

Registration form

**Modern Disinfection 2 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*

Name _____ **Signature** _____

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

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Phone:
Home (____) _____ **Work (____)** _____

Operator ID # _____ **Exp Date** _____

Class/Grade _____

Your certificate will be mailed to you in about two weeks.

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

Water Treatment ___ Distribution ___ Collection ___ Wastewater Treatment ___

Other _____

Your certificate will be mailed to you in about two weeks.

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If you've paid on the Internet, Please write your customer# _____

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

DISCLAIMER NOTICE

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

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

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

State Approval Listing URL...

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

You can obtain a printed version of the course manual from TLC for an additional \$79.95 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.

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

Modern Disinfection CEU Course Answer Key

Name _____ Telephone # _____

Please select one answer. You can X, Underline, Bold or Circle the answer.

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

**MODERN DISINFECTION CEU TRAINING COURSE
CUSTOMER SERVICE RESPONSE CARD**

DATE: _____

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.

Modern Disinfection CEU Training Course Assignment

The Modern Disinfectant CEU Assignment is available in Word on the Internet for your convenience. Please visit www.ABCTLC.com and download the assignment and fax or e-mail back the Answer Key to TLC.

You will have 90 days from receipt of this manual 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. If you should need any assistance, please use your Adobe Acrobat search function.

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

Multiple choice questions, select only one answer per question.

Chlorine Timeline

1. 1879 - This marked the first time that chlorine was applied as a _____. William Soper of England treated the feces of typhoid patients before disposal into the sewer.
 - A. Compressed chlorine gas
 - B. Chlorinated lime or chloride of lime
 - C. Disinfectant
 - D. Chlorine gas
 - E. None of the Above
2. 1893- This date was the first time that chlorine was applied as a _____ on a plant scale basis. This application was made at Hamburg, Germany.
 - A. Compressed chlorine gas
 - B. Chlorinated lime or chloride of lime
 - C. Disinfectant
 - D. Chlorine gas
 - E. None of the Above
3. 1903- This marked the first time _____ was used as a disinfectant in drinking water. This took place in Middlekerke, Belgium. Prior to this date, chlorine was applied through the use of hydrated lime, chloride of lime, or bleaching powder.
 - A. Compressed chlorine gas
 - B. Chlorinated lime or chloride of lime
 - C. Disinfectant
 - D. Chlorine gas
 - E. None of the Above
4. 1908- The first full scale chlorine installation at a drinking water plant in the United States was initiated in this year. This installation took place at the Bubbly Creek Filter Plant in Chicago. This plant served the Chicago Stockyards and was designed by George A. Johnson. The raw water contained a large amount of sewage which was causing sicknesses in the livestock. Johnson implemented chlorine through _____, and the bacterial content of the water dropped drastically.
 - A. Compressed chlorine gas
 - B. Chloride of lime
 - C. Disinfectant
 - D. Chlorine gas
 - E. None of the Above

5. 1910- C. R. Darnall became the first to use _____ from steel cylinders, which is an approach still commonly used today. His installation was in Youngstown, Ohio. His implementation used a pressure-reducing mechanism, a metering device, and an absorption chamber. It was moderately successful, but his setup was only used once.

- A. Compressed chlorine gas
- B. Chlorinated lime or chloride of lime
- C. Disinfectant
- D. Chlorine gas
- E. None of the Above

6. 1912- John Kienle, chief engineer of the Wilmington, Delaware water department, invented another way to apply chlorine to drinking water. He developed a way to push _____ from cylinders into an absorption tower in which water was flowing opposite the flow of the chlorine. Because the gas flow was opposite the water flow, the chlorine was able to disinfect the water.

- A. Compressed chlorine
- B. Chlorinated lime or chloride of lime
- C. Disinfectant
- D. Chlorine gas
- E. None of the Above

7. 1913- An Ornstein chlorinator was installed at Kienle's Wilmington, Delaware water treatment plant. This marked the first time a commercial chlorination system was installed at a municipal water treatment plant. The chlorinator used the same basic premise that Kienle's previous installation did, but the Ornstein chlorinator used both a _____ to more accurately control the amount of chlorine added to the system.

- A. Amount and frequency
- B. High and low pressure gauge
- C. Standards dramatically increased
- D. Eliminate taste and odor problems
- E. None of the Above

8. 1914- On October 14, 1914, the Department of the Treasury enacted the first set of standards that required the use of disinfection for drinking water. These standards called for a maximum level of bacterial concentration of 2 coliforms per 100 milliliters. Because chlorination was the main disinfectant at the time, these _____ the number of treatment plants using chlorine.

- A. Amount and frequency
- B. High and low pressure gauge
- C. Standards dramatically increased
- D. Eliminate taste and odor problems
- E. None of the Above

9. 1919- Two important discoveries were made during this year. Wolman and Enslow discovered the concept of chlorine demand which states that the amount of chlorine needed to disinfect the water is related to the concentration of the waste and the amount of time the chlorine has to contact the water. The other important discovery of 1919 was by Alexander Houston. He discovered that chlorine can also _____ in water.

- A. Amount and frequency
- B. High and low pressure gauge
- C. Standards dramatically increased
- D. Eliminate taste and odor problems
- E. None of the Above

10. 1925- New drinking water standards were enacted that reduced the maximum permissible limit of coliforms from 2 to 1 coliform per 100 milliliters. This increased the _____ of chlorination again.

- A. Amount and frequency
- B. High and low pressure gauge
- C. Standards dramatically increased
- D. Eliminate taste and odor problems
- E. None of the Above

11. 1939- The theory of the _____ was discovered in this year.

- A. Chlorine dioxide
- B. Disinfection byproducts
- C. Compound loop principle
- D. Chlorine breakpoint
- E. None of the Above

12. 1960- A new implementation practice was discovered in this year. The _____ of chlorinator control was implemented, which is the most recent major discovery in chlorine application.

- A. Chlorine dioxide
- B. Disinfection byproducts
- C. Compound loop principle
- D. Chlorine breakpoint
- E. None of the Above

13. 1972- A report entitled "Industrial Pollution of the Lower Mississippi River in Louisiana" was published containing the first evidence of _____ in drinking water resulting from organic pollution in source water.

- A. Chlorine dioxide
- B. Disinfection byproducts
- C. Compound loop principle
- D. Chlorine breakpoint
- E. None of the Above

14. As is evident by the dates in the timeline, most of the innovation in _____ occurred over 70 years ago.

- A. Chlorination
- B. Disinfection byproducts
- C. Compound loop principle
- D. Chlorine breakpoint
- E. None of the Above

15. Most of the current research is being performed in other areas of disinfection. These areas include ozone, _____, and UV radiation.

- A. Chlorine dioxide
- B. Disinfection byproducts
- C. Compound loop principle
- D. Chlorine breakpoint
- E. None of the Above

16. _____ is still the most widely used disinfectant in the United States, but other areas of the world are beginning to use other methods of disinfection with increasing frequency.
- A. Chlorine dioxide
 - B. Disinfection byproducts
 - C. Compound loop principle
 - D. Chlorine
 - E. None of the Above
17. Since _____ is still widely used, a thorough understanding of how it disinfects and is implemented is important to those interested in water treatment.
- A. Chlorine
 - B. Disinfection byproducts
 - C. Compound loop principle
 - D. Chlorine breakpoint
 - E. None of the Above
18. A variety of factors come into play in deciding which type of _____ is right for your operation.
- A. Disinfectant system
 - B. Some kind of warning
 - C. Health risks
 - D. Typical safeguards
 - E. None of the Above
19. The decision to install a system could be the result of local concerns and potential to mitigate _____, as well as improved community relations. In any event, the operator of an onsite water or wastewater treatment plant needs to consider some of the safeguards that need to be in place as well.
- A. Disinfectant system
 - B. Some kind of warning
 - C. Health risks
 - D. Typical safeguards
 - E. None of the Above
20. _____ include operator training and instrumentation monitoring that will perform a shutdown function if something goes above a certain level.
- A. Disinfectant system
 - B. Some kind of warning
 - C. Health risks
 - D. Typical safeguards
 - E. None of the Above
21. If you detect an ozone leak, you can do an interconnect and do a plant shutdown. UV has safeguards where you have monitors that tell you what your dosage is, and if you're over or under your dosage it will perform _____ of whatever you want to do."
- A. Disinfectant system
 - B. Some kind of warning
 - C. Health risks
 - D. Typical safeguards
 - E. None of the Above

Modern Water Treatment Disinfectants

22. Many water suppliers add a disinfectant to drinking water to kill germs such as _____ and e coli. Especially after heavy rainstorms, your water system may add more disinfectant to guarantee that these germs are killed.

- A. Chlorine
- B. Chloramine
- C. Chlorine Dioxide
- D. Giardia
- E. None of the Above

23. Some people who use drinking water containing _____ well in excess of EPA's standard could experience irritating effects to their eyes and nose.

- A. Chlorine
- B. Chloramine
- C. Chlorine Dioxide
- D. None of the Above

24. Some people who drink water containing _____ well in excess of the EPA's standard could experience stomach discomfort.

- A. Chlorine
- B. Chloramine
- C. Chlorine Dioxide
- D. Giardia
- E. None of the Above

25. Some people who use drinking water containing _____ well in excess of EPA's standard could experience irritating effects to their eyes and nose.

- A. Chlorine
- B. Chloramines
- C. Chlorine Dioxide
- D. Giardia
- E. None of the Above

26. Some people who drink water containing _____ well in excess of the EPA's standard could experience stomach discomfort or anemia.

- A. Chlorine
- B. Chloramines
- C. Chlorine Dioxide
- D. Giardia
- E. None of the Above

27. Some infants and young children who drink water containing _____ in excess of the EPA's standard could experience nervous system effects.

- A. Chlorine
- B. Chloramine
- C. Chlorine Dioxide
- D. Giardia
- E. None of the Above

28. Similar effects may occur in fetuses of pregnant women who drink water containing _____ in excess of the EPA's standard. Some people may experience anemia.

- A. Chlorine
- B. Chloramine
- C. Chlorine Dioxide
- D. Giardia
- E. None of the Above

29. Disinfectant alternatives will include _____, and Ultraviolet light. You will see an increase of these technologies in the near future.
- A. Haloacetic Acids
 - B. Disinfection Byproducts (DBPS)
 - C. Total Trihalomethanes
 - D. Ozone
 - E. None of the Above
30. _____ form when disinfectants added to drinking water to kill germs react with naturally-occurring organic matter in water.
- A. Haloacetic Acids
 - B. Disinfection Byproducts (DBPS)
 - C. Total Trihalomethanes
 - D. Ozone
 - E. None of the Above
31. Some people who drink water containing _____ in excess of the EPA's standard over many years may experience problems with their liver, kidneys, or central nervous systems, and may have an increased risk of getting cancer.
- A. Haloacetic Acids
 - B. Disinfection Byproducts (DBPS)
 - C. Trihalomethanes
 - D. Ozone
 - E. None of the Above
32. Some people who drink water containing _____ in excess of the EPA's standard over many years may have an increased risk of getting cancer.
- A. Haloacetic Acids
 - B. Disinfection Byproducts (DBPS)
 - C. Total Trihalomethanes
 - D. Ozone
 - E. None of the Above
33. Some people who drink water containing _____ in excess of the EPA's standard over many years may have an increased risk of getting cancer.
- A. Haloacetic Acids
 - B. Disinfection Byproducts (DBPS)
 - C. Total Trihalomethanes
 - D. Bromate
 - E. None of the Above
34. Some infants and young children who drink water containing _____ in excess of the EPA's standard could experience nervous system effects.
- A. Chlorine
 - B. Chlorite
 - C. Chlorine Dioxide
 - D. Giardia
 - E. None of the Above
35. Similar effects may occur in fetuses of pregnant women who drink water containing _____ in excess of the EPA's standard. Some people may experience anemia.
- A. Chlorine
 - B. Chlorite
 - C. Chlorine Dioxide
 - D. Giardia
 - E. None of the Above

36. _____ are formed when disinfectants used in water treatment plants react with bromide and/or natural organic matter (i.e., decaying vegetation) present in the source water.
- A. Trihalomethanes
 - B. Disinfection byproducts
 - C. Chloroform
 - D. Haloacetic Acids
 - E. None of the Above
37. Different disinfectants produce different types or amounts of _____.
- A. Trihalomethanes
 - B. Disinfection byproducts
 - C. Chloroform
 - D. Haloacetic Acids
 - E. None of the Above
38. _____ for which regulations have been established have been identified in drinking water, including trihalomethanes, haloacetic acids, bromate, and chlorite.
- A. Trihalomethanes
 - B. Disinfection byproducts
 - C. Chloroform
 - D. Haloacetic Acids
 - E. None of the Above
39. _____ are a group of four chemicals that are formed along with other disinfection byproducts when chlorine or other disinfectants used to control microbial contaminants in drinking water react with naturally occurring organic and inorganic matter in water.
- A. Trihalomethanes
 - B. Disinfection byproducts
 - C. Chloroform
 - D. Haloacetic Acids
 - E. None of the Above
40. The trihalomethanes are _____, bromodichloromethane, dibromochloromethane, and bromoform.
- A. Trihalomethanes
 - B. Disinfection byproducts
 - C. Chloroform
 - D. Haloacetic Acids
 - E. None of the Above
41. _____ are a group of chemicals that are formed along with other disinfection byproducts when chlorine or other disinfectants used to control microbial contaminants in drinking water react with naturally occurring organic and inorganic matter in water.
- A. Trihalomethanes
 - B. Haloacetic Acids (HAA5)
 - C. Chloroform
 - D. Bromate
 - E. None of the Above
42. The regulated haloacetic acids, known as HAA5, are: monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, and _____.
- A. Trihalomethanes
 - B. Dibromoacetic acid
 - C. Chloroform
 - D. Bromate
 - E. None of the Above

43. _____ is a chemical that is formed when ozone used to disinfect drinking water reacts with naturally occurring bromide found in source water.

- A. Trihalomethanes
- B. Chlorine dioxide
- C. Chloroform
- D. Bromate
- E. None of the Above

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

- A. Trihalomethanes
- B. Chlorine dioxide
- C. Chloroform
- D. Bromate
- E. None of the Above

45. Chlorite is a byproduct formed when _____ is used to disinfect water.

- A. Trihalomethanes
- B. Chlorine dioxide
- C. Chloroform
- D. None of the Above

Microbial Regulations

46. One of the key regulations developed and implemented by the _____ to counter pathogens in drinking water is the Surface Water Treatment Rule.

- A. Maximum Contaminant Level Goal (MCLG)
- B. United States Environmental Protection Agency (USEPA)
- C. Interim Enhanced Surface Water Treatment Rule
- D. Stage 1 Disinfectants/Disinfection Byproducts Rule
- E. None of the Above

47. The _____ was established in December 1998 to control Cryptosporidium, and to maintain control of pathogens while systems lower disinfection byproduct levels to comply with the Stage 1 Disinfectants/Disinfection Byproducts Rule.

- A. Maximum Contaminant Level Goal (MCLG)
- B. United States Environmental Protection Agency (USEPA)
- C. Interim Enhanced Surface Water Treatment Rule
- D. Stage 1 Disinfectants/Disinfection Byproducts Rule
- E. None of the Above

48. The EPA established a _____ of zero for all public water systems and a 99% removal requirement for Cryptosporidium in filtered public water systems that serve at least 10,000 people.

- A. Maximum Contaminant Level Goal (MCLG)
- B. United States Environmental Protection Agency (USEPA)
- C. Interim Enhanced Surface Water Treatment Rule
- D. Stage 1 Disinfectants/Disinfection Byproducts Rule
- E. None of the Above

Microbes

49. _____ are common in the environment and are generally not harmful.

- A. Cryptosporidium
- B. Coliform bacteria
- C. Giardia lamblia
- D. Fecal Coliform
- E. None of the Above

50. The presence of these _____ in drinking water is usually a result of a problem with the treatment system or the pipes which distribute water, and indicates that the water may be contaminated with germs that can cause disease.

- A. Cryptosporidium
- B. Bacteria
- C. Giardia lamblia
- D. Fecal Coliform
- E. None of the Above

51. _____ and E coli are bacteria whose presence indicates that the water may be contaminated with human or animal wastes.

- A. Cryptosporidium
- B. Coliform bacteria
- C. Giardia lamblia
- D. Fecal Coliform
- E. None of the Above

52. _____ in these wastes can cause short-term effects, such as diarrhea, cramps, nausea, headaches, or other symptoms.

- A. Cryptosporidium
- B. Coliform bacteria
- C. Microbes
- D. Fecal Coliform
- E. None of the Above

53. _____ is a parasite that enters lakes and rivers through sewage and animal waste. It causes cryptosporidiosis, a mild gastrointestinal disease.

- A. Cryptosporidium
- B. Coliform bacteria
- C. Giardia lamblia
- D. Fecal Coliform
- E. None of the Above

54. The disease cryptosporidiosis can be severe or fatal for people with severely weakened immune systems. The EPA and CDC have prepared advice for those with severely compromised immune systems who are concerned about _____.

- A. Cryptosporidium
- B. Coliform bacteria
- C. Giardia lamblia
- D. Fecal Coliform
- E. None of the Above

55. _____ is a parasite that enters lakes and rivers through sewage and animal waste. It causes gastrointestinal illness (e.g. diarrhea, vomiting, and cramps).

- A. Cryptosporidium
- B. Coliform bacteria
- C. Giardia lamblia
- D. Fecal Coliform
- E. None of the Above

Chlorine (DDBP)

56. Today, most of our drinking water supplies are free of the micro-organisms — viruses, bacteria, and protozoa — that cause serious and life-threatening diseases, such as _____ fever.
- A. Free available chlorine
 - B. Important group of compounds
 - C. Cholera and typhoid
 - D. Chlorinated derivatives
 - E. None of the Above
57. Living cells react with chlorine and reduce its concentration while they die. The organic matter and other substances that are present, convert to _____, some of which are effective killing agents.
- A. Free available chlorine
 - B. Important group of compounds
 - C. Cholera and typhoid
 - D. Chlorinated derivatives
 - E. None of the Above
58. Chlorine present as Cl , HOCl , and OCl^- is called _____ and that which is bound but still effective is combined chlorine.
- A. Free available chlorine
 - B. Important group of compounds
 - C. Cholera and typhoid
 - D. Chlorinated derivatives
 - E. None of the Above
59. A particularly _____ with combined chlorine is the chloramines formed by reactions with ammonia.
- A. Free available chlorine
 - B. Important group of compounds
 - C. Cholera and typhoid
 - D. Chlorinated derivatives
 - E. None of the Above
60. One especially important _____ using chlorine is the ease of overdosing to create a "residual" concentration.
- A. Free available chlorine
 - B. Feature of disinfection
 - C. Cholera and typhoid
 - D. Chlorinated derivatives
 - E. None of the Above
61. There is a constant danger that safe water leaving the treatment plant may become contaminated later. This _____ concentration of chlorine provides some degree of protection right to the water faucet.
- A. Breakpoint Chlorination
 - B. Chlorination by-products
 - C. Free available chlorine
 - D. Residual
 - E. None of the Above

62. With _____, a typical residual is from 0.1 to 0.5 ppm. Because chlorinated organic compounds are less effective, a typical residual is 2 ppm for combined chlorine.

- A. Breakpoint Chlorination
- B. Chlorination by-products
- C. Free available chlorine
- D. Residual
- E. None of the Above

63. There will be no chlorine residual unless there is an excess over the amount that reacts with the organic matter present. However, reaction kinetics complicates interpretation of chlorination data. The correct excess is obtained in a method called "_____".

- A. Breakpoint Chlorination
- B. Chlorination by-products
- C. Free available chlorine
- D. Residual
- E. None of the Above

Chlorine By-Products

64. _____ are the chemicals formed when the chlorine used to kill disease-causing micro-organisms reacts with naturally occurring organic matter (e.g., decay products of vegetation) in the water.

- A. Breakpoint Chlorination
- B. Chlorination by-products
- C. Free available chlorine
- D. Residual
- E. None of the Above

65. The most common _____ found in U.S. drinking water supplies are the trihalomethanes (THMs).

- A. Breakpoint Chlorination
- B. Chlorination by-products
- C. Free available chlorine
- D. Residual
- E. None of the Above

66. The Principal Trihalomethanes are: Chloroform, bromodichloromethane, chlorodibromomethane, and bromoform. Other less common chlorination by-products includes the _____ and haloacetonitriles.

- A. Haloacetic acids
- B. Chlorination by-products
- C. Free available chlorine
- D. High organic matter concentrations
- E. None of the Above

67. The amount of _____ formed in drinking water can be influenced by a number of factors, including the season and the source of the water.

- A. Trihalomethanes or (THM)
- B. Chlorination by-products
- C. Free available chlorine
- D. High organic matter concentrations
- E. None of the Above

68. THM concentrations are generally lower in winter than in summer, because concentrations of natural _____ are lower and less chlorine is required to disinfect at colder temperatures.

- A. Trihalomethanes or (THM)
- B. Chlorination by-products
- C. Free available chlorine
- D. Organic matter
- E. None of the Above

69. THM levels are also low when wells or large lakes are used as the drinking water source, because _____ are generally low in these sources.

- A. Trihalomethanes or (THM)
- B. Chlorination by-products
- C. Free available chlorine
- D. Organic matter concentrations
- E. None of the Above

70. The opposite — high organic matter concentrations and high _____ levels — is true when rivers or other surface waters are used as the source of the drinking water.

- A. Trihalomethanes or (THM)
- B. Chlorination by-products
- C. Free available chlorine
- D. High organic matter concentrations
- E. None of the Above

Health Effects

71. Laboratory animals exposed to very high levels of _____ have shown increased incidences of cancer.

- A. Trihalomethanes or (THM)
- B. Chlorination by-products
- C. Free available chlorine
- D. High organic matter concentrations
- E. None of the Above

72. Several studies of cancer incidence in human populations have reported associations between long-term exposure to high levels of _____ and an increased risk of certain types of cancer.

- A. Trihalomethanes or (THM)
- B. Chlorination by-products
- C. Free available chlorine
- D. High organic matter concentrations
- E. None of the Above

73. For instance, a recent study conducted in the Great Lakes basin reported an increased risk of bladder and possibly colon cancer in people who drank _____ for 35 years or more.

- A. Trihalomethanes or (THM)
- B. Chlorination by-products
- C. Chlorinated surface water
- D. High organic matter concentrations
- E. None of the Above

74. Possible relationships between exposure to _____ and adverse reproductive effects in humans have also been examined recently.

- A. Chlorination by-products
- B. Disinfected
- C. High levels of THMs
- D. Chlorine dioxide
- E. None of the Above

75. 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 _____ other than THMs.

- A. Chlorination by-products
- B. Disinfected
- C. Chlorine disinfection
- D. Chlorine dioxide
- E. None of the Above

Chlorine Disinfectants/Disinfectant By-Products (DBPs)

76. _____ is a naturally existing element that has been used to disinfect drinking water supplies in America for most of the 20th Century.

- A. Chlorination by-products
- B. Disinfected
- C. Chlorine disinfection
- D. Chlorine
- E. None of the Above

77. _____ has been extremely effective in protecting drinking water resources from bacterial and viral contamination. It has virtually wiped out instances of water-borne diseases like typhoid fever, cholera and dysentery in America and other developed countries.

- A. Chlorination by-products
- B. Disinfected
- C. Chlorine disinfection
- D. Chlorine dioxide
- E. None of the Above

78. Over 200 million Americans currently drink water that has been _____.

- A. Chlorination by-products
- B. Disinfected
- C. Chlorine disinfection
- D. Chlorine dioxide
- E. None of the Above

79. The three primary chemical agents used in chlorine disinfection are: _____, chloramine (chlorine and ammonia bonded together) and chlorine dioxide (chlorine and oxygen bonded together).

- A. Chlorination by-products
- B. Disinfected
- C. Chlorine disinfection
- D. Free Chlorine
- E. None of the Above

80. _____ are very active compounds. When added to a water supply, disinfectants not only kill bacteria and viruses, but also react with other chemicals present in the water. These chemicals generally enter the water supply through natural plant and soil breakdown.

- A. DBPs
- B. Disinfectants
- C. Chlorine dioxide
- D. High concentration level exposure
- E. None of the Above

81. When _____ react with other chemicals, new compounds known as disinfectant by-products or "DBPs", are created. DBPs associated with chlorine disinfection include trihalomethanes (THMs), such as chloroform.

- A. DBPs
- B. Disinfectants
- C. Chlorine dioxide
- D. High concentration level exposure
- E. None of the Above

82. Because chlorination has been used for almost 100 years to disinfect water supplies, approximately 40 percent of the _____ from chlorination have been identified and researched.

- A. DBPs
- B. Disinfectants
- C. Chlorine dioxide
- D. High concentration level exposure
- E. None of the Above

83. Much less is known about the kind of _____ produced by other disinfectants because of their relatively recent emergence.

- A. DBPs
- B. Disinfectants
- C. Chlorine dioxide
- D. High concentration level exposure
- E. None of the Above

84. Use of chloramine or chlorine dioxide in chlorine disinfection produces fewer _____ than chlorine, but each has associated risks.

- A. DBPs
- B. Disinfectants
- C. Chlorine dioxide
- D. High concentration level exposure
- E. None of the Above

85. Chloramine is not as strong a disinfectant as chlorine, and disinfection with _____ produces its own DBPs.

- A. DBPs
- B. Disinfectants
- C. Chlorine dioxide
- D. High concentration level exposure
- E. None of the Above

86. Animal research using high concentration of _____ found increased occurrence of cancer development, although why this occurs has not yet been determined. Research on the relationship between DBPs and cancer and other health risks is ongoing.

- A. DBPs
- B. Disinfectants
- C. Chlorine dioxide
- D. High concentration level exposure
- E. None of the Above

87. American drinking water has very _____ of DBPs.

- A. DBPs
- B. Disinfectants
- C. Chlorine dioxide
- D. Low concentrations
- E. None of the Above

88. The U.S. Environmental Protection Agency (USEPA) has not been able to link exposure to DBPs at low concentration levels and the health risks associated with _____.

- A. DBPs
- B. Disinfectants
- C. Chlorine dioxide
- D. High concentration level exposure
- E. None of the Above

89. The Safe Drinking Water Act Amendments of 1996 required USEPA to comply with the regulatory timeline it set forth in its initial Disinfectant and Disinfectant-By-Product (DDPB) rule and _____.

- A. Interim Enhanced Surface Water Treatment Rule (IESWTR)
- B. DBPs
- C. THMs
- D. Disinfect throughout the distribution system
- E. None of the Above

90. The research on _____ and their impact on public health continues, and serious questions about the actual health risks posed by DBPs still remain.

- A. Interim Enhanced Surface Water Treatment Rule (IESWTR)
- B. DBPs
- C. THMs
- D. Disinfect throughout the distribution system
- E. None of the Above

Risks and Benefits of Chlorine

91. Current evidence indicates that the benefits of chlorinating our drinking water — reduced incidence of water-borne diseases — are much greater than the risks of health effects from _____.

- A. Interim Enhanced Surface Water Treatment Rule (IESWTR)
- B. DBPs
- C. THMs
- D. Disinfect throughout the distribution system
- E. None of the Above

92. Although other disinfectants are available, _____ continues to be the choice of water treatment experts. When used with modern water filtration practices, chlorine is effective against virtually all infective agents — bacteria, viruses, and protozoa.

- A. Ozone
- B. DBPs
- C. Chlorine
- D. Disinfect throughout the distribution system
- E. None of the Above

93. It is easy to apply, and, most importantly, small amounts of chlorine remain in the water and continue to _____. This ensures that the water remains free of microbial contamination on its journey from the treatment plant to the consumer's tap.

- A. Ozone
- B. DBPs
- C. THMs
- D. Disinfect throughout the distribution system
- E. None of the Above

94. A number of cities use _____ to disinfect their source water and to reduce THM formation.

- A. Ozone
- B. Chloramines
- C. THMs
- D. Disinfect throughout the distribution system
- E. None of the Above

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

- A. Ozone
- B. Chloramines
- C. THMs
- D. Disinfect throughout the distribution system
- E. None of the Above

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

- A. Ozone
- B. Chloramines
- C. THMs
- D. Disinfect throughout the distribution system
- E. None of the Above

97. _____ are weaker disinfectants than chlorine, especially against viruses and protozoa; however, they are very persistent and, as such, can be useful for preventing re-growth of microbial pathogens in drinking water distribution systems.

- A. Ozone
- B. Chloramines
- C. THMs
- D. Disinfect throughout the distribution system
- E. None of the Above

98. _____ can be an effective disinfectant, but it forms chlorate and chlorite, compounds whose toxicity has not yet been fully determined.

- A. Ozone
- B. Chloramines
- C. THMs
- D. Chlorine dioxide
- E. None of the Above

99. In general, the preferred method of controlling chlorination by-products is removal of the naturally occurring organic matter from the source water so it cannot react with the _____ to form by-products.

- A. Ozone
- B. Chloramines
- C. THMs
- D. Chlorine
- E. None of the Above

100. _____ levels may also be reduced through the replacement of chlorine with alternative disinfectants. A third option is removal of the by-products by adsorption on activated carbon beds.

- A. Ozone
- B. Chloramines
- C. THMs
- D. Chlorination by-products
- E. None of the Above

101. It is extremely important that water treatment plants ensure that methods used to control _____ do not compromise the effectiveness of water disinfection.

- A. Ozone
- B. Chloramines
- C. THMs
- D. Chlorination by-products
- E. None of the Above

Halogens

102. Before we get started, let's review the halogens. The halogens are a chemical series. They are the elements in Group 17 (old-style: VII or VIIA) of the periodic table: fluorine (F), chlorine (Cl), bromine (Br), iodine (I), astatine (At) and the as yet undiscovered _____.

- A. Ununseptium (Uus)
- B. Simpler substances
- C. One type of atom
- D. Halogen(s)
- E. None of the Above

103. The _____ is the single most unifying concept in chemistry. It is a structured listing of all known elements, or substances, that consist of one type of atom.

- A. Periodic table
- B. Simpler substances
- C. One type of atom
- D. Halogen(s)
- E. None of the Above

104. Elements cannot be reduced to _____.
- A. Ununseptium (Uus)
 - B. Simpler substances
 - C. One type of atom
 - D. Halogen(s)
 - E. None of the Above
105. The term " _____ " means "salt-former" and compounds containing halogens are called "salts".
- A. Ununseptium (Uus)
 - B. Simpler substances
 - C. One type of atom
 - D. Halogen(s)
 - E. None of the Above
106. The word _____ was coined to mean elements which produce salt in union with a metal. It comes from 18th c. scientific French nomenclature based on erring adaptations of Greek roots.
- A. Ununseptium (Uus)
 - B. Simpler substances
 - C. One type of atom
 - D. Halogen(s)
 - E. None of the Above
107. Halogens are highly reactive, and as such can be harmful or lethal to _____ in sufficient quantities.
- A. Chlorine
 - B. Diatomic interhalogen compounds
 - C. Halides
 - D. Halogen(s)
 - E. None of the Above
108. Chlorine and iodine are both used as _____, swimming pools, fresh wounds, dishes, and surfaces.
- A. Chlorine
 - B. Diatomic interhalogen compounds
 - C. Halides
 - D. Halogen(s)
 - E. None of the Above
109. Chlorine and iodine kill bacteria and other _____, a process known as sterilization. Their reactive properties are also put to use in bleaching.
- A. Chlorine
 - B. Diatomic interhalogen compounds
 - C. Halides
 - D. Halogen(s)
 - E. None of the Above
110. _____ is the active ingredient of most fabric bleaches and is used in the production of most paper products.
- A. Chlorine
 - B. Diatomic interhalogen compounds
 - C. Halides
 - D. Halogen(s)
 - E. None of the Above

Halides

111. These elements are _____ in their natural form. They require one more electron to fill their outer electron shells, and so have a tendency to form a singly-charged negative ion.

- A. Chlorine
- B. Diatomic molecules
- C. Halides
- D. Halogen(s)
- E. None of the Above

112. The negative ion is referred to as a _____; salts containing these ions are known as halides.

- A. Chlorine
- B. Diatomic interhalogen compounds
- C. Halide Ion
- D. Halogen(s)
- E. None of the Above

113. Halide ions combined with single hydrogen atoms form the hydrohalic acids (i.e., HF, HCl, HBr, HI), a series of particularly strong acids. (HAt, or "hydrastatic acid", should also qualify, but it is not typically included in discussions of hydrohalic acid due to astatine's extreme instability toward alpha decay.) They react with each other to form _____.

- A. Chlorine
- B. Interhalogen compounds
- C. Halides
- D. Halogen(s)
- E. None of the Above

114. _____ (BrF, ICl, ClF, etc.) bear strong superficial resemblance to the pure halogens. Many synthetic organic compounds such as plastic polymers, and a few natural ones, contain halogen atoms; these are known as halogenated compounds or organic halides.

- A. Chlorine
- B. Diatomic interhalogen compounds
- C. Halides
- D. Halogen(s)
- E. None of the Above

Chlorine

115. Chlorine is by far the most abundant of the halogens, and the only one needed in relatively large amounts (as _____) by humans.

- A. Chloride ions
- B. Diatomic interhalogen compounds
- C. Halides
- D. Halogen(s)
- E. None of the Above

116. Chloride ions play a key role in brain function by mediating the action of the inhibitory transmitter _____ and are also used by the body to produce stomach acid. Iodine is needed in trace amounts for the production of thyroid hormones such as thyroxine.

- A. Chlorine
- B. GABA
- C. Halides
- D. Halogen(s)
- E. None of the Above

117. 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. Chlorine
- B. Fluoride
- C. Halides
- D. Halogen(s)
- E. None of the Above

118. All halogens have 7 electrons in their _____, giving them an oxidation number of -1. The halogens exist, at room temperature, in all three states of matter: Solid- Iodine, Astatine. Liquid- Bromine. Gas- Fluorine, Chlorine

- A. Chlorine
- B. Outer shells
- C. Halides
- D. Halogen(s)
- E. None of the Above

The pH Scale

119. pH: A measure of the acidity of water. The pH scale runs from 0 to 14 with 7 being the mid point or neutral. A pH of less than 7 is on the acid side of the scale with 0 as the point of greatest acid activity. A pH of more than 7 is on the basic (_____) side of the scale with 14 as the point of greatest basic activity.

- A. Alkaline
- B. Logarithmic
- C. Acid or Acidic
- D. Basic activity
- E. None of the Above

120. The _____ of a water sample is measured on a pH scale. This scale ranges from 0 (maximum acidity) to 14 (maximum alkalinity). The middle of the scale, 7, represents the neutral point. The acidity increases from neutral toward 0.

- A. Alkaline or Alkalinity
- B. Logarithmic
- C. Acidity
- D. Basic activity
- E. None of the Above

121. Because the scale is _____, a difference of one pH unit represents a tenfold change. For example, the acidity of a sample with a pH of 5 is ten times greater than that of a sample with a pH of 6. A difference of 2 units, from 6 to 4, would mean that the acidity is one hundred times greater, and so on.

- A. Alkaline or Alkalinity
- B. Logarithmic
- C. Acid or Acidic
- D. Basic activity
- E. None of the Above

122. Normal rain has a pH of 5.6 – slightly _____ because of the carbon dioxide picked up in the earth's atmosphere by the rain.

- A. Alkaline or Alkalinity
- B. Logarithmic
- C. Acidic
- D. Basic activity
- E. None of the Above

Chlorine Exposure Limits and Related Information

123. The current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for chlorine is 1 ppm (3 milligrams per cubic meter ($\text{mg}/\text{m}^{(3)}$)) as a ceiling limit. A worker's _____ shall at no time exceed this ceiling level.

- A. Exposure to chlorine
- B. Unpleasant and irritating smell
- C. Readily compressed
- D. Elemental symbol
- E. None of the Above

124. Physical and chemical properties of chlorine: A yellowish green, nonflammable and liquefied gas with an _____.

- A. Exposure to chlorine
- B. Unpleasant and irritating smell
- C. Readily compressed
- D. Elemental symbol
- E. None of the Above

125. The gas can be _____ into a clear, amber-colored liquid, a noncombustible gas, and a strong oxidizer.

- A. Exposure to chlorine
- B. Unpleasant and irritating smell
- C. Readily compressed
- D. Elemental symbol
- E. None of the Above

126. Solid chlorine is about _____ and gaseous chlorine is about 2.5 times heavier than air.

- A. Exposure to chlorine
- B. Unpleasant and irritating smell
- C. Readily compressed
- D. Elemental symbol
- E. None of the Above

127. Atomic number of chlorine is _____.

- A. Exposure to chlorine
- B. Unpleasant and irritating smell
- C. Readily compressed
- D. Elemental symbol
- E. None of the Above

128. Cl is the elemental symbol and Cl_2 is the _____.

- A. Exposure to chlorine
- B. Unpleasant and irritating smell
- C. Readily compressed
- D. Chemical formula
- E. None of the Above

129. Monochloramine, dichloramine, and trichloramine is also known as _____. $\text{Cl}_2 + \text{NH}_4$.

- A. Exposure to chlorine
- B. Unpleasant and irritating smell
- C. Combined Available Chlorine
- D. Elemental symbol
- E. None of the Above

130. HOCl and OCl⁻; The OCl⁻ is the hypochlorite ion and both of these species are known as free available chlorine. These are the _____. formed by chlorine in water and they are known collectively as hypochlorous acid and the hypochlorite ion.

- A. Exposure to chlorine
- B. Two main chemical species
- C. Readily compressed
- D. Elemental symbol
- E. None of the Above

131. When chlorine gas is added to water, it _____. The chemical equation that best describes this reaction is $\text{Cl}_2 + \text{H}_2\text{O} \rightarrow \text{H}^+ + \text{Cl}^- + \text{HOCl}$.

- A. Exposure to chlorine
- B. Rapidly hydrolyzes
- C. Readily compressed
- D. Elemental symbol
- E. None of the Above

132. Hypochlorous acid is the _____ with the possible exception of chlorine dioxide.

- A. Corrode the teeth
- B. Headaches and dizziness
- C. Most germicidal of the chlorine compounds
- D. Downstream of the evaporator
- E. None of the Above

133. On 1 ton chlorine gas containers, the chlorine pressure reducing valve should be located _____ when using an evaporator. This is the liquid chlorine supply line and it is going to be made into chlorine gas.

- A. Corrode the teeth
- B. Headaches and dizziness
- C. Warn and evacuate people
- D. Downstream of the evaporator
- E. None of the Above

134. Safety precautions when using chlorine gas. In addition to protective clothing and goggles, chlorine gas should be _____ so that any leaking gas cannot concentrate.

- A. Corrode the teeth
- B. Used only in a well ventilated area
- C. Warn and evacuate people
- D. Downstream of the evaporator
- E. None of the Above

135. Emergency procedures in the case of a large uncontrolled chlorine leak are as follows: Notify local emergency response team, _____ in adjacent areas, and be sure that no one enters the leak area without adequate self-contained breathing equipment.

- A. Corrode the teeth
- B. Headaches and dizziness
- C. Warn and evacuate people
- D. Downstream of the evaporator
- E. None of the Above

136. The connection from a chlorine cylinder to a chlorinator should be replaced by using a new, approved gasket on the connector. _____ instructions.

- A. Corrode the teeth
- B. Always follow your manufacturer's
- C. Warn and evacuate people
- D. Downstream of the evaporator
- E. None of the Above

137. Symptoms of chlorine exposure. Burning of eyes, nose, and mouth, coughing, sneezing, choking, nausea and vomiting, _____, fatal pulmonary edema, pneumonia, and skin blisters.

- A. Corrode the teeth
- B. Headaches and dizziness
- C. Warn and evacuate people
- D. Downstream of the evaporator
- E. None of the Above

138. A little Cl₂ gas will _____ and then progress to throat cancer.

- A. Corrode the teeth
- B. Headaches and dizziness
- C. Warn and evacuate people
- D. Downstream of the evaporator
- E. None of the Above

139. Approved method for storing a 150 - 200 pound chlorine cylinder: Secure each cylinder in an upright position, _____ over the valve and firmly secure each cylinder. Never store near heat. Always store the empty in an upright, secure position with proper signage.

- A. Corrode the teeth
- B. Attach the protective bonnet
- C. Warn and evacuate people
- D. Downstream of the evaporator
- E. None of the Above

Chlorine's Appearance and Odor

140. Chlorine is a _____ with a characteristic pungent odor. It condenses to an amber liquid at approximately -34 degrees C (-29.2 degrees F) or at high pressures.

- A. May burst when exposed
- B. Greenish-yellow gas
- C. Olfactory fatigue
- D. Corrosive material
- E. None of the Above

141. Odor thresholds ranging from 0.08 to part per million (ppm) parts of air have been reported. Prolonged exposures may result in _____.

- A. May burst when exposed
- B. Greenish-yellow gas
- C. Olfactory fatigue
- D. Corrosive material
- E. None of the Above

Reactivity

142. Conditions Contributing to Instability: Cylinders of chlorine _____ to elevated temperatures.

- A. May burst when exposed
- B. Greenish-yellow gas
- C. Olfactory fatigue
- D. Corrosive material
- E. None of the Above

143. Chlorine in solution forms a _____.

- A. May burst when exposed
- B. Greenish-yellow gas
- C. Olfactory fatigue
- D. Corrosive material
- E. None of the Above

144. Incompatibilities: Flammable gases and vapors form explosive mixtures with chlorine. Contact between chlorine and many combustible substances (such as gasoline and petroleum products, hydrocarbons, turpentine, alcohols, acetylene, hydrogen, ammonia, and sulfur), reducing agents, and _____ may cause fires and explosions.

- A. Use water spray or fog
- B. Will attack some
- C. Will burn in
- D. Finely divided metals
- E. None of the Above

145. Contact between chlorine and arsenic, bismuth, boron, calcium, activated carbon, carbon disulfide, glycerol, hydrazine, iodine, methane, oxomonoasilane, potassium, propylene, and silicon _____.

- A. Use water spray or fog
- B. Should be avoided
- C. Will burn in
- D. None of the Above

146. Chlorine reacts with hydrogen sulfide and water to form hydrochloric acid, and _____ with carbon monoxide and sulfur dioxide to form phosgene and sulfuryl chloride.

- A. Use water spray or fog
- B. Will attack some
- C. Will burn in
- D. It reacts
- E. None of the Above

147. Chlorine is _____ with moisture, steam, and water.

- A. Use water spray or fog
- B. Will attack some
- C. Will burn in
- D. Also incompatible
- E. None of the Above

148. Special Precautions: Chlorine _____ forms of plastics, rubber, and coatings.

- A. Use water spray or fog
- B. Will attack some
- C. Will burn in
- D. Finely divided metals
- E. None of the Above

149. Flammability: Chlorine is a non-combustible gas. The National Fire Protection Association has assigned a flammability rating of 0 (no fire hazard) to chlorine; however, most combustible materials _____ chlorine.

- A. Use water spray or fog
- B. Will attack some
- C. Will burn in
- D. Finely divided metals
- E. None of the Above

150. Extinguishant: For small fires use water only; do not use dry chemical or carbon dioxide. Contain and let large fires involving chlorine burn. If fire must be fought, _____.

- A. Use water spray or fog
- B. Will attack some
- C. Will burn in
- D. Finely divided metals
- E. None of the Above

151. Fires involving chlorine should be _____ from the maximum distance possible.

- A. Fought upwind
- B. Isolate the hazard area
- C. Ventilate closed spaces
- D. Withdraw from the area
- E. None of the Above

152. Keep unnecessary people away; _____ and deny entry.

- A. Fought upwind
- B. Isolate the hazard area
- C. Ventilate closed spaces
- D. Withdraw from the area
- E. None of the Above

153. For a massive fire in a cargo area, use unmanned hose holders or monitor nozzles; if this is impossible, _____ and let the fire burn.

- A. Self- contained breathing apparatus
- B. Cool fire exposed containers
- C. Ventilate closed spaces
- D. Withdraw from the area
- E. None of the Above

154. Emergency personnel should stay out of low areas and _____ before entering.

- A. Self- contained breathing apparatus
- B. Cool fire exposed containers
- C. Ventilate closed spaces
- D. Withdraw from the area
- E. None of the Above

155. Containers of chlorine may explode in the heat of the fire and should be moved from the fire area if it is possible to do so safely. If this is not possible, _____ from the sides with water until well after the fire is out.

- A. Self- contained breathing apparatus
- B. Cool fire exposed containers
- C. Ventilate closed spaces
- D. Withdraw from the area
- E. None of the Above

156. Stay away from the ends of containers. Firefighters should wear a full set of protective clothing and _____when fighting fires involving chlorine.

- A. Self- contained breathing apparatus
- B. Cool fire exposed containers
- C. Ventilate closed spaces
- D. Withdraw from the area
- E. None of the Above

Chlorine Basics

157. One of the most effective and economical germ-killers, chlorine also destroys and deactivates a wide range of _____in homes, hospitals, swimming pools, hotels, restaurants, and other public places.

- A. Dangerous germs
- B. Disinfectant qualities
- C. Life-threatening infections
- D. Destroying any possible
- E. None of the Above

158. Chlorine's powerful _____come from its ability to bond with and destroy the outer surfaces of bacteria and viruses.

- A. Dangerous germs
- B. Disinfectant qualities
- C. Life-threatening infections
- D. Destroying any possible
- E. None of the Above

159. First used as a germicide to prevent the spread of "child bed fever" in the maternity wards of Vienna General Hospital in Austria in 1846, chlorine has been one of society's most potent weapons against a wide array of _____, viruses, and bacteria for 150 years.

- A. Dangerous germs
- B. Disinfectant qualities
- C. Life-threatening infections
- D. Destroying any possible
- E. None of the Above

160. When the first men to set foot on the moon returned to earth (Apollo 11 mission: 24.7.69) a hypochlorite solution was chosen as one of the disinfectants for _____moon germs.

- A. Dangerous germs
- B. Disinfectant qualities
- C. Life-threatening infections
- D. Destroying any possible
- E. None of the Above

161. When released to air, chlorine will react with water to form hypochlorous acid and hydrochloric acid, which _____from the atmosphere by rainfall.

- A. Not accumulate
- B. Rarely found
- C. Breaks down
- D. Are removed
- E. None of the Above

162. Chlorine is slightly soluble in water. It reacts with water to form hypochlorous acid and hydrochloric acid. The hypochlorous acid _____ rapidly.

- A. Not accumulate
- B. Rarely found
- C. Breaks down
- D. Are removed
- E. None of the Above

163. The hydrochloric acid also _____; its breakdown products will lower the pH of the water (makes it more acidic).

- A. Not accumulate
- B. Rarely found
- C. Breaks down
- D. Are removed
- E. None of the Above

164. Since chlorine is a gas it is _____ in soil. If released to soil, chlorine will react with moisture forming hypochlorous acid and hydrochloric acid. These compounds can react with other substances found in soil.

- A. Not accumulate
- B. Rarely found
- C. Breaks down
- D. Are removed
- E. None of the Above

165. Chlorine does _____ in the food chain.

- A. Not accumulate
- B. Rarely found
- C. Breaks down
- D. Are removed
- E. None of the Above

Disinfectant Qualities

166. Restaurants and meat and poultry processing plants rely on chlorine bleach and other chlorine-based products to kill harmful levels of bacteria such as _____ on food preparation surfaces and during food processing.

- A. Potassium, and magnesium
- B. Yellowish crystalline solid
- C. Chlorine disinfection
- D. Salmonella and E. coli
- E. None of the Above

167. 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 _____ for use in meat and poultry processing facilities.

- A. Potassium, and magnesium
- B. Yellowish crystalline solid
- C. Chlorine disinfection
- D. Salmonella and E. coli
- E. None of the Above

Properties

168. Because it is highly reactive, chlorine is usually found in nature bound with other elements like sodium, _____.

- A. Potassium, and magnesium
- B. Yellowish crystalline solid
- C. Chlorine disinfection
- D. Salmonella and E. coli
- E. None of the Above

169. When chlorine is isolated as a free element, chlorine is a greenish yellow gas, which is 2.5 times heavier than air. It turns to a liquid state at -34°C (-29°F), and it becomes a _____ at -103°C (-153°F).

- A. Potassium, and magnesium
- B. Yellowish crystalline solid
- C. Chlorine disinfection
- D. Salmonella and E. coli
- E. None of the Above

170. Chemists began experimenting with chlorine and chlorine compounds in the 18th century. They learned that chlorine has _____ a chemical bridge between various elements and compounds that would not otherwise react with each other.

- A. Seawater
- B. Chlorine
- C. Organic compounds
- D. Sodium chloride
- E. None of the Above

171. _____ has been especially useful in studying and synthesizing organic compounds -- compounds that have at least one atom of the element carbon in their molecular structure.

- A. Seawater
- B. Chlorine
- C. Organic compounds
- D. Sodium chloride
- E. None of the Above

172. All living organisms, including humans, are composed of _____.

- A. Seawater
- B. Chlorine
- C. Organic compounds
- D. Sodium chloride
- E. None of the Above

173. _____ is one of the most abundant chemical elements on Earth. It is ubiquitous in soils, minerals, plants and animals.

- A. Seawater
- B. Chlorine
- C. Organic compounds
- D. Sodium chloride
- E. None of the Above

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

- A. Seawater
- B. Chlorine
- C. Organic compounds
- D. Sodium chloride
- E. None of the Above

175. _____'s chemical properties have been harnessed innovatively for good use. For example, this element plays a huge role in public health.

- A. Seawater
- B. Chlorine
- C. Organic compounds
- D. Sodium chloride
- E. None of the Above

176. Chlorine-based disinfectants are capable of removing a wide variety of disease-causing germs from _____ as well as from hospital and food production surfaces.

- A. Seawater
- B. Chlorine
- C. Organic compounds
- D. Sodium chloride
- E. None of the Above

Released From the Salt of the Earth

177. Chlorine is produced industrially from the compound _____, one of the many salts found in geologic deposits formed from the slow evaporation of ancient seawater.

- A. Seawater
- B. Chlorine
- C. Organic compounds
- D. Sodium chloride
- E. None of the Above

Co-Products

178. As the reaction demonstrates, chlorine gas cannot be produced without producing caustic soda, so chlorine and caustic soda are known as " _____," and their economics are inextricably linked.

- A. Chlor-alkali
- B. Caustic soda
- C. Co-products
- D. Alkali
- E. None of the Above

179. Caustic soda, also called " _____," is used to produce a wide range of organic and inorganic chemicals and soaps.

- A. Chlor-alkali
- B. Alkali
- C. Caustic soda
- D. Co-products
- E. None of the Above

180. The pulp and paper, alumina and textiles industries use _____ in their manufacturing processes.

- A. Chlor-alkali
- B. Caustic soda
- C. Co-products
- D. Alkali
- E. None of the Above

181. The " _____ " industry obtains two very useful chemicals by applying electrical energy to sea salt.

- A. Chlor-alkali
- B. Alkali
- C. Caustic soda
- D. Co-products
- E. None of the Above

Definitions

182. Chlorine Gas Feed Room

A chlorine gas feed room, for the purposes of this document, is a room that contains the chlorinator(s) and active cylinder(s) _____ at a water or wastewater facility.

- A. Used to apply chlorine gas
- B. Is a room other than a
- C. Chlorine gas feed room
- D. Is the danger of the gas
- E. None of the Above

Chlorine Gas Storage Room

183. A chlorine gas storage room, for the purposes of this document, is a room other than a _____, in which full, partial, or empty chlorine gas cylinders or ton containers are stored at a water or wastewater facility.

- A. Used to apply chlorine gas
- B. Is a room other than a
- C. Chlorine gas feed room
- D. Is the danger of the gas
- E. None of the Above

Gas Chlorinator

184. A gas chlorinator is a device used to meter and control the application rate of chlorine gas into a liquid. There _____ escaping at a water or wastewater treatment facility. The gas chlorinator should be isolated from a water or wastewater treatment plant.

- A. Used to apply chlorine gas
- B. Is a room other than a
- C. Chlorine gas feed room
- D. Is the danger of the gas
- E. None of the Above

Chlorine Cabinet

185. A chlorine cabinet is a pre-assembled or factory built unit that contains the equipment _____ at a water or wastewater treatment facility. It is isolated from a water or wastewater treatment plant.

- A. Used to apply chlorine gas
- B. Is a room other than a
- C. Chlorine gas feed room
- D. Is the danger of the gas
- E. None of the Above

Oxidation

186. The term "oxidation" originally meant a reaction in which oxygen combines chemically with another substance, but its usage has long been broadened to include any reaction in which _____ are transferred.

- A. Oxidation
- B. Reaction
- C. Electrons
- D. Halogen
- E. None of the Above

187. Oxidation and reduction always occur simultaneously (redox _____), and the substance which gains electrons is termed the oxidizing agent.

- A. Oxidation
- B. Reactions
- C. Electrons
- D. Halogen
- E. None of the Above

188. _____ may also be displaced within the molecule without being completely transferred away from it.

- A. Oxidation
- B. Reaction
- C. Electrons
- D. Halogen
- E. None of the Above

189. Partial loss of electrons likewise constitutes _____ in its broader sense and leads to the application of the term to a large number of processes, which at first sight might not be considered to be oxidation.

- A. Electrons
- B. Halogen
- C. Oxidation
- D. One oxidation state
- E. None of the Above

190. Reaction of a hydrocarbon with a halogen, for example, $\text{CH}_4 + 2 \text{Cl} \rightarrow \text{CH}_3\text{Cl} + \text{HCl}$, involves partial _____ of the methane; halogen addition to a double bond is regarded as an oxidation.

- A. Electrons
- B. Halogen
- C. Oxidation
- D. One oxidation state
- E. None of the Above

191. Dehydrogenation is also a form of _____; when two hydrogen atoms, each having one electron, are removed from a hydrogen-containing organic compound by a catalytic reaction with air or oxygen, as in oxidation of alcohol to aldehyde.

- A. Oxidation
- B. One oxidation state
- C. Electrons
- D. Halogen
- E. None of the Above

Oxidation Number

192. The number of electrons that must be added to or subtracted from an atom in a combined state to convert it to the elemental form; i.e., in barium chloride (BaCl₂) the _____ number of barium is +2 and of chlorine is -1.

- A. Oxidation
- B. One oxidation state
- C. Electrons
- D. Halogen
- E. None of the Above

193. Many elements can exist in more than _____.

- A. Oxidation
- B. One oxidation state
- C. Electrons
- D. Halogen
- E. None of the Above

Chemistry of Chlorination

194. Chlorine can be added as _____, calcium hypochlorite or chlorine gas. When any of these is added to water, chemical reactions occur as these equations show:

- A. Hypochlorous acid
- B. Calcium hydroxide
- C. Sodium hypochlorite
- D. Hypochlorite ion
- E. None of the Above

195. $Cl_2 + H_2O = HOCl + HCl$

(chlorine gas) (water) (_____) (hydrochloric acid)

- A. Hypochlorous acid
- B. Calcium hydroxide
- C. Sodium hypochlorite
- D. Hypochlorite ion
- E. None of the Above

196. $CaOCl_2 + H_2O = 2HOCl + Ca(OH)_2$

(calcium hypochlorite) (water) (_____) (calcium hydroxide)

- A. Hypochlorous acid
- B. Calcium hydroxide
- C. Sodium hypochlorite
- D. None of the Above

197. $NaOCl + H_2O = HOCl + Na(OH)$

(sodium hypochlorite) (water) (_____) (sodium hydroxide)

- A. Hypochlorous acid
- B. Hypochlorite ion
- C. Calcium hydroxide
- D. Sodium hypochlorite
- E. None of the Above

198. All three forms of chlorine produce _____ when added to water. Hypochlorous acid is a weak acid but a strong disinfecting agent.

- A. Hypochlorous acid
- B. Hypochlorite ion
- C. Calcium hydroxide
- D. Sodium hypochlorite
- E. None of the Above

199. The amount of _____ depends on the pH and temperature of the water. Under normal water conditions, hypochlorous acid will also chemically react and break down into a hypochlorite ion.

- A. Hypochlorous acid
- B. Hypochlorite ion
- C. Calcium hydroxide
- D. Sodium hypochlorite
- E. None of the Above

200. (OCI^-) : $\text{HOCl} = \text{H}^+ + \text{OCI}^-$ Also expressed $\text{HOCl} = \text{H}^+ + \text{OCI}^-$ (hypochlorous acid) (hydrogen) (_____)

- A. Hypochlorous acid
- B. Hypochlorite ion
- C. Calcium hydroxide
- D. Sodium hypochlorite
- E. None of the Above

201. The hypochlorite ion is a much weaker disinfecting agent than _____, about 100 times less effective.

- A. Hypochlorite ion
- B. Calcium hydroxide
- C. Hypochlorous acid
- D. None of the Above

202. Let's now look at how pH and temperature affect the ratio of hypochlorous acid to hypochlorite ions. As the temperature is decreased, the ratio of _____ increases.

- A. Hypochlorite ion
- B. Calcium hydroxide
- C. Sodium hypochlorite
- D. Hypochlorous acid
- E. None of the Above

203. 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. Hypochlorite ion
- B. Calcium hydroxide
- C. Sodium hypochlorite
- D. Hypochlorous acid
- E. None of the Above

204. All other things being equal, higher _____ and a lower pH are more conducive to chlorine disinfection.

- A. Hypochlorite ion
- B. Calcium hydroxide
- C. Sodium hypochlorite
- D. Hypochlorous acid
- E. None of the Above

Types of Residual

205. If water were pure, the measured _____ in the water should be the same as the amount added. But water is not 100% pure.

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

206. There are always other substances (_____) such as iron, manganese, turbidity, etc., which will combine chemically with the chlorine.

- A. Free chlorine residual
- B. Total residual
- C. Interfering agents
- D. Amount of chlorine
- E. None of the Above

207. This is called the chlorine demand. Naturally, once chlorine molecules are combined with these interfering agents, they are not capable of disinfection. It is _____ that is much more effective as a disinfecting agent.

- A. Free chlorine residual or Free chlorine
- B. Total residual
- C. Combined chlorine residual
- D. Amount of chlorine
- E. None of the Above

208. So let's look now at how free, total and combined chlorine are related. When a chlorine residual test is taken, either a total or a _____ can be read.

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

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

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

210. Total chlorine residual = free + _____.

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

211. _____ 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 residual
- B. Total residual
- C. Combined chlorine residual
- D. Amount of chlorine
- E. None of the Above

212. Break-point chlorination is where the chlorine demand has been satisfied, and any additional chlorine will be considered _____.

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

Residual Concentration/Contact Time (CT) Requirements

213. _____ to eliminate fecal and coliform bacteria may not be sufficient to adequately reduce pathogens such as Giardia or viruses to desired levels.

- A. Concentration
- B. CT or CTs
- C. Residual
- D. Disinfection
- E. None of the Above

214. Use of the "CT" _____ concept is recommended to demonstrate satisfactory treatment, since monitoring for very low levels of pathogens in treated water is analytically very difficult.

- A. Concentration
- B. CT or CTs
- C. Residual
- D. Disinfection
- E. None of the Above

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

- A. Concentration
- B. CT or CTs
- C. Residual
- D. Disinfection
- E. None of the Above

216. The _____ is measured at the end of the process, and the contact time used is the T10 of the process unit (time for 10% of the water to pass).

- A. Residual
- B. Disinfection
- C. Concentration
- D. CT or CTs
- E. None of the Above

217. $CT = \text{_____ (mg/L)} \times \text{Time (minutes)}$

- A. Concentration
- B. CT or CTs
- C. Residual
- D. Disinfection
- E. None of the Above

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

- A. Residual
- B. Disinfection
- C. Concentration
- D. CT or CTs
- E. None of the Above

Required Giardia/Virus Reduction

219. All surface water treatment systems _____ in pathogen levels:
3-log reduction in Giardia; and 4-log reduction in viruses.

- A. Based on unpolluted raw water sources
- B. May require greater removals
- C. Are dependent on pH
- D. Shall ensure a minimum reduction
- E. None of the Above

220. These requirements are _____ with Giardia levels of = 1 cyst/100 L, and a finished water goal of 1 cyst/100,000 L (equivalent to 1 in 10,000 risk of infection per person per year).

- A. Shall ensure a minimum reduction
- B. Based on unpolluted raw water sources
- C. May require greater removals
- D. Are dependent on pH
- E. None of the Above

221. Higher raw water contamination levels _____.

- A. Shall ensure a minimum reduction
- B. Based on unpolluted raw water sources
- C. May require greater removals
- D. Are dependent on pH
- E. None of the Above

Required CT Value

222. Required CT values are _____, and the disinfectant used.

- A. Dependent on pH, residual concentration, temperature
- B. Based on unpolluted raw water sources
- C. May require greater removals
- D. Are dependent on pH
- E. None of the Above

Calculation and Reporting of CT Data

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

- A. Concentration
- B. CT or CTs
- C. Residual
- D. None of the Above

224. Actual CT values are then compared to required _____ values.

- A. CT or CTs
- B. Residual
- C. Disinfection
- D. Concentration
- E. None of the Above

225. Results shall be reported as a _____ Ratio, along with the appropriate pH, temperature, and disinfectant residual. The reduction Ratio must be greater than 1.0 to be acceptable.

- A. CT or CTs
- B. Reduction
- C. Disinfection
- D. None of the Above

226. Users may also calculate and record _____. Reduction Ratio = CT actual divide by CT required.

- A. CT or CTs
- B. Actual log reductions
- C. Disinfection
- D. Concentration
- E. None of the Above

Chlorine Review

227. _____: 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. Combined Chlorine Residual
- C. Chlorine Residual
- D. Concentration
- E. None of the Above

228. _____: The concentration of chlorine in the water after the chlorine demand has been satisfied.

- A. Chlorine Demand
- B. Combined Chlorine Residual
- C. Chlorine Residual
- D. Concentration
- E. None of the Above

229. The concentration is normally expressed in terms of _____, which includes both the free and combined or chemically bound chlorine residuals.

- A. Chlorine Demand
- B. Total Chlorine Residual
- C. Chlorine Residual
- D. Concentration
- E. None of the Above

230. _____: The amount of chlorine used up in a water purification system; used as a monitoring measurement by system operators.

- A. Chlorine Demand
- B. Combined Chlorine Residual
- C. Chlorine Residual
- D. Concentration
- E. None of the Above

231. _____ is defined as 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 Demand
- B. Combined Chlorine
- C. Chlorine Residual
- D. Concentration
- E. None of the Above

232. Ammonia is sometimes deliberately added to chlorinated public water supplies to provide inorganic _____.

- A. Chloramines
- B. Total Chlorine Residual
- C. Combined chlorine
- D. Pre-chlorination
- E. None of the Above

233. Free Chlorine: Free chlorine is defined as the concentration of _____ in water present as dissolved gas (Cl_2), hypochlorous acid (HOCl), and/or hypochlorite ion (OCl^-). The three forms of free chlorine exist together in equilibrium.

- A. Chloramines
- B. Residual chlorine
- C. Combined chlorine
- D. Pre-chlorination
- E. None of the Above

234. Regardless of whether _____ is practiced or not, 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. Chloramines
- B. Total Chlorine Residual
- C. Combined chlorine
- D. Pre-chlorination
- E. None of the Above

235. _____: The total of free residual and combined residual chlorine in a water purification system; used as a monitoring measurement by system operators.

- A. Chloramines
- B. Total Chlorine Residual
- C. Combined chlorine
- D. Pre-chlorination
- E. None of the Above

236. Total chlorine is the sum of free and _____.

- A. Chloramines
- B. Total Chlorine Residual
- C. Combined chlorine
- D. Pre-chlorination
- E. None of the Above

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

- A. Chloramines
- B. Total Chlorine
- C. Combined chlorine
- D. Pre-chlorination
- E. None of the Above

238. When _____ are present in the municipal water supply, then total chlorine will be higher than free chlorine.

- A. Chloramines
- B. Total Chlorine Residual
- C. Combined chlorine
- D. Pre-chlorination
- E. None of the Above

239. _____: The 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 growths.

- A. Chloramines
- B. Total Chlorine Residual
- C. Combined chlorine
- D. Pre-chlorination
- E. None of the Above

240. _____: The addition of chlorine after a process or adding chlorine downstream to meet a demand in the system.

- A. Sterilization
- B. Breakpoint chlorination
- C. Disinfection
- D. Post Chlorination
- E. None of the Above

241. _____ means adding Cl₂ to the water until the Cl₂ demand is satisfied. Until all the microorganisms are killed.

- A. Sterilization
- B. Breakpoint chlorination
- C. Disinfection
- D. Chlorination
- E. None of the Above

242. _____: A 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. Sterilization
- B. Breakpoint chlorination
- C. Disinfection
- D. Chlorination
- E. None of the Above

243. The _____ of public drinking supplies was originally met with resistance, as people were concerned about the health effects of the practice.

- A. Sterilization
- B. Breakpoint chlorination
- C. Disinfection
- D. Chlorination
- E. None of the Above

244. The use of chlorine has greatly reduced the _____ as it is effective against almost all bacteria and viruses, as well as amoeba.

- A. Sterilization
- B. Breakpoint chlorination
- C. Disinfection
- D. Chlorination
- E. None of the Above

245. _____ kills everything.

- A. Sterilization
- B. Breakpoint chlorination
- C. Disinfection
- D. Chlorination
- E. None of the Above

246. Chlorine reacts with bacteria as if it was _____ and burns the skin or covering killing the bacteria.

- A. Very corrosive
- B. Breakpoint chlorination
- C. Disinfection
- D. Chlorination
- E. None of the Above

247. The sample must be taken within the distribution system of your PWS. If you take it before the distribution system you will not get an accurate reading. The sample must be taken at the same tap that you take the _____.

- A. Bac-t sample
- B. Breakpoint chlorination
- C. Disinfection
- D. Chlorination
- E. None of the Above

Chlor-Alkali Membrane Process

248. The _____ occurs in a cell containing electrodes submerged in solutions called electrolytes.

- A. Low voltage direct current (DC)
- B. Electrolysis
- C. Electrode
- D. Membrane
- E. None of the Above

249. One _____ is referred to as the anode and is submerged in a salt water solution.

- A. Low voltage direct current (DC)
- B. Electrode
- C. Membrane
- D. Electrolysis
- E. None of the Above

250. The second electrode is the _____ and is submerged in a sodium hydroxide (caustic soda) solution.

- A. Low voltage direct current (DC)
- B. Cathode
- C. Membrane
- D. None of the Above

251. A membrane is used to keep the two different solutions from mixing. This particular method of producing chlorine is called the chlor-alkali _____ process.

- A. Low voltage direct current (DC)
- B. Electrode
- C. Membrane
- D. Electrolysis
- E. None of the Above

252. When a _____ power supply is applied to the electrodes in the cell, the sodium and chlorine ions in the brine are attracted in opposite directions to the polarized electrodes.

- A. Low voltage direct current (DC)
- B. Electrolysis
- C. Electrode
- D. Membrane
- E. None of the Above

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

- A. Chlorine gas bubble
- B. Electrolysis
- C. Electrode
- D. Membrane
- E. None of the Above

254. When the sodium crosses the membrane, it combines with a _____ at the cathode (electrode) making sodium hydroxide, or caustic soda (NaOH).

- A. Hydroxyl ion
- B. Electrolysis
- C. Electrode
- D. Membrane
- E. None of the Above

255. The hydroxyl ion originates from the _____ at the cathode where hydrogen gas also develops.

- A. Dissolution of water
- B. Electrolysis
- C. Electrode
- D. Membrane
- E. None of the Above

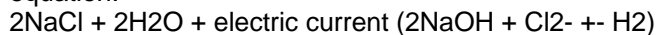
256. The membrane in the cell keeps the two solutions separate; otherwise, the chlorine gas bubble would immediately combine with the _____, or bleach.

- A. Caustic soda forming sodium hypochlorite
- B. Electrolysis
- C. Electrode
- D. Membrane
- E. None of the Above

257. This process, which uses a membrane to separate the _____, is called the chlor-alkali process.

- A. Two solutions
- B. Electrolysis
- C. Electrode
- D. Membrane
- E. None of the Above

258. The _____ for the chlor-alkali process is illustrated in the following equation:



- A. Chemical equation
- B. Electrolysis
- C. Electrode
- D. Membrane
- E. None of the Above

Chlorine's Effectiveness

259. As the concentration of the chlorine _____, the required contact time to disinfect decreases.

- A. Increases
- B. Decreases
- C. Reacts
- D. None of the Above

260. Chlorination is more effective as water temperature _____.

- A. Increases
- B. Decreases
- C. Reacts
- D. Combines
- E. None of the Above

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

- A. Increases
- B. Decreases
- C. Reacts
- D. Combines
- E. None of the Above

262. Chlorination is less _____ in cloudy (turbid) water.

- A. Increases
- B. Effective
- C. Reacts
- D. Combines
- E. None of the Above

263. When chlorine is _____ to the water supply, part of it combines with other chemicals in water (like iron, manganese, hydrogen sulfide, and ammonia) and is not available for disinfection.

- A. Increases
- B. Decreases
- C. Reacts
- D. Added
- E. None of the Above

264. The amount of chlorine that _____ with the other chemicals plus the amount required to achieve disinfection is the chlorine demand of the water.

- A. Increases
- B. Decreases
- C. Reacts
- D. Combines
- E. None of the Above

Chlorine Gas, some of these questions seem to repeat.

265. Background: Chlorine gas is a pulmonary irritant with intermediate water solubility that causes _____ in the upper and lower respiratory tract.

- A. Acute damage
- B. Few breaths
- C. Extremely reactive
- D. It burns
- E. None of the Above

266. Chlorine is a yellowish-green gas at standard temperature and pressure. It is _____ with most elements.

- A. Acute damage
- B. Few breaths
- C. It burns
- D. Extremely reactive
- E. None of the Above

267. Because its density is greater than that of air, the gas settles low to the ground. It is a respiratory irritant, and _____ the skin.
- A. Acute damage
 - B. Few breaths
 - C. Extremely reactive
 - D. It burns
 - E. None of the Above
268. Just a _____ of Cl₂ gas is fatal.
- A. Acute damage
 - B. Few breaths
 - C. Extremely reactive
 - D. It burns
 - E. None of the Above
269. Cl₂ gas _____ occur naturally, although Chlorine can be found in a number of compounds.
- A. Acute damage
 - B. Few breaths
 - C. Does not occur
 - D. It burns
 - E. None of the Above
270. Chlorine gas is likely the most widely used _____.
- A. Oxidizing microbiocide
 - B. Biocide of choice
 - C. Strong oxidizer
 - D. Hydrolyzes or hydrolyzation
 - E. None of the Above
271. Chlorine gas has traditionally been the _____ in many cooling water treatment systems.
- A. Oxidizing microbiocide
 - B. Biocide of choice
 - C. Strong oxidizer
 - D. Hydrolyzes or hydrolyzation
 - E. None of the Above
272. Chlorine gas is a _____ that is relatively easy to feed and is quite inexpensive.
- A. Oxidizing microbiocide
 - B. Biocide of choice
 - C. Strong oxidizer
 - D. Hydrolyzes or hydrolyzation
 - E. None of the Above
273. Upon chlorine gas introduction into the water stream, chlorine _____ into hypochlorous acid (HOCl) and hydrochloric acid (HCl).
- A. Oxidizing microbiocide
 - B. Strong oxidizer
 - C. Hydrolyzes
 - D. Biocide of choice
 - E. None of the Above

274. This _____ provides the active toxicant, HOCl, which is pH-dependent.
- A. Oxidizing microbiocide
 - B. Biocide of choice
 - C. Strong oxidizer
 - D. Hydrolization
 - E. None of the Above
275. In alkaline cooling systems, it readily dissociates to form the _____.
- A. Hypochlorite ion (OCl⁻)
 - B. Higher pH
 - C. Non-selective
 - D. HOCl
 - E. None of the Above
276. This dissociation phenomenon is important to remember when working with systems that will operate at a _____.
- A. Hypochlorite ion (OCl⁻)
 - B. Higher pH
 - C. Non-selective
 - D. HOCl
 - E. None of the Above
277. In alkaline conditions, OCl⁻ becomes the predominant species and lacks the biocidal efficacy of the non-dissociated form. Considerably more _____ is present at a pH of 7.0 than at pH 8.5.
- A. Hypochlorite ion (OCl⁻)
 - B. Higher pH
 - C. Non-selective
 - D. HOCl
 - E. None of the Above
278. It is also widely known that chlorine is _____, making it very sensitive to contamination from either cooling water makeup or from in-plant process leaks.
- A. Hypochlorite ion (OCl⁻)
 - B. Higher pH
 - C. Non-selective
 - D. HOCl
 - E. None of the Above
279. Ammonia, organic acids and organic compounds, sulfides, iron and manganese all easily react with _____.
- A. Hypochlorite ion (OCl⁻)
 - B. Higher Ph
 - C. Non-selective
 - D. HOCl
 - E. None of the Above
280. The amount of chlorine needed to react with these contamination species is referred to as chlorine demand and it must be satisfied before active _____ is available to provide a free chlorine residual.
- A. Hypochlorite ion (OCl⁻)
 - B. Higher Ph
 - C. Non-selective
 - D. HOCl
 - E. None of the Above

281. The combination of high chlorine demand in process-contaminated systems and the dissociation process in _____ systems creates the need for greater chlorine feed to obtain the same microbial efficacy.

- A. Hypochlorite ion (OCl⁻)
- B. Alkaline
- C. Non-selective
- D. HOCl
- E. None of the Above

282. Since HCl removes alkalinity, pH depression and system corrosion could occur. In _____ the passive metal oxide layers protecting the metal may resolubilize, exposing the surface to corrosion.

- A. Increased chloride
- B. Low pH water
- C. Free mineral acidity
- D. Deactivated
- E. None of the Above

283. At _____ (pH <4.3), many passivating inhibitors become ineffective, and corrosion will proceed rapidly.

- A. Free mineral acidity
- B. Increased chloride
- C. Low pH water
- D. Deactivated
- E. None of the Above

284. _____ may also have a negative impact on system corrosion.

- A. Increased chloride
- B. Low pH water
- C. Deactivated
- D. None of the Above

285. The _____ ion (Cl⁻) can damage or penetrate the passive oxide layer, leading to localized damage of the metal surface.

- A. Chloride
- B. Low pH water
- C. Free mineral acidity
- D. Deactivated
- E. None of the Above

286. High chlorine concentrations have also been shown to directly attack traditional organic-based corrosion inhibitors. When these inhibitors are " _____," the metal surface would then be susceptible to corrosion.

- A. Increased chloride
- B. Low pH water
- C. Deactivated
- D. None of the Above

Pathophysiology

287. Chlorine is a greenish-yellow, _____ gas at room temperature and atmospheric pressure.

- A. Airway symptoms
- B. Exposure time
- C. Accounts for its effect
- D. Noncombustible
- E. None of the Above

288. The intermediate water solubility of chlorine accounts for its effect on the upper _____ and the lower respiratory tract.

- A. Airway
- B. Exposure time
- C. Accounts for its effect
- D. Noncombustible
- E. None of the Above

289. Exposure to chlorine gas may be prolonged because its moderate water solubility may not cause upper _____ for several minutes.

- A. Airway symptoms
- B. Exposure time
- C. Accounts for its effect
- D. Noncombustible
- E. None of the Above

290. In addition, the density of the gas is greater than that of air, causing it to remain near ground level and increasing _____.

- A. Airway symptoms
- B. Exposure time
- C. Accounts for its effect
- D. Noncombustible
- E. None of the Above

291. The odor threshold for chlorine is approximately 0.3-0.5 parts per million (ppm); however, _____ air levels from permissible air levels may be difficult until irritative symptoms are present.

- A. Distinguishing toxic
- B. Exposure time
- C. Accounts for its effect
- D. Noncombustible
- E. None of the Above

Mechanism of Activity

292. The mechanisms of the above biological activity are poorly understood and the predominant anatomic site of injury may vary, depending on the _____ produced.

- A. Hypochlorous acid
- B. Free oxygen radicals
- C. Chemical species
- D. Targets of the acid
- E. None of the Above

293. Cellular injury is believed to result from the oxidation of functional groups in cell components, from reactions with tissue water to form hypochlorous and hydrochloric acid, and from the generation of _____.

- A. Hypochlorous acid
- B. Free oxygen radicals
- C. Chemical species
- D. Targets of the acid
- E. None of the Above

Solubility Effects

294. _____ is highly soluble in water.

- A. Hypochlorous acid
- B. Free oxygen radicals
- C. Chemical species
- D. Targets of the acid
- E. None of the Above

295. The predominant _____ are the epithelia of the ocular conjunctivae and upper respiratory mucus membranes.

- A. Hypochlorous acid
- B. Free oxygen radicals
- C. Chemical species
- D. Targets of the acid
- E. None of the Above

296. _____ is also highly water soluble with an injury pattern similar to hydrochloric acid.

- A. Hypochlorous acid
- B. Free oxygen radicals
- C. Chemical species
- D. Targets of the acid
- E. None of the Above

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

- A. Hypochlorous acid
- B. Free oxygen radicals
- C. Chemical species
- D. Targets of the acid
- E. None of the Above

Early Response to Chlorine Gas

298. Chlorine gas, when mixed with ammonia, reacts to form chloramine gas. In the presence of water, _____ and hypochlorous acid or hydrochloric acid.

- A. Pulmonary congestion
- B. Chloramines decompose to ammonia
- C. Response to chlorine exposure
- D. None of the Above

299. The early _____ depends on the (1) concentration of chlorine gas, (2) duration of exposure, (3) water content of the tissues exposed, and (4) individual susceptibility.

- A. Pulmonary congestion
- B. Chloramines decompose to ammonia
- C. Response to chlorine exposure
- D. Acute inflammation
- E. None of the Above

Immediate Effects

300. The immediate effects of chlorine gas toxicity include _____ of the conjunctivae, nose, pharynx, larynx, trachea, and bronchi.

- A. Pulmonary congestion
- B. Chloramines decompose to ammonia
- C. Response to chlorine exposure
- D. Acute inflammation
- E. None of the Above

301. Irritation of the airway mucosa leads to _____ to active arterial and capillary hyperemia.

- A. Pulmonary congestion
- B. Chloramines decompose to ammonia
- C. Local edema secondary
- D. Acute inflammation
- E. None of the Above

302. Plasma exudation results in filling the alveoli with edema fluid, resulting in _____.

- A. Pulmonary congestion
- B. Chloramines decompose to ammonia
- C. Response to chlorine exposure
- D. Acute inflammation
- E. None of the Above

Pathological Findings

303. Pathologic findings are nonspecific. They include severe pulmonary edema, pneumonia, hyaline membrane formation, multiple _____, and ulcerative tracheobronchitis.

- A. Pulmonary thromboses
- B. Pulmonary injury
- C. Pulmonary edema
- D. None of the Above

304. The hallmark of _____ associated with chlorine toxicity is pulmonary edema, manifested as hypoxia.

- A. Pulmonary thromboses
- B. Pulmonary injury
- C. Pulmonary edema
- D. None of the Above

305. Noncardiogenic _____ is thought to occur when there is a loss of pulmonary capillary integrity.

- A. Pulmonary thromboses
- B. Pulmonary injury
- C. Pulmonary edema
- D. None of the Above

306. The chlorination of water supplies and polluted waters _____ to destroy or deactivate disease-producing microorganisms.

- A. Carcinogenic chloro-organic compounds
- B. Adverse effects
- C. Resulting from the reaction
- D. Serves primarily
- E. None of the Above

307. A secondary benefit, particularly in treating drinking water, is the overall improvement in water quality resulting from the reaction of chlorine with ammonia, iron, manganese, sulfide, and some _____ substances.

- A. Organic
- B. Adverse effects
- C. Resulting from the reaction
- D. Serves primarily
- E. None of the Above

308. Chlorination may produce _____.
- A. Carcinogenic chloro-organic compounds
 - B. Adverse effects
 - C. Resulting from the reaction
 - D. Serves primarily
 - E. None of the Above
309. Taste and odor characteristics of phenols and other _____ present in a water supply may be intensified.
- A. Organic compounds
 - B. Adverse effects
 - C. Resulting from the reaction
 - D. Serves primarily
 - E. None of the Above
310. Potentially _____ such as chloroform may be formed.
- A. Carcinogenic chloro-organic compounds
 - B. Adverse effects
 - C. Resulting from the reaction
 - D. Serves primarily
 - E. None of the Above
311. Combined chlorine formed on _____ of ammonia- or amine-bearing waters adversely affects some aquatic life.
- A. Chloramines
 - B. Chlorination
 - C. Hypochlorous acid
 - D. Chlorine-to-nitrogen ratio
 - E. None of the Above
312. To fulfill the primary purpose of _____ and to minimize any adverse effects, it is essential that proper testing procedures be used with a foreknowledge of the limitations of the analytical determination.
- A. Chloramines
 - B. Chlorination
 - C. Hypochlorous acid
 - D. Chlorine-to-nitrogen ratio
 - E. None of the Above
313. Chlorine applied to water in its molecular or hypochlorite form initially undergoes hydrolysis to form free chlorine consisting of aqueous molecular chlorine, _____, and hypochlorite ion.
- A. Chloramines
 - B. Chlorination
 - C. Hypochlorous acid
 - D. Chlorine-to-nitrogen ratio
 - E. None of the Above
314. The relative proportion of these free chlorine forms is pH- and temperature-dependent. At the pH of most waters, _____ and hypochlorite ion will predominate.
- A. Chloramines
 - B. Chlorination
 - C. Hypochlorous acid
 - D. Chlorine-to-nitrogen ratio
 - E. None of the Above

315. Free chlorine reacts readily with ammonia and certain nitrogenous compounds to form combined chlorine. With ammonia, chlorine reacts to form the _____: monochloramine, dichloramine, and nitrogen trichloride.

- A. Chloramines
- B. Chlorination
- C. Hypochlorous acid
- D. Chlorine-to-nitrogen ratio
- E. None of the Above

316. The presence and concentrations of these combined forms depend chiefly on pH, temperature, initial _____, absolute chlorine demand, and reaction time. Both free and combined chlorine may be present simultaneously.

- A. Chloramines
- B. Chlorination
- C. Hypochlorous acid
- D. Chlorine-to-nitrogen ratio
- E. None of the Above

317. Combined chlorine in water supplies may be formed in the treatment of raw waters containing ammonia or by the addition of _____.

- A. Sodium Hypochlorite
- B. Ammonia or ammonium salts
- C. Increases the pH of the water
- D. Chlorine
- E. None of the Above

318. Chlorinated wastewater effluents, as well as certain _____ industrial effluents, normally contain only combined chlorine.

- A. Sodium Hypochlorite
- B. Ammonia or ammonium salts
- C. Increases the pH of the water
- D. Chlorinated
- E. None of the Above

319. Historically the principal analytical problem has been to distinguish between free and combined forms of _____.

- A. Sodium Hypochlorite
- B. Ammonia or ammonium salts
- C. Increases the pH of the water
- D. Chlorine
- E. None of the Above

Sodium Hypochlorite Section

320. The world's most universal and reliable means of water and wastewater disinfection is _____.

- A. Sodium Hypochlorite
- B. Ammonia or ammonium salts
- C. Increases the pH of the water
- D. Chlorination
- E. None of the Above

321. Two fundamental methods include gas chlorination (Cl_2) and liquid chlorination (NaOCl) otherwise known as _____.

- A. Sodium Hypochlorite
- B. Ammonia or ammonium salts
- C. Increases the pH of the water
- D. Chlorine
- E. None of the Above

322. Sodium hypochlorite (NaOCl) is a solution made from reacting _____ with a sodium hydroxide solution.

- A. Sodium Hypochlorite
- B. Ammonia or ammonium salts
- C. Increases the pH of the water
- D. Chlorine
- E. None of the Above

323. These two reactants are the major co-products from most chlor-alkali cells.

_____ has a variety of uses and is an excellent disinfectant/antimicrobial agent.

- A. Sodium Hypochlorite
- B. Ammonia or ammonium salts
- C. Increases the pH of the water
- D. Chlorine
- E. None of the Above

324. Sodium hypochlorite also significantly _____.

- A. Sodium Hypochlorite
- B. Ammonia or ammonium salts
- C. Increases the pH of the water
- D. Chlorine
- E. None of the Above

325. When sodium hypochlorite is used, it must be counterbalanced by a strong acid like sodium bisulfate or muriatic acid to keep the _____ within the ideal range.

- A. Sodium Hypochlorite
- B. Ammonia or ammonium salts
- C. pH
- D. Chlorine
- E. None of the Above

326. The hypochlorite form of chlorine _____. The most widely used form of hypochlorite is the liquid, sodium hypochlorite (NaOCl), with more than 150 tons per day consumed in the United States.

- A. Differs from
- B. Be gravity-fed
- C. Equally susceptible
- D. Has been used since 1850
- E. None of the Above

327. Sodium hypochlorite application in cooling water _____ the same as with gas chlorine; HOCl is produced as the active toxicant.

- A. Differs from
- B. Be gravity-fed
- C. Is essentially
- D. Widely used
- E. None of the Above

328. The HOCl is _____ to process contamination, has the same chlorine demand as gas chlorine and displays the same tendency to dissociate.

- A. Differs from
- B. Be gravity-fed
- C. Equally susceptible
- D. Widely used
- E. None of the Above

329. Sodium hypochlorite _____ chlorine gas in two respects: method of feed and hydrolization properties.

- A. Differs from
- B. Be gravity-fed
- C. Equally susceptible
- D. Widely used
- E. None of the Above

330. Sodium hypochlorite can either _____ or applied with a metering pump. The latter is generally recognized as a consistently more accurate method.

- A. Differs from
- B. Be gravity-fed
- C. Equally susceptible
- D. Widely used
- E. None of the Above

331. The second difference, in hydrolysis, lies in the end products. The _____ reaction with water liberates sodium hydroxide (NaOH).

- A. NaOH or Sodium hydroxide
- B. pH
- C. NaOCl Or Sodium hypochlorite
- D. 'liqueur de Javel'
- E. None of the Above

332. The addition of _____ differs in that it tends to add alkalinity to the water. In large concentrations it may artificially elevate pH, leading to precipitation of calcium carbonate.

- A. NaOH or Sodium hydroxide
- B. pH
- C. NaOCl Or Sodium hypochlorite
- D. 'liqueur de Javel'
- E. None of the Above

333. While NaOCl eliminates low _____ corrosion as a concern, the use of large quantities in contaminated systems still introduces a high concentration of the chloride ion, which can be very aggressive to cooling system metals.

- A. NaOH or Sodium hydroxide
- B. pH
- C. NaOCl Or Sodium hypochlorite
- D. 'liqueur de Javel'
- E. None of the Above

334. Many of the other problems associated with chlorine remain present with _____.

- A. NaOH or Sodium hydroxide
- B. pH
- C. NaOCl Or Sodium hypochlorite
- D. 'liqueur de Javel'
- E. None of the Above

When was Sodium Hypochlorite Discovered?

335. Sodium hypochlorite has a long history. Around 1785 the Frenchman Berthollet developed liquid bleaching agents based on _____.

- A. NaOH or Sodium hydroxide
- B. pH
- C. NaOCl Or Sodium hypochlorite
- D. 'liqueur de Javel'
- E. None of the Above

336. The Javel company introduced this product and called it _____. At first, it was used to bleach cotton. Because of its specific characteristics it soon became a popular compound. Hypochlorite can remove stains from clothes at room temperature.

- A. NaOH or Sodium hydroxide
- B. pH
- C. NaOCl Or Sodium hypochlorite
- D. 'liqueur de Javel'
- E. None of the Above

337. In France, sodium hypochlorite is still known as _____.

- A. NaOH or Sodium hydroxide
- B. pH
- C. NaOCl Or Sodium hypochlorite
- D. 'Eau de Javel'
- E. None of the Above

Characteristics of Sodium hypochlorite

338. Sodium hypochlorite is a clear, slightly yellowish solution with a _____.

- A. Oxidation
- B. Sodium hypochlorite
- C. Chlorine or Chlorine gas
- D. Hypochlorous acid
- E. None of the Above

339. _____ has a relative density of is 1,1 (5,5% watery solution).

- A. Oxidation
- B. Sodium hypochlorite
- C. Chlorine or Chlorine gas
- D. Hypochlorous acid
- E. None of the Above

340. As a bleaching agent for domestic use it usually contains 5% _____ (with a pH of around 11, it is irritating). If it is more concentrated, it contains a concentration 10-15% sodium hypochlorite (with a pH of around 13, it burns and is corrosive).

- A. Oxidation
- B. Sodium hypochlorite
- C. Chlorine or Chlorine gas
- D. Hypochlorous acid
- E. None of the Above

341. _____ is unstable.

- A. Oxidation
- B. Sodium hypochlorite
- C. Chlorine or Chlorine gas
- D. Hypochlorous acid
- E. None of the Above

342. _____ evaporates at a rate of 0,75 gram active chlorine per day from the solution. Then heated sodium hypochlorite disintegrates.

- A. Oxidation
- B. Sodium hypochlorite
- C. Chlorine
- D. Hypochlorous acid
- E. None of the Above

343. This also happens when sodium hypochlorite comes in contact with acids, sunlight, certain metals and poisonous and corrosive gasses, including _____.

- A. Oxidation
- B. Sodium hypochlorite
- C. Chlorine gas
- D. Hypochlorous acid
- E. None of the Above

344. Sodium hypochlorite is a strong _____ and reacts with flammable compounds and reducers.

- A. Oxidator
- B. Sodium hypochlorite
- C. Chlorine or Chlorine gas
- D. Hypochlorous acid
- E. None of the Above

345. _____ solution is a weak base that is inflammable. These characteristics must be kept in mind during transport, storage and use of sodium hypochlorite.

- A. Oxidation
- B. Sodium hypochlorite
- C. Chlorine or Chlorine gas
- D. Hypochlorous acid
- E. None of the Above

346. When sodium hypochlorite dissolves in water, two substances form, which play a role in _____ and disinfection.

- A. Oxidation
- B. Sodium hypochlorite
- C. Chlorine or Chlorine gas
- D. Hypochlorous acid
- E. None of the Above

347. These are hypochlorous acid (HOCl) and the less active hypochlorite ion (OCl⁻). The pH of the water determines how much _____ is formed.

- A. Oxidation
- B. Sodium hypochlorite
- C. Chlorine or Chlorine gas
- D. Hypochlorous acid
- E. None of the Above

348. While _____ is used, acetic acid (HCl) is used to lower the pH.

- A. Oxidation
- B. Sodium hypochlorite
- C. Chlorine or Chlorine gas
- D. Sulfuric acid
- E. None of the Above

349. _____ can be used as an alternative for acetic acid.

- A. Oxidation
- B. Sodium hypochlorite
- C. Chlorine or Chlorine gas
- D. Sulfuric acid
- E. None of the Above

350. Less harmful gasses are produced when _____ is used.

- A. Oxidation
- B. Sulfuric acid
- C. Chlorine or Chlorine gas
- D. Hypochlorous acid
- E. None of the Above

351. _____ is a strong acid that strongly reacts with bases and is very corrosive.

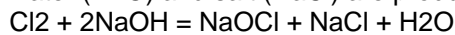
- A. Oxidation
- B. Sulfuric acid
- C. Chlorine or Chlorine gas
- D. Hypochlorous acid
- E. None of the Above

Sodium hypochlorite can be produced in two ways:

352. By dissolving salt in softened water, which results in a concentrated brine solution. The solution is electrolyzed and forms a _____ solution in water. This solution contains 150 g active chlorine (Cl₂) per liter. During this reaction the explosive hydrogen gas is also formed.

- A. Sodium hypochlorite
- B. Caustic soda (NaOH)
- C. Ammonia (NH₃)
- D. Chlorine
- E. None of the Above

353. By adding chlorine gas (Cl₂) to caustic soda (NaOH). When this is done, _____, water (H₂O) and salt (NaCl) are produced according to the following reaction:



- A. Sodium hypochlorite
- B. Caustic soda (NaOH)
- C. Ammonia (NH₃)
- D. Chlorine
- E. None of the Above

354. Hypochlorite neutralizes sulphur hydrogen gas (SH) and _____.

- A. Sodium hypochlorite Or Hypochlorite
- B. Caustic soda (NaOH)
- C. Ammonia (NH₃)
- D. Chlorine
- E. None of the Above

355. _____ is also used to detoxify cyanide baths in metal industries.

- A. Hypochlorite
- B. Caustic soda (NaOH)
- C. Ammonia (NH₃)
- D. Chlorine
- E. None of the Above

356. _____ can be used to prevent algae and shellfish growth in cooling towers.

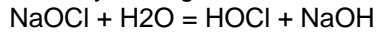
- A. Hypochlorite
- B. Caustic soda (NaOH)
- C. Ammonia (NH₃)
- D. Chlorine
- E. None of the Above

357. In water treatment, hypochlorite is used to disinfect water. In households, _____ is used frequently for the purification and disinfection of the house.

- A. Hypochlorite
- B. Caustic soda (NaOH)
- C. Ammonia (NH₃)
- D. Chlorine
- E. None of the Above

How does Sodium Hypochlorite Disinfection Work?

358. By adding _____ to water, hypochlorous acid (HOCl) is formed:



- A. Hypochlorite
- B. Hypochlorous acid (HOCl)
- C. Ammonia (NH₃)
- D. Chlorine
- E. None of the Above

359. _____ is divided into hydrochloric acid (HCl) and oxygen (O). The oxygen atom is a very strong oxidator.

- A. Sodium hypochlorite Or Hypochlorite
- B. Hypochlorous acid (HOCl)
- C. Ammonia (NH₃)
- D. Chlorine
- E. None of the Above

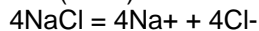
360. _____ is effective against bacteria, viruses and fungi.

- A. Sodium hypochlorite
- B. Hypochlorous acid (HOCl)
- C. Ammonia (NH₃)
- D. Chlorine
- E. None of the Above

361. _____ disinfects the same way as chlorine does.

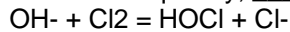
- A. Sodium hypochlorite
- B. Hypochlorous acid (HOCl)
- C. Ammonia (NH₃)
- D. Chlorine
- E. None of the Above

362. There are various ways to use sodium hypochlorite. For _____, a solution of salt (NaCl) in water is applied. Sodium (Na⁺) and chloride (Cl⁻) ions are produced.



- A. Sodium hypochlorite Or Hypochlorite
- B. Salt electrolysis
- C. Ammonia (NH₃)
- D. Chlorine
- E. None of the Above

363. Subsequently, _____ and hydroxide react to form hypochlorite:



- A. Sodium hypochlorite Or Hypochlorite
- B. Hypochlorous acid (HOCl)
- C. Ammonia (NH₃)
- D. Chlorine
- E. None of the Above

Salt Electrolysis System

364. The advantage of the _____ is that no transport or storage of sodium hypochlorite is required.

- A. Lower pH
- B. Salt electrolysis system
- C. Hypochlorous acid
- D. Sodium hypochlorite
- E. None of the Above

365. When _____ is stored for a long time, it becomes inactive.

- A. Lower pH
- B. Salt electrolysis system
- C. Hypochlorous acid
- D. Sodium hypochlorite
- E. None of the Above

366. Another advantage of the on site process is that chlorine lowers the pH and no other acid is required to _____.

- A. Lower pH
- B. Salt electrolysis system
- C. Hypochlorous acid
- D. Sodium hypochlorite
- E. None of the Above

367. The hydrogen gas that is produced is explosive and as a result ventilation is required for explosion prevention. This system is slow and a buffer of extra _____ needs to be used.

- A. Lower pH
- B. Salt electrolysis system
- C. Hypochlorous acid
- D. Sodium hypochlorite
- E. None of the Above

368. The maintenance and purchase of the _____ is much more expensive than sodium hypochlorite.

- A. Lower pH
- B. Electrolysis system
- C. Hypochlorous acid
- D. Sodium hypochlorite
- E. None of the Above

369. When _____ is used, acetic or sulphuric acid are added to the water. An overdose can produce poisonous gasses.

- A. Lower pH
- B. Salt electrolysis system
- C. Hypochlorous acid
- D. Sodium hypochlorite
- E. None of the Above

370. If the dosage is too low, the _____ becomes too high and can irritate the eyes.

- A. pH
- B. Salt electrolysis system
- C. Hypochlorous acid
- D. None of the Above

371. Because _____ is used both to oxidize pollutions (urine, sweat, cosmetics) and to remove pathogenic microorganisms, the required concentration of sodium hypochlorite depends on the concentrations of these pollutions.

- A. Lower pH
- B. Salt electrolysis system
- C. Hypochlorous acid
- D. Sodium hypochlorite
- E. None of the Above

372. The amount of _____ helps determine the required concentration. If the water is filtered before sodium hypochlorite is applied, less sodium hypochlorite is needed.

- A. Lower pH
- B. Organic pollution
- C. Hypochlorous acid
- D. None of the Above

Theory

373. Disinfection with chlorine is very popular in water and wastewater treatment because of its low cost, ability to form a residual, and its effectiveness at low concentrations. Although it is used as a _____, it is a dangerous and potentially fatal chemical if used improperly.

- A. Disinfectant
- B. Chlorination
- C. Free chlorine
- D. Ammonia
- E. None of the Above

374. Despite the fact the _____ process may seem simple; it is actually a quite complicated process.

- A. Disinfection
- B. Chlorination
- C. Free chlorine
- D. Ammonia
- E. None of the Above

375. _____ in wastewater treatment systems is a fairly complex science which requires knowledge of the plant's effluent characteristics.

- A. Disinfectant or disinfection
- B. Chlorination
- C. Free chlorine
- D. Ammonia
- E. None of the Above

376. When _____ is added to the wastewater, it takes on various forms depending on the pH of the wastewater.

- A. Disinfectant or disinfection
- B. Chlorination
- C. Free chlorine
- D. Ammonia
- E. None of the Above

377. It is important to understand the forms of _____ which are present because each has a different disinfecting capability. The acid form, HOCL, is a much stronger disinfectant than the hypochlorite ion, OCL⁻.

- A. Disinfectant or disinfection
- B. Chlorination
- C. Chlorine
- D. Ammonia
- E. None of the Above

378. _____ present in the effluent can also cause problems as chloramines are formed, which have very little disinfecting power.

- A. Disinfectant or disinfection
- B. Chlorination
- C. Free chlorine
- D. Ammonia
- E. None of the Above

379. Some methods to overcome the types of chlorine formed are to adjust the _____ of the wastewater prior to chlorination or to simply add a larger amount of chlorine.

- A. Disinfectant or disinfection
- B. Chlorination
- C. pH
- D. Ammonia
- E. None of the Above

380. An adjustment in the _____ would allow the operators to form the most desired form of chlorine, hypochlorous acid, which has the greatest disinfecting power.

- A. Disinfectant or disinfection
- B. Chlorination
- C. pH
- D. Ammonia
- E. None of the Above

Routes of Exposure

381. Hypochlorite solutions can liberate _____ such as chlorine.

- A. Toxic gases
- B. Odor or irritant properties
- C. Low-level exposures
- D. Heavier than air
- E. None of the Above

382. Chlorine's _____ generally provide adequate warning of hazardous concentrations.

- A. Toxic gases
- B. Odor or irritant properties
- C. Low-level exposures
- D. Heavier than air
- E. None of the Above

383. Prolonged, _____, such as those that occur in the workplace, can lead to olfactory fatigue and tolerance of chlorine's irritant effects.

- A. Toxic gases
- B. Odor or irritant properties
- C. Low-level exposures
- D. Heavier than air
- E. None of the Above

384. Chlorine is _____ and may cause asphyxiation in poorly ventilated, enclosed, or low-lying areas.

- A. Toxic gases
- B. Odor or irritant properties
- C. Low-level exposures
- D. Heavier than air
- E. None of the Above

385. Children exposed to the same levels of gases as adults may receive a larger dose because they _____ area/body weight ratios and higher minute volumes/weight ratios.

- A. Toxic gases
- B. Odor or irritant properties
- C. Have greater lung surface
- D. Heavier than air
- E. None of the Above

386. Children may be more vulnerable to _____ than adults because of the smaller diameter of their airways. In addition, they may be exposed to higher levels than adults in the same location because of their short stature and the higher levels of chlorine found nearer to the ground.

- A. Hypochlorite
- B. Corrosive agents
- C. Metabolic acidosis
- D. Aspiration
- E. None of the Above

Skin/Eye Contact

387. Direct contact with _____ solutions, powder, or concentrated vapor causes severe chemical burns, leading to cell death and ulceration.

- A. Hypochlorite
- B. Corrosive agents
- C. Metabolic acidosis
- D. Aspiration
- E. None of the Above

388. Because of their relatively larger surface _____, children are more vulnerable to toxicants affecting the skin.

- A. Hypochlorite
- B. Corrosive agents
- C. Area/weight ratio
- D. Aspiration
- E. None of the Above

Ingestion

389. Ingestion of _____ solutions causes vomiting and corrosive injury to the gastrointestinal tract.

- A. Hypochlorite
- B. Corrosive agents
- C. Metabolic acidosis
- D. Aspiration
- E. None of the Above

390. Household bleaches (3 to 6% sodium _____) usually cause esophageal irritation, but rarely cause strictures or serious injury such as perforation.

- A. Hypochlorite
- B. Corrosive agents
- C. Metabolic acidosis
- D. Aspiration
- E. None of the Above

391. _____ may contain higher concentrations of sodium hypochlorite and are more likely to cause serious injury.

- A. Hypochlorite
- B. Corrosive agents
- C. Commercial bleaches
- D. Aspiration
- E. None of the Above

392. _____ is rare, but has been reported following the ingestion of household bleach.

- A. Hypochlorite
- B. Corrosive agents
- C. Metabolic acidosis
- D. Aspiration
- E. None of the Above

393. Pulmonary complications resulting from _____ may also be seen after ingestion.

- A. Hypochlorite
- B. Corrosive agents
- C. Metabolic acidosis
- D. Aspiration
- E. None of the Above

Sources/Uses

394. Sodium and _____ are manufactured by the chlorination of sodium hydroxide or lime.

- A. Calcium hypochlorite
- B. Sodium hypochlorite
- C. Chlorine
- D. Household bleaches
- E. None of the Above

395. Sodium and calcium hypochlorite are used primarily as oxidizing and _____ or disinfectants.

- A. Calcium hypochlorite
- B. Sodium hypochlorite
- C. Chlorine
- D. Bleaching agents
- E. None of the Above

396. Dosage is simple; transport and storage of _____ are safe.

- A. Calcium hypochlorite
- B. Sodium hypochlorite
- C. Chlorine
- D. Household bleaches
- E. None of the Above

397. _____ is as effective as chlorine gas for disinfection.

- A. Calcium hypochlorite
- B. Sodium hypochlorite
- C. Chlorine
- D. Household bleaches
- E. None of the Above

398. _____ produces residual disinfectant.

- A. Calcium hypochlorite
- B. Sodium hypochlorite
- C. Chlorine
- D. Household bleaches
- E. None of the Above

Disadvantages

399. _____ is a dangerous and corrosive substance. While working with sodium hypochlorite, safety measures have to be taken to protect workers and the environment.

- A. Calcium hypochlorite
- B. Sodium hypochlorite
- C. Chlorine
- D. Household bleaches
- E. None of the Above

400. Sodium hypochlorite should not come in contact with _____, because that will cause it to disintegrate.

- A. Calcium hypochlorite
- B. Sodium hypochlorite
- C. Chlorine
- D. Household bleaches
- E. None of the Above

You are finished with the assignment, please fax or e-mail the answer key to us and always call afterwards to ensure we received it. Thank you for your business.