464. Effective training for employees who are required to use respirators is helpful.

- A. True
- B. False

465. The training may be comprehensive, understandable, and recur bi-annually and more often if necessary.

- A. True
- B. False

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

- A. True
- B. False

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

467. Why the respirator is necessary and obtain an improper fit, usage, or maintenance which will compromise the protective effect of the respirator

- A. True
- B. False

468. How to inspect, put on, remove, use, and check the seals of a transmission

- A. True
- B. False

469. What the procedures are for proper maintenance and storage of the respirator

- A. True
- B. False

Retraining shall be conducted annually and when:

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

- A. True
- B. False

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

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

Examples: dust, fumes, mists not containing oil

A. True B. False

Respirators for IDLH atmospheres.

472. The following respirators will be used in IDLH atmospheres:

A full face piece pressure demand SCBA certified by OSHA for a minimum service life of thirty hours.

A. True B. False

The respirators shall be cleaned and disinfected when:

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

A. True B. False

Respirator Inspection

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

A. True B. False

Respirators shall be inspected as follows:

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

A. True B. False

Laboratory Analysis Chapter 7 25 Questions

Sample Procedures

476. The recommended method for detection of somatic and F-specific coliphage in streamwater samples is the single-agar layer (SAL), direct plating method with induction of β (beta)-galactosidase.

A. True B. False

477. In the SAL method, an agar medium, E. coli host culture, chemicals that induce the β (beta)-galactosidase enzyme, and appropriate antibiotics are mixed with 100-mL sample volumes.

A. True B. False

478. Large sample volumes, such as 1-L volumes or greater, are recommended for detection of coliphage in ground water.

A. True B. False

479. The mCP agar method (U.S. Environmental Protection Agency, 1996c) is used to analyze samples for enumeration of _____.

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

480. Using standard MF techniques, _____ are incubated anaerobically for 24 hours at 44.5°C.

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

481. After incubation and exposure of the plates to ammonium hydroxide, all straw-colored colonies that turn dark pink to magenta are counted as _____.

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

482. Analyses for _____ are done with 100-, 30-, and 10-mL volumes of streamwater.

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

483. The recommended method for detection of Cryptosporidium oocysts and Giardia cysts in water is Method 1623 (U.S. Environmental Protection Agency, 1999c).

- A. True
- B. False

QA/QC Activities and Measures

484. QA/QC activities and measures, such as proper sterilization of sample bottles and other equipment, must be taken to reduce contamination.

- A. True
- B. False

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

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

Field personnel should do the following:

486. For every sample by field personnel for total coliform, E. coli, and enterococci analyses, a _____ must be prepared to determine the sterility of equipment and supplies.

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

487. Sample results are suspect if contamination is found from a MF equipment or _____ blank.

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

488. _____ for coliphage, Cryptosporidium, Giardia, and enteric virus samples are different from the MF equipment blanks for bacterial analysis.

- A. Equipment blanks
- B. MF procedure blanks
- C. Sterile working surfaces
- D. Appropriate laboratory equipment
- E. Prepare a MF procedure blank
- F. None of the Above

Quality Assurance and Quality Control in the Laboratory

489. Production analytical laboratories may be evaluated using the following criteria: (1) appropriate and approved methods, (2) documented standard operating procedures, (3) approved quality-assurance plan, (4) fully documented quality control data, (5) participation in the standard reference sample project, (6) scientific capability of personnel, and (7) _____.

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

490. Microbiology laboratories must follow good laboratory practices set forth by the American Public Health Association for cleanliness, safety practices, procedures for _____, and specifications for reagent water quality.

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

Factors in Chlorine Disinfection: Concentration and Contact Time

491. 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

492. 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

493. What are chemical compounds formed by combining a specific ratio of chlorine and ammonia in water. Because chloramines are relatively weak as a disinfectant, they are almost never used as a primary disinfectant?

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

494. Which 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

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

- A. Chlorine dioxide (ClO₂)
- B. Bromate
- C. Chloramine
- D. Ozone
- E. Disinfection compounds
- F. None of the Above

Factors in Chlorine Disinfection: Concentration and Contact Time

496. _____ 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. Many synthetic organic compounds
- E. Neither fluorine nor bromine
- F. None of the Above

Understanding Waterborne Viruses

497. _____ may be present in fecal-contaminated waters.

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

498. The current method for culturing _____ under the ICR (U.S. Environmental Protection Agency, 1996c) is recognized as being difficult to implement; therefore, the ICR does not preclude the use of additional methods for research purposes.

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

499. One method, reverse-transcriptase-polymerase chain reaction (RT-PCR), a gene-probe method that amplifies and recognizes the nucleic acids of _____, has been adequately validated by the USEPA.

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

Sampling Procedures

Streamwater Sample Collection

500. When designing a sampling plan, 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