

**Registration form**

**WWT SYSTEM OPERATOR TRAINING COURSE \$200.00  
48 HOUR RUSH ORDER PROCESSING FEE ADDITIONAL \$50.00**

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

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

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

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

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

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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.

No Refunds.

# WWT SYSTEM OPERATOR CEU Course Answer Key

Name \_\_\_\_\_

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

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

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

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

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

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

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*Please circle, underline, bold or X only one correct answer  
A felt tipped pen works best*

- |             |             |             |             |
|-------------|-------------|-------------|-------------|
| 1. A B      | 18. A B C D | 35. A B C D | 52. A B C D |
| 2. A B      | 19. A B C D | 36. A B C D | 53. A B C D |
| 3. A B      | 20. A B C D | 37. A B C D | 54. A B C D |
| 4. A B      | 21. A B C D | 38. A B C D | 55. A B C D |
| 5. A B      | 22. A B C D | 39. A B C D | 56. A B C D |
| 6. A B      | 23. A B C D | 40. A B C D | 57. A B C D |
| 7. A B      | 24. A B C D | 41. A B C D | 58. A B C D |
| 8. A B      | 25. A B C D | 42. A B C D | 59. A B C D |
| 9. A B      | 26. A B C D | 43. A B     | 60. A B C D |
| 10. A B     | 27. A B C D | 44. A B     | 61. A B C D |
| 11. A B C D | 28. A B C D | 45. A B     | 62. A B C D |
| 12. A B C D | 29. A B C D | 46. A B     | 63. A B C D |
| 13. A B C D | 30. A B C D | 47. A B     | 64. A B C D |
| 14. A B C D | 31. A B C D | 48. A B C D | 65. A B C D |
| 15. A B C D | 32. A B C D | 49. A B C D | 66. A B C D |
| 16. A B C D | 33. A B C D | 50. A B C D | 67. A B C D |
| 17. A B C D | 34. A B C D | 51. A B C D | 68. A B C D |

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|--------------|--------------|--------------|--------------|
| 69. A B C D  | 101. A B C D | 133. A B     | 165. A B     |
| 70. A B C D  | 102. A B C D | 134. A B C D | 166. A B     |
| 71. A B C D  | 103. A B     | 135. A B C D | 167. A B C D |
| 72. A B C D  | 104. A B     | 136. A B     | 168. A B C D |
| 73. A B C D  | 105. A B     | 137. A B     | 169. A B C D |
| 74. A B C D  | 106. A B     | 138. A B     | 170. A B     |
| 75. A B C D  | 107. A B     | 139. A B     | 171. A B     |
| 76. A B C D  | 108. A B     | 140. A B     | 172. A B C D |
| 77. A B C D  | 109. A B     | 141. A B     | 173. A B C D |
| 78. A B C D  | 110. A B     | 142. A B     | 174. A B C D |
| 79. A B C D  | 111. A B     | 143. A B     | 175. A B C D |
| 80. A B C D  | 112. A B     | 144. A B     | 176. A B C D |
| 81. A B C D  | 113. A B     | 145. A B     | 177. A B C D |
| 82. A B C D  | 114. A B     | 146. A B     | 178. A B C D |
| 83. A B C D  | 115. A B     | 147. A B     | 179. A B C D |
| 84. A B C D  | 116. A B     | 148. A B     | 180. A B C D |
| 85. A B C D  | 117. A B     | 149. A B     | 181. A B C D |
| 86. A B C D  | 118. A B     | 150. A B C D | 182. A B C D |
| 87. A B C D  | 119. A B     | 151. A B C D | 183. A B C D |
| 88. A B C D  | 120. A B     | 152. A B C D | 184. A B C D |
| 89. A B C D  | 121. A B     | 153. A B C D | 185. A B C D |
| 90. A B C D  | 122. A B     | 154. A B C D | 186. A B C D |
| 91. A B C D  | 123. A B     | 155. A B C D | 187. A B C D |
| 92. A B C D  | 124. A B     | 156. A B C D | 188. A B C D |
| 93. A B C D  | 125. A B     | 157. A B C D | 189. A B C D |
| 94. A B C D  | 126. A B     | 158. A B C D | 190. A B C D |
| 95. A B C D  | 127. A B C D | 159. A B C D | 191. A B C D |
| 96. A B C D  | 128. A B C D | 160. A B C D | 192. A B C D |
| 97. A B C D  | 129. A B C D | 161. A B C D | 193. A B C D |
| 98. A B C D  | 130. A B     | 162. A B C D | 194. A B C D |
| 99. A B C D  | 131. A B     | 163. A B     | 195. A B C D |
| 100. A B C D | 132. A B     | 164. A B     | 196. A B C D |

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| 197. A B C D | 229. A B C D | 261. A B     | 293. A B     |
| 198. A B C D | 230. A B C D | 262. A B C D | 294. A B     |
| 199. A B C D | 231. A B C D | 263. A B C D | 295. A B C D |
| 200. A B C D | 232. A B C D | 264. A B C D | 296. A B C D |
| 201. A B C D | 233. A B C D | 265. A B C D | 297. A B C D |
| 202. A B C D | 234. A B C D | 266. A B C D | 298. A B C D |
| 203. A B     | 235. A B C D | 267. A B C D | 299. A B C D |
| 204. A B     | 236. A B C D | 268. A B C D | 300. A B C D |
| 205. A B C D | 237. A B C D | 269. A B C D | 301. A B C D |
| 206. A B C D | 238. A B C D | 270. A B C D | 302. A B C D |
| 207. A B C D | 239. A B C D | 271. A B C D | 303. A B C D |
| 208. A B C D | 240. A B C D | 272. A B C D | 304. A B C D |
| 209. A B C D | 241. A B C D | 273. A B C D | 305. A B C D |
| 210. A B     | 242. A B C D | 274. A B C D | 306. A B C D |
| 211. A B     | 243. A B C D | 275. A B C D | 307. A B C D |
| 212. A B C D | 244. A B C D | 276. A B C D | 308. A B C D |
| 213. A B C D | 245. A B C D | 277. A B C D | 309. A B C D |
| 214. A B C D | 246. A B C D | 278. A B     | 310. A B C D |
| 215. A B C D | 247. A B C D | 279. A B C D | 311. A B     |
| 216. A B     | 248. A B C D | 280. A B     | 312. A B     |
| 217. A B     | 249. A B C D | 281. A B     | 313. A B     |
| 218. A B     | 250. A B C D | 282. A B     | 314. A B C D |
| 219. A B     | 251. A B C D | 283. A B     | 315. A B C D |
| 220. A B     | 252. A B C D | 284. A B     | 316. A B C D |
| 221. A B C D | 253. A B C D | 285. A B C D | 317. A B C D |
| 222. A B C D | 254. A B C D | 286. A B C D | 318. A B     |
| 223. A B C D | 255. A B C D | 287. A B C D | 319. A B     |
| 224. A B C D | 256. A B C D | 288. A B C D | 320. A B     |
| 225. A B C D | 257. A B C D | 289. A B C D | 321. A B     |
| 226. A B C D | 258. A B C D | 290. A B C D | 322. A B     |
| 227. A B C D | 259. A B     | 291. A B C D | 323. A B C D |
| 228. A B C D | 260. A B     | 292. A B C D | 324. A B C D |

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| 325. A B C D | 344. A B C D | 363. A B C D | 382. A B     |
| 326. A B C D | 345. A B C D | 364. A B C D | 383. A B     |
| 327. A B C D | 346. A B C D | 365. A B C D | 384. A B     |
| 328. A B C D | 347. A B C D | 366. A B C D | 385. A B     |
| 329. A B C D | 348. A B C D | 367. A B C D | 386. A B     |
| 330. A B C D | 349. A B C D | 368. A B C D | 387. A B C D |
| 331. A B C D | 350. A B C D | 369. A B C D | 388. A B C D |
| 332. A B C D | 351. A B C D | 370. A B C D | 389. A B C D |
| 333. A B C D | 352. A B C D | 371. A B     | 390. A B C D |
| 334. A B C D | 353. A B C D | 372. A B     | 391. A B C D |
| 335. A B C D | 354. A B C D | 373. A B     | 392. A B C D |
| 336. A B C D | 355. A B C D | 374. A B C D | 393. A B C D |
| 337. A B C D | 356. A B C D | 375. A B C D | 394. A B C D |
| 338. A B C D | 357. A B C D | 376. A B C D | 395. A B     |
| 339. A B C D | 358. A B C D | 377. A B C D | 396. A B     |
| 340. A B C D | 359. A B C D | 378. A B C D | 397. A B     |
| 341. A B C D | 360. A B C D | 379. A B C D | 398. A B     |
| 342. A B C D | 361. A B C D | 380. A B C D | 399. A B C D |
| 343. A B C D | 362. A B C D | 381. A B C D | 400. A B C D |

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**Signature**

***Please write down any questions you were not able to find the answers or that have errors.***

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

**WWT SYSTEM OPERATOR  
CEU TRAINING COURSE  
CUSTOMER SERVICE RESPONSE CARD**

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E-MAIL \_\_\_\_\_ PHONE \_\_\_\_\_

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

Please rate the difficulty of your course.

Very Easy    0    1    2    3    4    5    Very Difficult

Please rate the difficulty of the testing process.

Very Easy    0    1    2    3    4    5    Very Difficult

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

Very Similar    0    1    2    3    4    5    Very Different

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

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Any other concerns or comments.

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## **When finished with your assignment.**

Please scan the Registration Page, Answer Key and Driver's License and email it to [info@TLCH2O.com](mailto:info@TLCH2O.com).

If you are unable to scan, take a photo of these documents with your iPhone and send these to TLC, [info@TLCH2O.com](mailto:info@TLCH2O.com).

If you are unable to scan and email, please fax these to TLC,

**(928) 468-0675**

**If you fax, call to confirm that we received your paperwork.**

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



# WWT SYSTEM OPERATOR CEU Course Assignment

*The Assignment is available in Word on the Internet for your Convenience, please visit [www.ABCTLIC.com](http://www.ABCTLIC.com) and download the assignment and email it back to TLC.*

You will have 90 days from the start of this course to complete in order to receive your Professional Development Hours (PDHs) or Continuing Education Unit (CEU). A score of 70 % is necessary to pass this course. If you should need any assistance, please email all concerns and the completed manual to [info@tlch2o.com](mailto:info@tlch2o.com).

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

**Multiple Choice, please select only one answer per question. There are no intentional trick questions.**

## **Hyperlink to the Glossary and Appendix**

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

### **Primary Wastewater Components and Constituents**

1. When oxygen chemically combined, such as in water molecules can be used for respiration by aerobes  
A. True    B. False
2. Methane Fermenters – bacteria that break down the volatile acids to methane, carbon dioxide and water.  
A. True    B. False
3. Anaerobic- a condition in which “free” or dissolved oxygen is not present in the aquatic environment.  
A. True    B. False
4. Saprophytic bacteria thrive without the presence of oxygen.  
A. True    B. False
5. Anaerobic Bacteria that break down complex solids to volatile acids.  
A. True    B. False
6. Aerobic is a condition in which free or dissolved oxygen is present in the aquatic environment.  
A. True    B. False
7. Aerobic Bacteria will live and reproduce only in an environment containing oxygen.  
A. True    B. False
8. Reduction is the addition of oxygen to an element or compound, or removal of hydrogen or an electron from an element or compound in a chemical reaction.  
A. True    B. False

9. Oxidation is the addition of hydrogen, removal of oxygen or addition of electrons to an element or compound.

- A. True    B. False

10. Under anaerobic conditions in wastewater, sulfur compounds or elemental sulfur are reduced to H<sub>2</sub>S or sulfide ions.

- A. True    B. False

### Biological

11. Bacteria and other small organisms in water consume organic matter in sewage, turning it into new bacterial cells, \_\_\_\_\_, and other by-products.

- A. Oxygen                      C. Secondary treatment  
B. Carbon dioxide            D. None of the Above

### Organic Matter

12. Large amounts of biodegradable materials can reduce or deplete the \_\_\_\_\_ in the water needed by aquatic life.

- A. Carbon Dioxide            C. Nutrients  
B. Supply of oxygen            D. None of the Above

13. One of the measurements used to assess overall wastewater strength, the amount of oxygen organisms needed to break down wastes in wastewater is referred to as?

- A. BOD                      C. COD  
B. MLSS                    D. None of the Above

14. Some organic compounds are more stable than others are and cannot be quickly broken down by organisms; this is true of \_\_\_\_\_ developed for agriculture and industry.

- A. Most inorganic substances    C. Many synthetic organic compounds  
B. Organic material(s)            D. None of the Above

15. Which of the following are toxic to humans, fish, and aquatic plants and often are disposed of improperly in drains or carried in stormwater?

- A. Nitrogen and phosphorus    C. Pesticides and herbicide(s)  
B. Turbidity                    D. None of the Above

16. Two toxic \_\_\_\_\_ like benzene and toluene are found in some solvents, pesticides, and other products.

- A. Nutrients from wastewater    C. Organic compounds  
B. Inorganic materials            D. None of the Above

### Oil and Grease

17. Which of the following also adds to the septic tank scum layer, causing more frequent tank pumping to be required?

- A. Nutrients from wastewater    C. Excessive grease  
B. Inorganic materials            D. None of the Above

18. Which of the following used for motors and industry are considered hazardous waste and should be collected and disposed of separately from wastewater?

- A. Nitrogen and phosphorus    C. Petroleum-based waste oil(s)  
B. Inorganic substances            D. None of the Above

19. When large amounts of oils and greases are discharged, these increase \_\_\_\_\_ and they may float to the surface and harden, causing aesthetically displeasing conditions.

- A. BOD
- B. COD
- C. Petroleum-based waste oil(s)
- D. None of the Above

### Nutrients

20. Which of the following are essential to living organisms and are the chief nutrients present in natural water?

- A. Oxygen
- B. Carbon dioxide
- C. Carbon, nitrogen, and phosphorus
- D. Answers A,B and C

21. Primarily \_\_\_\_\_ but occasionally nitrogen, causes nutrient enrichment which results in excessive growth of algae.

- A. Phosphorus
- B. Nitrifying Bacteria
- C. Ammonia
- D. Calcium Hydroxide

### Inorganic and Synthetic Organic Chemicals

22. Inorganic and Synthetic Organic Chemicals can cause \_\_\_\_\_ problems, and many are not effectively removed by conventional wastewater treatment.

- A. Toxic
- B. Ecology
- C. Excessive growth of aerobic bacteria
- D. Taste and odor

### Biological Components Section Introduction

#### Biochemical Oxygen Demand

23. The BOD test has merit as a pollution parameter continues to be debated, \_\_\_\_\_ has the advantage of a long period of record.

- A. BOD
- B. CBOD
- C. MLSS
- D. MLVSS

### Application Specific Microbiology

24. Which of the following is the preferred methodology in wastewater treatment affecting the efficiency of biological nutrient removal?

- A. Attached growth
- B. Advanced treatment technologies
- C. Application-specific microbiology
- D. None of the Above

### Pretreatment Section

25. Discharges containing pollutants causing corrosive structural damage to the POTW, but in no case discharges with a pH lower than 5.0, unless the POTW is specifically designed to accommodate such?

- A. Categorical pretreatment standards
- B. Discharge(s)
- C. Violation of the general prohibitions
- D. None of the Above

26. Which of the following containing pollutants in amounts causing obstruction to the flow in the POTW resulting in interference?

- A. Interference or pass through
- B. Discharges
- C. Categorical pretreatment standards
- D. None of the Above

27. Which of the following of any pollutants released at a flow rate and/or concentration that will cause interference with the POTW?

- A. Discharge(s)
- B. Pass through
- C. Violation of the general prohibitions
- D. None of the Above

28. Discharges of petroleum oil, non-biodegradable cutting oil, or products of mineral oil origin in amounts that will cause?

- A. Interference or pass through
- B. Discharge or discharges
- C. Eight categories of pollutant discharges
- D. None of the Above

29. Which of the following results in the presence of toxic gases, vapors, or fumes within the POTW in a quantity that may cause acute worker health and safety problems?

- A. Categorical pretreatment standards
- B. Discharge(s)
- C. Violation of the general prohibitions
- D. None of the Above

30. Which of the following except at discharge points designated by the POTW?

- A. Interference or pass through
- B. Discharge or discharges
- C. Discharges of trucked or hauled pollutants
- D. None of the Above

### **Categorical Standards**

31. Categorical pretreatment standards are national, uniform, technology-based standards that apply to discharges to POTWs from specific industrial categories and limit the?

- A. Categorical pretreatment standards
- B. Pass through
- C. Discharge of specific pollutants
- D. None of the Above

32. Which of the following for both existing and new sources (are promulgated by the EPA pursuant to Section 307(b) and (c) of the CWA?

- A. Flow rate and/or concentration
- B. Pass through
- C. Categorical pretreatment standards
- D. None of the Above

### **FOG Introduction**

#### **Controlling Fats, Oils, and Grease Discharges from Food Service Establishments**

33. Commercial food preparation establishments with inadequate grease controls is the primary method that FOG gets into our sewer collection system mainly from \_\_\_\_\_pouring the substances down their drains.

- A. CSO/SSO
- B. POTWs
- C. Residential customers
- D. None of the Above

34. Sewer backups and overflows on streets, properties and even in customers' homes and/or businesses are caused because of improper disposal of fats, oils and grease, FOG builds up in the \_\_\_\_\_ and eventually block collection pipes and sewer lines, resulting in

- A. Sewer system
- B. POTW's requirement(s)
- C. Least management practices (LMPs)
- D. None of the Above

35. Ponds, streams or rivers will be contaminated due to \_\_\_\_\_ and will also impact the environment negatively.

- A. Overflow(s)
- B. FOG
- C. POTW Commercial FOG Program(s)
- D. None of the Above

### **Primary Wastewater Treatment Section**

#### **Conventional A/S Wastewater Treatment Plant Overview**

##### **Primary Treatment**

36. Coarse solids are removed from the wastewater in the primary stage of treatment. In some treatment plants, \_\_\_\_\_ may be combined into one basic operation.

- A. Primary and secondary stages
- B. Biological processes
- C. Suspended growth process(es)
- D. None of the Above

37. The secondary stage uses this term to further purify wastewater.  
A. Primary and secondary stages                      C. Suspended growth process(es)  
B. Biological processes                                      D. None of the Above

**Preliminary Treatment**

38. Large amounts of \_\_\_\_\_ entering a treatment plant can cause serious operating problems, such as excessive wear of pumps and other equipment.

- A. Solid(s)                                      C. Grit and sand  
B. Finer debris                                D. Dissolved organic and inorganic constituents

39. Which of the following enters from the collection system into the Coarse Screening process?

- A. Raw wastewater                      C. Dissolved organic and inorganic constituents  
B. Biological processes                D. None of the Above

40. Especially in cities with combined sewer systems, removing the-this missing term-that washes off streets or land during storms is very important.

- A. Very fine solids                      C. Primary sludge  
B. Grit and gravel                        D. None of the Above

**Primary Sedimentation**

41. When the wastewater enters a sedimentation tank, it slows down and the suspended solids gradually sink to the bottom, this mass of solids is called?

- A. Very fine solids                      C. Primary sludge  
B. RAS                                        D. Heavy pollutants

42. Which of the following wastewater treatment terms consist of minute particles of matter that can be removed from the wastewater with further treatment such as sedimentation or gravity settling, chemical coagulation, or filtration?

- A. Solid(s)                                      C. Dissolved organic and inorganic constituents  
B. Suspended solids                        D. None of the Above

**Temperature**

43. The best temperatures for wastewater treatment probably range from 77 to 95 degrees Fahrenheit.

- A. True    B. False

44. Hot water is a byproduct of many manufacturing processes, is not a pollutant. When discharged in large quantities, it can raise the temperature of receiving streams improving the natural balance of aquatic life.

- A. True    B. False

**pH**

45. The acidity or alkalinity of wastewater affects both treatment and the environment.

- A. True    B. False

46. pH indicates increasing acidity while a low pH indicates increasing alkalinity.

- A. True    B. False

## Secondary Treatment Section

### Secondary Treatment

47. The wastewater enters from Preliminary Treatment into the clarifier process which is a biological process consisting of large oval shaped basins capable of removing these finer solids.

- A. True    B. False

48. Maintaining a population of microorganisms within the oxidation basins that consumes \_\_\_\_\_ and also adhere to the solids themselves.

- A. Total Solids                      C. Very fine solids  
B. TDS                                  D. None of the Above

49. Which of the following form larger and heavier aggregates that can be physically separated?

- A. Solid(s)                              C. Finer solids  
B. Finer debris                         D. None of the Above

50. The two most common conventional methods used to achieve secondary treatment are: \_\_\_\_\_ and suspended growth processes.

- A. Attached growth processes      C. Unsuspended growth process(es)  
B. Finer debris                         D. None of the Above

51. The Secondary Treatment stage consists of a biological process such as \_\_\_\_\_ and a physical process, Secondary Clarification.

- A. Trickling filters                    C. Phosphorus-reduction system(s)  
B. Oxidation Ditches                 D. None of the Above

52. The Preliminary Treatment stage removes as much \_\_\_\_\_ as possible using physical processes.

- A. Solid(s)                              C. Grit and gravel  
B. Finer debris                         D. None of the Above

### Raw Water Screening

53. Raw wastewater may or may not be \_\_\_\_\_ before being directed into the pond treatment system. The first two ponds in the pond system may be operated in series or in parallel.

- A. Screened and de-gritted         C. Compacted clay bottoms and sides  
B. Series or in parallel                D. None of the above

54. Generally, the microorganisms in the first ponds treat the incoming effluent, while the next pond is the settling or polishing pond. The third pond is to provide \_\_\_\_\_ where the biological solids generated in the first two ponds can settle.

- A. Wind and algae                    C. Activated sludge  
B. A quiet zone                        D. None of the above

55. Ponds generally do not have a secondary clarifier, the \_\_\_\_\_ fulfills the clarifier action.

- A. Wind and algae                    C. Settling or polishing pond  
B. Series or in parallel                D. None of the above

### Pond Lining

56. Ponds may be lined with a synthetic liner or simply have \_\_\_\_\_.

- A. Wind and algae                    C. Compacted clay bottoms and sides  
B. Series or in parallel                D. None of the above

57. Many ponds rely on \_\_\_\_\_ to supply oxygen instead of mechanical aeration.  
 A. Wind and algae                      C. Compacted clay bottoms and sides  
 B. Series or in parallel operation   D. None of the above
58. Filamentous bacteria generally do not cause any operational problems in lagoons, in contrast to activated sludge where \_\_\_\_\_ and poor sludge settling is a common problem.  
 A. Redox potential                      C. BOD removal  
 B. Filamentous bulking                D. None of the Above
59. Most heterotrophic bacteria have a wide range in environmental tolerance and can function effectively in \_\_\_\_\_ over a wide range in pH and temperature.  
 A. Redox potential                      C. BOD removal  
 B. Poor sludge settling                D. None of the Above
60. Aerobic BOD removal generally proceeds well from pH \_\_\_\_\_ and at temperatures from 3-4°C to 60-70°C (37.4 -39.2° F to 140-158°F in the ATAD process (mesophilic bacteria are replaced by thermophilic bacteria at temperatures above 35°C).  
 A. 5.5 to 8.0                              C. 6.5 to 7.0  
 B. 6.5 to 9.0                              D. None of the Above
61. BOD removal generally declines rapidly below \_\_\_\_\_ C and ceases at \_\_\_\_\_ C.  
 A. 3-4° - 1-2°                            C. 1-2° - 3-4°  
 B. 4-6° - 2-3°                            D. None of the Above
62. A very specialized group of bacteria occurs to some extent in lagoons (and other wastewater treatment systems) that can oxidize ammonia via nitrite to nitrate, termed nitrifying bacteria. These bacteria are strict aerobes and require a redox potential of at least \_\_\_\_\_ m V.  
 A. +200                                    C. 2,000  
 B. - 200                                    D. None of the Above

### Lagoon Systems

63. Lagoon systems take advantage of \_\_\_\_\_ and microorganisms in the wastewater to renovate sewage.  
 A. Nitrogen removal system(s)                      C. Natural aeration  
 B. Suspended film system(s)                            D. None of the Above

### Microorganisms in Lagoons

64. Swimming and \_\_\_\_\_ engulf bacteria or other prey.  
 A. Gliding ciliates                                      C. Heterotrophic bacteria  
 B. Predators    D. None of the Above
65. Which of the following bugs or terms attach to the biomass and vortex suspended bacteria into their gullets, while crawlers break bacteria loose from the floc surface?  
 A. Floc-forming bacteria                              C. Stalked ciliate(s)  
 B. Aerobic bacteria                                    D. None of the Above
66. Predators feed mostly on stalked and \_\_\_\_\_.  
 A. Floc-forming bacteria                              C. Methane Fermenters  
 B. Swimming ciliates                                    D. None of the Above

67. The following changes in food, dissolved oxygen, temperature, pH, total dissolved solids, sludge age, presence of toxins, and other factors create a dynamic environment for the \_\_\_\_\_?  
A. Treatment organism(s)      C. Floc-forming bacteria  
B. Aerobic bacteria              D. None of the Above

68. Food (organic loading) regulates \_\_\_\_\_?  
A. Strict aerobes                  C. Microorganism numbers  
B. Predators                        D. None of the Above

### Lagoon Microorganisms Introduction

69. Which of the following are similar to those found in other treatment processes such as activated sludge?  
A. Treatment organism(s)      C. Floc-forming bacteria  
B. Aerobic bacteria              D. None of the Above

70. Which of the following degrade wastes, and grows as single bacteria dispersed in the wastewater?  
A. Strict aerobes                  C. Many bacterial species  
B. Predators                        D. None of the Above

71. Which of the following grow in a large aggregate due to exocellular polymer production?  
A. Predators                        C. Floc-forming bacteria  
B. Aerobic bacteria              D. None of the Above

72. Growth form is important as these flocs degrade \_\_\_\_\_ and settle at the end of the process, producing a low TSS effluent.  
A. Anaerobic action              C. BOD  
B. Application-specific bacteria    D. None of the Above

73. Which of the following bugs or terms occur in lagoons, usually at specific growth environments?  
A. Anaerobic action              C. A number of filamentous bacteria  
B. Absence of free oxygen        D. None of the Above

74. Which of the following have a wide range in environmental tolerance and can function effectively in BOD removal over a wide range in pH and temperature?  
A. Strict aerobes                  C. Most heterotrophic bacteria  
B. Predators                        D. None of the Above

75. A very specialized group of bacteria occurs to some extent in lagoons (and other wastewater treatment systems) that can oxidize ammonia via nitrite to nitrate are termed?  
A. Strict aerobes                  C. Nitrifying bacteria  
B. Predators                        D. None of the Above

### Mixed or Suspended Lagoons

76. In the facultative lagoons, the power input is reduced causing accumulation of solids in the bottom which undergo \_\_\_\_\_, while the upper portions are maintained aerobic.  
A. Facultative lagoon(s)        C. Dissolved organic and inorganic constituents  
B. Anaerobic decomposition      D. None of the Above



### Advanced Methods of Wastewater Treatment

77. As our country and the demand for clean water have grown, it has become more important to produce cleaner wastewater effluents, yet \_\_\_\_\_ are more difficult to remove than others.

- A. Biofilm
- B. Some contaminants
- C. Soluble nutrients
- D. None of the Above

78. All WWTPs provide a minimum of?

- A. Biofilm and chemical removal
- B. Secondary treatment
- C. Pretreatment and pollution prevention
- D. None of the Above

### Advanced Treatment Technologies

79. Which of the following can be extensions of conventional secondary biological treatment to further stabilize oxygen-demanding substances?

- A. Hydraulic Detention Time
- B. Activated sludge system
- C. Advanced treatment technologies
- D. None of the Above

80. Advanced treatment may include physical-chemical separation techniques such as adsorption, flocculation/precipitation, membranes for advanced filtration, \_\_\_\_\_, and reverse osmosis.

- A. Denitrification process
- B. Organic material
- C. Ion exchange
- D. None of the Above

### Activated Sludge Process Section

#### Regular MLSS Removal

81. To maintain a stable treatment process, MLSS must be removed on a regular schedule. The MLSS can be removed from the bottom of the clarifier or from the \_\_\_\_\_.

- A. Secondary sludge wasting
- B. Solids handling process
- C. Activated sludge basin
- D. None of the above

82. The \_\_\_\_\_ removed directly from the basin is renamed as WAS.

- A. MLSS
- B. CRT
- C. WAS
- D. None of the above

83. Some clarifiers have separate pipelines for RAS and WAS. In other cases, WAS is pumped out of the \_\_\_\_\_ pipeline.

- A. RAS
- B. CRT
- C. WAS
- D. None of the above

#### Wasting Rates

84. CRT was defined as the average length of time in days that an organism remains in the \_\_\_\_\_.

- A. Secondary treatment system
- B. Solids handling process
- C. Many activated sludge plants
- D. None of the above

85. The operator determines the operating \_\_\_\_\_ for the facility and maintains it through wasting the appropriate amount of excess biomass (Waste Activated Sludge, WAS) from the secondary system.

- A. Mixed Liquor
- B. CRT
- C. WAS
- D. None of the above

86. The amount of \_\_\_\_\_ in the secondary system is controlled and maintained through solids wasting.
- A. Biomass (MLSS)      C. WAS  
B. CRT                      D. None of the above
87. In nearly all activated sludge plants, wasting is accomplished by directing a portion of the Return Sludge to the \_\_\_\_\_.
- A. Secondary sludge wasting      C. Many activated sludge plants  
B. Solids handling facility      D. None of the above
88. Wasting Return Sludge rather than \_\_\_\_\_ minimizes the volume of water that must be processed by the sludge thickening/dewatering equipment.
- A. Mixed Liquor      C. RAS  
B. CRT                      D. None of the above
89. If intermittent wasting is practiced, it is usually best to waste over as long a time period as practical, and when the loading on the \_\_\_\_\_ is at the low point of the day.
- A. Secondary system                      C. Many activated sludge plants  
B. Solids handling process                      D. None of the above
90. Drastic changes should not be made in wasting rates from one day to the next; allow the \_\_\_\_\_ time to acclimate to a change before another change is made.
- A. Secondary sludge wasting      C. Advanced system  
B. Biological system                      D. None of the above
91. Consistency is a key element in successful \_\_\_\_\_ operation.
- A. Secondary system      C. Activated sludge plant  
B. The operator                      D. None of the above
92. Many activated sludge plants were originally designed to waste secondary solids into the primary clarifiers. The reasoning was that as the less dense biological solids co-settle with the \_\_\_\_\_ the combined sludge density would be increased.
- A. Mixed Liquor                      C. Scum  
B. Heavier primary solids                      D. None of the above
93. A more efficient operation will result if the WAS is wasted directly to a \_\_\_\_\_ and not allowed to return to the treatment system.
- A. Secondary sludge wasting      C. Many activated sludge plants  
B. Solids handling process      D. None of the above
94. It is crucial that adequate solids concentrating equipment and \_\_\_\_\_ are part of any plans for building or expanding an activated sludge plant.
- A. Secondary system      C. Solids storage capability  
B. The operator                      D. None of the above
95. Which of the following is one of the most important controls available to the operator because it controls the most important aspect of treatment, biomass population?
- A. Secondary system                      C. Activated sludge plant  
B. Secondary sludge wasting      D. None of the above

96. A good \_\_\_\_\_ control situation is one that allows the operator to set a totalizer which determines the maximum number of gallons wasted in a particular day and also allows the operator to control and monitor the WAS flow rate.

- A. MLSS concentration
- B. WAS
- C. BOD, nutrients, and oxygen
- D. None of the above

### Environmental Conditions

97. Waste activated sludge flow, along with environmental conditions such as water temperature and accessibility to \_\_\_\_\_, influences the process biology and level of treatment achieved.

- A. MLSS concentration
- B. WAS
- C. BOD, nutrients, and oxygen
- D. None of the above

98. Slower growing microorganisms, including the nitrification bacteria and some bacteria and some filaments, can only remain in the treatment process if the \_\_\_\_\_ is held long enough for them to reproduce.

- A. MLSS
- B. WAS
- C. BOD, nutrients, and oxygen
- D. None of the above

### Sludge Settling

99. Waste activated sludge determines how long the \_\_\_\_\_ stays in the system and, therefore, helps to determine which type of microorganisms will be present.

- A. MLSS
- B. WAS
- C. BOD, nutrients, and oxygen
- D. None of the above

100. The presence or absence of \_\_\_\_\_ will influence how fast the sludge settles in the clarifier.

- A. MLSS concentration
- B. WAS
- C. Filaments
- D. None of the above

101. Waste activated sludge also determines the \_\_\_\_\_.

- A. MLSS concentration
- B. WAS
- C. BOD, nutrients, and oxygen
- D. None of the above

### Organic Load

102. According to the text, as the cells are retained longer in the system, the flocculating characteristics of the cells improve since they start to produce extra cellular slime that favors?

- A. Secondary settling
- B. High degradation rate
- C. Flocculating
- D. None of the Above

103. The organic load (generally coming from primary treatment operations such as settling, screening or flotation) enters the reactor where the active microbial population is present. The reactor must be continuously aerated.

- A. True
- B. False

104. The mixture then passes to a settling tank where the cells are settled. The treated wastewater is disinfected while the secondary settling and is recycled in part to the aeration basin.

- A. True
- B. False

### **Common Types**

105. The most common types of activated sludge are the conventional and the continuous flow settling tank, in which the contents are completely mixed. In the conventional process, the wastewater is circulated along the aeration tank, with the flow being arranged by baffles in plug flow mode. The oxygen demand for this arrangement is maximum at the inlet as is the organic load concentration.

A. True    B. False

### **Sludge Problems and Solutions Section**

#### **Excess Solids**

106. Solids are generated by microorganism growth and reproduction. The influent BOD supplies the food for the growth and reproduction. As microorganisms' populations multiply, excess solids (microorganisms) must be removed (wasted).

A. True    B. False

#### **Final Clarifier Solids Loading Rate (SLR)**

107. The rate at which the activated sludge is returned from the final clarifiers to the aeration basins, along with the influent flow, effects the flow of solids into the clarifiers.

A. True    B. False

#### **Clarifier Sludge Blanket**

108. Solids settle and concentrate in the first clarifier forming a sludge blanket. The sludge blanket can increase depending on the WAS flow rate. The proper WAS flow rate allows for a desired sludge blanket.

A. True    B. False

#### **Filaments**

109. Filamentous organisms are a group of thread-like organisms that, when in excess, can impair the settling of activated sludge and create a bulking condition in the final clarifier.

A. True    B. False

#### **Oxidation Ditch**

110. Oxidation ditches are typically limited mix systems, and cannot be modified to approach plug flow conditions.

A. True    B. False

#### **Pin Floc**

111. Very fine floc particles with poor settling characteristics, usually indicative of a young sludge (high MLSS levels).

A. True    B. False

#### **Sludge Age**

112. Activated sludge (RAS) is recycled back through the aeration basins by returning settled sludge in the final clarifiers and thus remains in the activated sludge system for a number of days. For effective treatment, a specific sludge age is desired for the type of activated sludge system.

A. True    B. False

113. For conventional activated sludge, a sludge age of 1-3 days is typical. For extended aeration activated sludge, older sludge ages of 3-10 days are common. F/M ratio and sludge age is inversely related (1 divided by the sludge age approximates the F/M ratio).

A. True    B. False

**Constant MLSS (Mixed Liquor Suspended Solids)**

114. Provided the influent loadings are constant, the operator maintains a relatively constant solids inventory (MLSS level) in the aeration basins for a desired level of treatment. The range of MLSS is typically between 1000-4000 mg/L.

A. True    B. False

**Wasting Rates**

115. The concentration of WAS has a direct bearing on how much to waste and the volume wasted. On a volume basis, a thicker waste activated sludge (low WAS concentration) will require more amount of wasting than a thicker waste activated sludge (high WAS concentration).

A. True    B. False

**Extended Aeration Activated Sludge Plants**

116. For extended aeration activated sludge plants the range is between about 15 and 30 days. Generally, during the winter months, higher sludge ages are required to maintain a sufficient biological mass. In the summer time, biological activity increases and lower sludge ages normally produce a higher quality effluent.

A. True    B. False

**Clarifier Sludge Blanket**

117. Solids settle and concentrate in the final clarifiers forming a sludge blanket. The sludge blanket can increase or decrease depending on the RAS flow rate. The proper RAS flow rate allows for a desired sludge blanket.

A. True    B. False

**Young Sludge**

118. Young sludge is often associated with a low F/M. To correct for young sludge, it is necessary to increase wasting rates. This will decrease the amount of solids under aeration, reduce the F/M ratio, and increase the sludge age.

A. True    B. False

**Excessive Old Sludge**

119. The required pressure is an increase in the total system sludge mass. Decreased wasting is required to accomplish that objective. This problem is very rare.

A. True    B. False

**Return Rates Too Low**

120. Thin mixed liquor suspended solids and a sludge blanket build-up of solids. Rising clumps of sludge or gas bubbles may occur in the final clarifier.

A. True    B. False

**Return Rates Too High**

121. A sludge blanket in the final clarifier and a thick return activated sludge.

A. True    B. False

**Denitrification in Final Clarifier**

122. In the absence of oxygen, a sludge blanket that is too thick and remains in the clarifier too long can denitrify. Nitrates in the sludge will be converted to nitrogen gas. The release of nitrogen gas will cause small gas bubbles that will be observed at the clarifier surface. Clumps of sludge may also rise to the surface.

A. True    B. False

### Old Sludge

123. Old sludge filaments include *M. parvicella*, Type 0041, Type 0675, Type 1851 and Type 0803. *M. parvicella* is known for causing foaming and bulking occurrences, especially during winter operating conditions, in WWTPs that must remove ammonia year-round.

- A. True    B. False

### Stable Nitrification

124. At a water temperature of 20°C, the washout SRT for AOBs is approximately 1.6 weeks and the washout for POAs is approximately 2.0 days. To maintain a stable population and to avoid accidental loss of these bacteria resulting from accidental overwasting, the target SRT would need to be two to three times as long or between 1 and 3 days.

- A. True    B. False

### Slimy Foam

125. A grayish slimy foam that is very thick is commonly caused by nutrient deficiencies. It is often noted with a slime bulking condition.

- A. True    B. False

### Foam Trapping

126. A long-term solution includes some facilities using a vacuum truck to remove the foam from the surface. A short-term solution includes eliminating grease from the influent

- A. True    B. False

### Bacteria and Temperature Effect

127. Washout SRT is affected by temperature. For every 10°C drop in water temperature, the growth rate of bacteria decreases by 50% and the \_\_\_\_\_ doubles. Growth rates for floc forming and filament forming bacteria are similarly affected.

- A. MLSS                      C. Washout SRT  
B. CBOD                     D. WAS

### Denitrification

128. When \_\_\_\_\_ flow rates are too low, thick sludge blankets in the final clarifier can result. The operator will see gas bubbles (from ammonia gas) and rising/floating sludge clumps on the clarifier surface.

- A. MLSS                      C. RAS  
B. CBOD                     D. WAS

### Food –To- Microorganism Ratio (F/M Ratio)

129. For microbiological health and effective treatment, the microorganisms (mixed liquor suspended solids) under aeration should be maintained at a certain level for the amount of food (influent BOD) coming into the plant. This is known as the \_\_\_\_\_.

- A. MLSS                      C. Food to microorganism ratio  
B. CBOD                     D. WAS

## Nutrient Section

### TKN

130. The TKN content of influent municipal wastewater is typically between 5,000 and 6,000 mg/L.

- A. True    B. False

131. Organic nitrogen compounds in wastewater undergo microbial conversion to  $\text{NH}_3$  and ammonium ion  $\text{NH}_4^+$ .

- A. True    B. False

132. Recalcitrant means a certain compound is difficult to break down. This material can often be broken down given enough time, but not within the time it spends in secondary treatment.

A. True B. False

133. Inert means the material is safe for all microorganisms.

A. True B. False

### Ammonia

134. Ammonia is a nutrient that contains \_\_\_\_\_. Its chemical formula is  $\text{NH}_3$  in the un-ionized state and  $\text{NH}_4^+$  in the ionized form.

A. Nitrogen and hydrogen C. Phosphate  
B. Total ammonia D. Both total and unionized ammonia

135. Ammonia results can be expressed as: total ammonia (mg/l), un-ionized ammonia (mg/l), total ammonia (as N, mg/l), un-ionized ammonia (\_\_\_\_\_).

A.  $\mu\text{g/l}$  C. As N, mg/l  
B. mg/l/day D. mg/l

### Nitrification

136. Nitrification is an anaerobic process in which heterotrophic bacteria oxidize carbon for energy production.

A. True B. False

137. Nitrification is normally a one-step aerobic biological process for the oxidation of ammonia to nitrate.

A. True B. False

138. Ammonia-nitrogen ( $\text{NH}_3\text{-N}$ ) is first converted to nitrite ( $\text{NO}_2^-$ ) by ammonia oxidizing bacteria (AOB). The nitrite produced is then converted to nitrate ( $\text{NO}_3^-$ ) by nitrite oxidizing bacteria (NOB). Both reactions usually occur in the same process unit at a wastewater treatment plant (e.g., activated sludge mixed liquor or fixed film biofilm).

A. True B. False

### Total Inorganic Nitrogen (TIN)

139. Total inorganic nitrogen (TIN) as low as 5 mg/L N can be met through biological nitrification and denitrification.

A. True B. False

### Total Nitrogen

140. Total nitrogen in domestic wastewater typically ranges from 1.5 to 2.0 mg/L for low to high strength wastewater.

A. True B. False

141. Factors affecting concentration include the extent of infiltration and the presence of industries. Influent concentration varies during the day and can vary significantly during rainfall events, as a result of inflow and infiltration to the collection system.

A. True B. False

### **Nitrifying Bacteria**

142. Ammonia can be converted into nitrite and nitrate by nitrifying bacteria. Effluent ammonia-nitrogen ( $\text{NH}_3\text{-N}$ ) concentrations less than 1 mg/L  $\text{NH}_3\text{-N}$  are achievable.

A. True    B. False

### **Autotrophic Bacteria**

143. AOB and NOB are classified as autotrophic bacteria because they derive energy from the oxidation of reduced inorganic compounds (in this case, nitrogenous compounds) and use inorganic carbon ( $\text{CO}_2$ ) as a food source.

A. True    B. False

### **Significant Amount of Oxygen**

144. Nitrifying bacteria require a significant amount of oxygen to complete the reactions, produce a small amount of biomass, and cause destruction of alkalinity through the consumption of carbon dioxide and production of hydrogen ions.

A. True    B. False

### **Nitrogen Gas**

145. Nitrate can be converted to nitrogen gas by a variety of autotrophic bacteria. The nitrogen gas is returned to the digester.

A. True    B. False

146. Nitrate removal is limited by the amount of COD available.

A. True    B. False

### **Conversion of Nitrate to Nitrogen Gas**

147. In this oxygen free environment, bacteria use the oxygen attached to the nitrogen that is in the nitrate form, then the nitrogen gas is released.

A. True    B. False

148. Because nitrogen contains almost 50 percent of the earth's atmosphere, the release of nitrogen into the atmosphere causes a small amount of global warming.

A. True    B. False

149. The conversion of nitrate to nitrogen gas is accomplished by bacteria in a process known as denitrification. Effluent with nitrogen in the form of nitrate is retained in a tank that lacks oxygen, where carbon-containing chemicals, such as methanol, are added or a small stream of raw wastewater is mixed in with the nitrified effluent.

A. True    B. False

### **Phosphorus Section**

150. Total phosphorus (TP) in domestic wastewater typically ranges between \_\_\_\_\_ mg/L but can be higher depending on industrial sources, water conservation, or whether a detergent ban is in place.

A. 4 and 8                      C. 100 to 500  
B. 2 and 4                      D. 1,000 – 2,000

151. The \_\_\_\_\_ fraction is soluble and can be in one of several forms (e.g., phosphoric acid, phosphate ion) depending on the solution pH.

A. Orthophosphate              C. Phosphoric acid, phosphate ion  
B. Phosphorus                    D. Total phosphorus (TP)



152. Polyphosphates are high-energy, condensed \_\_\_\_\_ such as pyrophosphate and trimetaphosphate. They are also soluble but will not be precipitated out of wastewater by metal salts or lime. They can be converted to phosphate through hydrolysis, which is very slow, or by biological activity.

- A. Polyphosphates
- B. Phosphorus
- C. Phosphates
- D. Soluble organically bound non-biodegradable phosphorus

153. \_\_\_\_\_ is generally precipitated out and removed with the sludge.

- A. Organically bound phosphorus
- B. Phosphorus
- C. Soluble biodegradable phosphorus
- D. Particulate organically bound phosphorus

154. \_\_\_\_\_ can be hydrolyzed into orthophosphate during the treatment process.

- A. Polyphosphate
- B. Phosphorus
- C. Particulate organically bound phosphorus
- D. Soluble organically bound non-biodegradable phosphorus

155. \_\_\_\_\_ can either be in the form of soluble colloids or particulate. It can also be divided into biodegradable and non-biodegradable fractions.

- A. Organically bound phosphorus
- B. Phosphorus
- C. Soluble biodegradable phosphorus
- D. Particulate organically bound phosphorus

### Biological Phosphorus Control

156. Phosphorus removal can be achieved through chemical addition and a coagulation-sedimentation process discussed in the following section. Some biological treatment processes called biological nutrient removal (BNR) can also achieve nutrient reduction, removing \_\_\_\_\_.

- A. Polyphosphate
- B. Phosphorus
- C. Both nitrogen and phosphorus
- D. Soluble organically bound non-biodegradable phosphorus

### Phosphate Accumulating Organisms (PAOs)

157. PAOs accomplish removal of phosphate by accumulating it within their cells as \_\_\_\_\_.

- A. Polyphosphate
- B. Phosphorus
- C. Both nitrogen and phosphorus
- D. Soluble organically bound non-biodegradable phosphorus

### Production of Polyphosphate

158. PAOs are by no means the only bacteria that can accumulate \_\_\_\_\_ within their cells and in fact, the production of polyphosphate is a widespread ability among bacteria.

- A. Polyphosphate
- B. Phosphorus
- C. Phosphoric acid, phosphate ion
- D. Total phosphorus (TP)

### Luxury Uptake

159. In an anaerobic secondary treatment process, some of the CBOD is broken down through fermentation by anaerobic bacteria into soluble CBOD and simpler organic molecules called \_\_\_\_\_.

- A. COD
- B. VFAs
- C. Carbon and energy
- D. ATP

160. Volatile fatty acids are a preferred source of \_\_\_\_\_ by heterotrophic bacteria, including the PAOs, because these compounds are easily absorbed into the bacteria.

- A. COD
- B. VFAs
- C. Carbon and energy
- D. ATP

### Logistical Problem

161. The PAOs have a logistical problem: When PAOs are under anaerobic conditions, they are exposed to \_\_\_\_\_, but without oxygen, nitrite or nitrate present, they cannot access them.

- A. COD
- B. VFAs
- C. Carbon and energy
- D. ATP

### Adenosine Triphosphate (ATP) Energy

162. The PAOs take ATP to the next level and form an energy-rich compound called \_\_\_\_\_, which strings together large numbers of phosphate molecules.

- A. Polyphosphate
- B. VFAs
- C. Carbon and energy
- D. ATP

### Chemical Precipitation of Phosphorus

163. Phosphorus can also be precipitated through chemical addition. Alum, ferric chloride, or lime can be added to wastewater where these chemicals combine with phosphorus to form a solid. The precipitate is removed by settling or filtration.

- A. True
- B. False

164. Chemical phosphorus removal can meet effluent levels as low as 0.03 mg/L TP. Chemical and biological phosphorus removal methods are often used together in various combination processes.

- A. True
- B. False

### Tertiary Filtration

165. WWTPs typically use biological phosphorus removal methods to reduce P concentrations above 50 mg/L as P followed by chemical precipitation at or after the secondary clarifier.

- A. True
- B. False

### Biological Phosphorus Removal and Combination Processes

#### Principles

166. Biological phosphorus removal is achieved by contacting phosphorus accumulating organisms (PAOs) in the RAS with feed, containing volatile fatty acids (VFA), in a zone free of nitrates and DO (anaerobic zone).

- A. True
- B. False

### Fuhs & Chen Theory

167. PAOs have the ability to store a large mass of \_\_\_\_\_ in their cells in the form of polyphosphates.

- A. Carbon
- B. Phosphorus
- C. Poly- $\beta$ -hydroxybutyrate (PHB)
- D. Magnesium and potassium ions

### University of Cape Town (UCT) and Modified UCT (MUCT)

168. The UCT process was designed to reduce \_\_\_\_\_ to the anaerobic zone when high removal of nitrates in the effluent is not required. It consists of three stages: an anaerobic stage, an anoxic stage, and an aerobic stage.

- A. Nitrates
- B. A nitrate rich stream
- C. An anoxic zone
- D. An aerobic stage

### **Johannesburg (JHB), Modified Johannesburg and Westbank**

169. The JHB process is similar to the 3 Stage Pho-redox process, but has a pre-anoxic tank ahead of the anaerobic zone to protect the zone from nitrates when low effluent nitrates are not required. The low COD of the wastewater limited the de-nitrification capacity in the original plant (Northern Works), resulting in nitrates in the \_\_\_\_\_.

- A. RAS
- B. Pre-anoxic zone
- C. An anoxic zone
- D. An aerobic stage

### **Nitrification and Nutrient Removal Sub-Section**

170. Nitrosomonas europaea, which oxidizes ammonia to nitrite, and Nitrobacter winogradskyi, which oxidizes nitrite to nitrate.

- A. True
- B. False

171. Nitrification ceases at pH values above pH 9 and declines markedly at pH values below 7.

- A. True
- B. False

172. Which of the following bugs require a neutral pH and substantial alkalinity?

- A. Nitrifying bacteria
- B. Methane forming bacteria
- C. Anaerobic, heterotrophic bacteria
- D. None of the Above

173. Nitrifying bacteria exists in low numbers in lagoons, they prefer attached growth systems and/or?

- A. Nitrifying bacteria
- B. Low MLSS sludge systems
- C. High MLSS sludge systems
- D. None of the Above

174. Complete nitrification would be expected at pond pH values between pH \_\_\_\_\_.

- A. 7.5 and 9.5
- B. 7.0 and 8.5
- C. 6.0 and 7.5
- D. None of the Above

175. Which of the following bugs or related terms commonly occur in lagoons are involved in methane formation and in sulfate reduction?

- A. Nitrifying bacteria
- B. Methane forming bacteria
- C. Anaerobic, heterotrophic bacteria
- D. None of the Above

176. Anaerobic methane formation involves \_\_\_\_\_ bacteria.

- A. Three different groups of anaerobic
- B. Methane fermentation
- C. Organic overloading conditions
- D. None of the Above

177. Which of the following genera of anaerobic bacteria hydrolyze proteins, fats, and polysaccharides present in wastewater to amino acids?

- A. General anaerobic degraders
- B. Methane forming bacteria
- C. Nitrifying bacteria
- D. None of the Above

178. General anaerobic degraders - many genera of anaerobic bacteria hydrolyze proteins, fats, and polysaccharides present in wastewater to amino acids, short-chain peptides, fatty acids, glycerol, and mono- and di-saccharides

- A. Organic overloading conditions
- B. Methane fermentation
- C. General anaerobic degraders
- D. None of the Above

## Photosynthetic Organisms

179. Which of the following bugs or related terms is a diverse group of bacteria that converts products from above under anaerobic conditions to simple alcohols and organic acids?

- A. Acid-forming bacteria
- B. Methane bacteria
- C. Aerobic bacteria
- D. None of the Above

180. Which of the following bugs or related terms these bacteria convert formic acid, methanol, methylamine, and acetic acid under anaerobic conditions to methane?

- A. Nitrifying bacteria
- B. Methane forming bacteria
- C. General anaerobic degraders
- D. None of the Above

181. Which of the following bugs or related terms are environmentally sensitive and have a narrow pH range of 6.5-7.5 and require temperatures  $> 14^{\circ}$  C.

- A. Acid-forming bacteria
- B. Methane bacteria
- C. Aerobic bacteria
- D. None of the Above

182. Which of the following bugs or related terms, in which the products of these bugs become the substrate for the methane producers?

- A. Acid formers (principally acetic acid)
- B. Methane bacteria
- C. Aerobic bacteria
- D. None of the Above

183. Which of the following bugs or related terms ceases at cold temperature?

- A. Acid-forming bacteria
- B. Methane fermentation
- C. Aerobic bacteria
- D. None of the Above

184. Which of the following bugs or related terms can use sulfate as an electron acceptor, reducing sulfate to hydrogen sulfide?

- A. Nitrifying bacteria
- B. Methane forming bacteria
- C. Sulfate reducing bacteria
- D. None of the Above

185. Which of the following bugs or related terms is a major cause of odors in ponds?

- A. Sulfate reduction
- B. Methane fermentation
- C. Acid-forming bacteria
- D. None of the Above

186. Which of the following bugs or related terms and represented by about 28 genera, oxidize reduced sulfur compounds using light energy to produce sulfur and sulfate?

- A. Nitrifying bacteria
- B. Methane forming bacteria
- C. Red and green sulfur bacteria
- D. None of the Above

187. Which of the following bugs or related terms that can grow in profusion and give a lagoon a pink or red color?

- A. Chromatium, Thiocystis, and Thiopedia
- B. Methane bacteria
- C. Acid-forming bacteria
- D. None of the Above

188. According to the text, conversion of odorous sulfides to sulfur and sulfate by these bugs is a significant odor control mechanism in facultative and anaerobic lagoons.

- A. Methane bacteria
- B. Sulfur bacteria
- C. Acid-forming bacteria
- D. None of the Above

## Nutrient Constituents in Wastewater and Measurement Methods

### Nitrogen

189. Which of the following in domestic wastewater typically ranges from 20 to 70 mg/L for low to high strength wastewater?

- A. Organic carbon
- B. Total nitrogen
- C. BOD
- D. None of the Above

190. The major contributors of nitrogen to wastewater are \_\_\_\_\_ such as food preparation, showering, and waste excretion.

- A. Human activities
- B. Oxygen-demanding pollutants
- C. Bacteria and other microbes
- D. None of the Above

191. Influent concentration varies during the day and can vary significantly during rainfall events, as a result of?

- A. Oxygen-demanding pollutants
- B. Dissolved oxygen decrease
- C. Inflow and infiltration to the collection system
- D. None of the Above

### The TKN method has three major steps:

192. Digestion to convert organic nitrogen to?

- A. Ammonium sulfate
- B. Organic nitrogen
- C. Dissolved, biodegradable compounds
- D. None of the Above

193. Conversion of which term into condensed ammonia gas through addition of a strong base and boiling?

- A. Ammonia gas
- B. Ammonium sulfate
- C. Ammonia-nitrogen concentration
- D. None of the Above

194. Measuring the concentration includes ammonia, with this term being subtracted from the TKN to determine organic nitrogen.

- A. Ammonia gas
- B. Ammonium sulfate
- C. Ammonia-nitrogen concentration
- D. None of the Above

195. Nitrogen components in wastewater are typically reported on an " \_\_\_\_\_ " basis?

- A. As Nitrite
- B. As Nitrate
- C. As nitrogen
- D. None of the Above

196. Wastewater treatment plants are designed for nitrification and denitrification and these can remove 80 to 95 percent of \_\_\_\_\_, but the removal of organic nitrogen is typically much less efficient.

- A. TKN
- B. Inorganic nitrogen
- C. Aliphatic N compounds
- D. None of the Above

197. According to the text, domestic wastewater organic nitrogen may be present in particulate, colloidal or dissolved forms and consist of proteins, amino acids, \_\_\_\_\_, refractory natural compounds in drinking water.

- A. VFAs
- B. Nitrites
- C. Aliphatic N compounds
- D. None of the Above

198. Which of the following may be released in secondary treatment by microorganisms either through metabolism or upon death and lysis?

- A. TKN
- B. Organic nitrogen
- C. Aliphatic N compounds
- D. None of the Above

199. Which of the following happens by microorganisms releases some organic nitrogen as dissolved, biodegradable compounds?

- A. Ammonia gas
- B. THMs
- C. Hydrolysis of particulate and colloidal material
- D. None of the Above

200. Other forms of \_\_\_\_\_ may be more persistent in wastewater treatment processes.

- A. TKN
- B. Organic nitrogen
- C. Dissolved, biodegradable compounds
- D. None of the Above

### **Filamentous Bacteria**

201. According to the text, filaments are \_\_\_\_\_ that grow in long thread-like strands or colonies.

- A. Bacteria and fungi
- B. Facultative Bacteria
- C. Anaerobic to aerobic state Bacteria
- D. None of the Above

202. According to the text, filamentous bacteria function similar to \_\_\_\_\_ since they degrade BOD quite well.

- A. Floc forming bacteria
- B. Activated sludge
- C. Biofilm bacteria
- D. None of the Above

### **Site Specific Bacteria**

203. Aeration and biofilm building are the key operational parameters that contribute to the efficient degradation of organic matter (BOD/COD removal).

- A. True
- B. False

### **Facultative Bacteria**

204. Most of the bacteria absorbing the organic material in a wastewater treatment system are facultative in nature, meaning they are adaptable to survive and multiply in either anaerobic or aerobic conditions.

- A. True
- B. False

205. According to the text, usually, facultative bacteria will be \_\_\_\_\_ unless there is some type of mechanical or biochemical process used to add oxygen to the wastewater.

- A. Anaerobic
- B. Application-specific bacteria
- C. Aerobic
- D. None of the Above

### **Anaerobic Bacteria**

206. A typical use for \_\_\_\_\_ would be in a septic tank.

- A. Aerobic bacteria
- B. Anaerobic bacteria
- C. Facultative bacteria
- D. None of the Above

207. Which of the following or bugs release hydrogen sulfide as well as methane gas, both of which can create hazardous conditions?

- A. Aerobic bacteria
- B. Anaerobic bacteria
- C. Facultative bacteria
- D. None of the Above

208. Which of the following live and reproduce in the absence of free oxygen?

- A. Aerobic bacteria
- B. Anaerobic bacteria
- C. Facultative bacteria
- D. None of the Above

209. In order to remove a given amount of organic material in an anaerobic treatment system, the organic material must be exposed to a \_\_\_\_\_ and/or detained for a much longer period of time.

- A. Anaerobic action
- B. Absence of free oxygen
- C. Significantly higher quantity of bacteria
- D. None of the Above

### **Aerobic Bacteria**

210. Aerobic bacteria live and multiply in the presence of free oxygen.

- A. True
- B. False

211. Facultative bacteria always achieve an aerobic state when oxygen is present.

- A. True
- B. False

212. The metabolism of aerobes is much higher than?

- A. Application-specific bacteria
- B. Anaerobes
- C. Aerobic bacteria
- D. None of the Above

213. The by-products of \_\_\_\_\_ are carbon dioxide and water.

- A. Anaerobic action
- B. Application-specific bacteria
- C. Aerobic bacteria
- D. None of the Above

### **Hyperlink to the Glossary and Appendix**

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

### **Bacteria Section**

214. Many bacteria exist as \_\_\_\_\_ and the study of biofilms is very important.

- A. Filamentous Bacteria
- B. A biofilm
- C. Application-specific bacteria
- D. None of the Above

215. Bacteria come in a variety of shapes. The. Bacteria formed like simple shapes, round spheres or balls are called Cocci (singular coccus). The next simplest shape is cylindrical. Cylindrical bacteria are called rods (singular rod).

- A. True
- B. False

### **Peritrichous Bacteria**

216. Pleomorphic bacteria can assume a variety of shapes.

- A. True
- B. False

217. Bacteria may be classified according to whether they require oxygen (aerobic or anaerobic) and how they react to a test with Gram's stain.

- A. True
- B. False

218. Bacteria in which alcohol washes away Gram's stain is called gram-negative, while bacteria in which alcohol causes the bacteria's walls to absorb the stain are called Gram-positive.

- A. True
- B. False

### **Shigella dysenteriae**

219. Salmonella is spread by contaminated water and food, causes the most severe dysentery because of its potent and deadly Shiga toxin, but other species may also be dysentery agents.

- A. True
- B. False

220. Shigellae are Gram-negative, non-spore-forming, facultatively anaerobic, Pleomorphic bacteria.

- A. True    B. False

### Salmonella

221. Salmonellae usually do not ferment lactose; most of them produce hydrogen sulfide that, in media containing \_\_\_\_\_, reacts to form a black spot in the center of the creamy colonies.

- A. Ferric ammonium citrate            C. Alum sulfate  
B. Hydrogen sulfide                    D. None of the Above

### Fecal Coliform Bacteria

222. Although not necessarily agents of disease, \_\_\_\_\_ may indicate the presence of disease-carrying organisms, which live in the same environment as the fecal coliform bacteria.

- A. Fecal matter                    C. Fecal coliform bacteria  
B. Fecal concentration        D. None of the Above

223. Fecal Coliform Bacteria live in the waste material, or feces, excreted from the intestinal tract. When fecal coliform bacteria are present in high numbers in a water sample, it means that the water has received \_\_\_\_\_ from one source or another.

- A. Fecal matter                    C. Bacterial concentrations  
B. Fecal coliform                D. None of the Above

### Protozoans and Metazoans

224. Which of the following or bugs and the relative abundance of certain species can be a predictor of operational changes within a treatment plant?

- A. Nematodes and rotifers            C. Protozoans and metazoans  
B. Macroinvertebrates                D. None of the Above

225. In a wastewater treatment system, the next higher life form above bacteria is?

- A. Nematodes    C. Protozoan(s)  
B. Rotifers        D. None of the Above

226. Which of the following or bugs are also indicators of biomass health and effluent quality?

- A. Aerobic flocs                    C. Biomass health and effluent quality  
B. Protozoans                        D. None of the Above

227. Which of the following or bugs are very similar to protozoans except that they are usually multi-celled animals?

- A. Nematodes and rotifers            C. Worms  
B. Metazoan(s)                        D. None of the Above

### Dispersed Growth

228. According to the text, while a small amount of \_\_\_\_\_ between the floc particles is normal, excessive amounts can be carried through a secondary clarifier.

- A. Denitrification                    C. Bulking sludge  
B. Dispersed growth                D. None of the Above

### Paramecium sp.

229. Paramecium may also be seen paired up with a \_\_\_\_\_ which makes a good diagnostic key.

- A. Shelled amoeba(s)            C. Vorticella  
B. Paramecium                        D. None of the Above



230. Which of the following bugs is a medium to large size (100-300  $\mu\text{m}$ ) swimming ciliate, commonly observed in activated sludge, sometimes in abundant numbers?

- A. Shelled amoeba(s)
- B. Paramecium
- C. Euglypha
- D. None of the Above

231. Which of the following bugs is uniformly ciliated over the entire body surface with longer cilia tufts at the rear of the cell.

- A. Paramecium
- B. Euglypha
- C. Shelled amoeba(s)
- D. None of the Above

### Activated Sludge Bugs

232. The cell is highly engineered and because of this hydrolytic enzyme, it breaks the organic molecules into small units that are able to pass through the cell wall of the \_\_\_\_\_.

- A. Mixed bugs
- B. Compound
- C. Bacteria
- D. None of the Above

233. In wastewater treatment, the process of using bacteria-eating-bugs in the presence of oxygen to reduce the organics in water is called?

- A. Reduction
- B. Oxidation
- C. Activated sludge
- D. None of the Above

234. In the Activated Sludge process, the \_\_\_\_\_ are also called waste activated sludge.

- A. Organisms
- B. Settled bugs
- C. Mixed liquor
- D. None of the Above

235. The first group is the bacteria which eat the dissolved organic compounds is generally four (4) groups of bugs that do most of the "eating" in the \_\_\_\_\_ process.

- A. Mixed liquor
- B. Settled bugs
- C. Activated sludge
- D. None of the Above

236. The second and third groups of bugs are microorganisms known as the free-swimming and \_\_\_\_\_. These larger bugs eat the bacteria and are heavy enough to settle by gravity.

- A. Stalked ciliates
- B. Suctoria
- C. Activated sludge bugs
- D. None of the Above

237. Which bug feeds on the larger bugs and assist with settling is in the fourth group, known as?

- A. Water bear
- B. Suctoria
- C. Rotifer
- D. None of the Above

238. The Bacteria have several interesting properties--their "fat reserve" is stored on the outside of their body and this strange feature?

- A. Fur
- B. Feet
- C. No Mouth
- D. None of the Above

239. Once the bacteria have "contacted" their food, they start the digestion process. A chemical Enzyme is sent out through the cell wall to break up the \_\_\_\_\_.

- A. Mixed liquor
- B. Organic compounds
- C. Total Dissolved Solids
- D. None of the Above

240. An asset in settling the bug is its fat storage property and as the bugs “bump” into each other, the fat on each of them sticks together and causes flocculation of the \_\_\_\_\_.

- A. Mixed liquor
- B. Floc
- C. Non-organic solids and biomass
- D. None of the Above

241. What does facultative mean as far as bugs? What environments are they adaptable to survive and multiply in?

- A. Aerobic only
- B. Anaerobic only
- C. Either anaerobic or aerobic conditions
- D. None of the Above

242. The next step as in the text, this substance, which is the activated sludge, is used again by returning it to the influent of the aeration tank for mixing with the primary effluent and ample amounts of air?

- A. Carry over
- B. RAS
- C. Solids biomass
- D. None of the Above

243. We need to be able to properly identify the bugs and which commonly found bug is a medium size to large swimming Ciliate, commonly observed in activated sludge, sometimes in abundant numbers?

- A. Vorticella
- B. Euglypha
- C. Paramecium
- D. None of the Above

**Vorticella sp.**

244. Which of the following bugs feeds by producing a vortex with its feeding cilia?

- A. Shelled amoeba(s)
- B. Vorticella
- C. Euglypha
- D. None of the Above

245. According to the text, if treatment conditions are bad, for example, low DO or toxicity, \_\_\_\_\_ will leave their stalks.

- A. Shelled amoeba(s)
- B. Euglypha
- C. Vorticella
- D. None of the Above

**Euglypha sp.**

246. Which of the following bugs spines may be single or in groups of two or three?

- A. Shelled amoeba(s)
- B. Euglypha
- C. Vorticella
- D. None of the Above

247. The shell of this bug is often transparent, allowing the hyaline (watery) body to be seen inside the shell.

- A. Euglypha
- B. Shelled amoeba(s)
- C. Euchlanis
- D. None of the Above

248. Which of the following bugs are common in soil, treatment plants, and stream bottoms where decaying organic matter is present?

- A. Shelled amoeba(s)
- B. Euglypha
- C. Stalked ciliate
- D. None of the Above

**Euchlanis sp.**

249. Euchlanis is a typical?

- A. Euglypha
- B. Shelled amoeba(s)
- C. Rotifer(s)
- D. None of the Above

**Problems may appear during the operation of activated sludge systems, including:**

250. Which of the following wastewater treatment related terms that which settles too slowly and is not compactable, and caused by the predominance of filamentous organisms?

- A. Settling sludge
- B. Organic material
- C. Bulking sludge
- D. None of the Above

251. Which of the following terms' content in clarified effluent, which may be due to too high or too low solids retention time and to growth of filamentous microorganisms?

- A. Organic material
- B. High solids
- C. Biomass health and effluent quality
- D. None of the Above

252. Which of the following wastewater treatment related terms occurs when sludge that normally settles rises back to the surface after having settled?

- A. Denitrification
- B. Bulking sludge
- C. Rising sludge
- D. None of the Above

**Filamentous Organisms**

253. Which of the following wastewater treatment related terms reach too high a concentration, they can extend dramatically from the floc particles?

- A. Filamentous organisms
- B. Floc particles
- C. Organic material
- D. None of the Above

**Filamentous Bacteria Identification**

254. The foam from *Nocardia amarae* is usually a \_\_\_\_\_ unless algae are entrapped in it, in which case it appears green and brown.

- A. Viscous brown color
- B. Staining gram-positive
- C. Gram-positive, chemoautotrophic, filamentous
- D. None of the Above

**Microthrix parvicella**

255. *Microthrix parvicella* is another common cause of?

- A. Disruptive foaming
- B. Mixotrophic
- C. Viscous brown color
- D. None of the Above

**Sphaeroliticus natans**

256. Which of the following requires high levels of oxygen are necessary?

- A. Stain gram-negative
- B. A strict aerobe
- C. Slower growing filaments
- D. None of the Above

**Filamentous Bacteria**

257. Different filamentous bacteria such as *Microthrix*, *Sphaerotilus*, *Nostocoida*, *Thiothrix* or "Type 021N" and others cause?

- A. Bulking for very different reasons
- B. Dissolved oxygen decrease
- C. Sludge bulking
- D. None of the Above

258. There is a potential for instability with \_\_\_\_\_ is an acute problem when strict demands on treatment performance are in place.

- A. Organic carbon
- B. Activated sludge
- C. High BOD
- D. None of the Above

## Biological Criteria Sub-Section

### Water Quality Criteria

259. The Clean Water Act directs the EPA to develop criteria for water quality that accurately reflect the latest scientific knowledge about the effects of pollutants on aquatic life and human health.

- A. True    B. False

260. The Clean Water Act and the EPA includes specific information on the concentration and dispersal of pollutants through biological, physical, and chemical processes as well as the effects of pollutants on biological communities as a whole.

- A. True    B. False

### Human Health Criteria

261. EPA scientists research information to determine the levels at which specific chemicals are not likely to adversely affect water quality standard(s).

- A. True    B. False

### Biological Criteria

262. The EPA is developing methodologies that states can use to assess the biological integrity of their waters and, in so doing, set protective\_\_\_\_\_?

- A. Water quality standards            C. Acute (short term) and chronic (long term)  
B. Harmful effects of pollution        D. Human health and aquatic life criteria

263. These methodologies will describe scientific methods for determining a particular aquatic community's health and for maintaining optimal conditions in\_\_\_\_\_?

- A. Allowable concentrations            C. Various bodies of water  
B. Water quality                            D. Human health and aquatic life criteria

### Genera

264. Which of the following means the microorganisms that are attached to a surface over which they grow are called "attached growth processes"?

- A. Carbonaceous BOD                    C. Suspended growth processes  
B. Attached growth processes        D. Biomat

## Laboratory Analysis/ Process Control Section

### pH Testing Section

265. When an atom loses \_\_\_\_\_and thus has more protons than electrons, the atom is a positively-charged ion or cation.

- A. A proton                                C. An electron  
B. Charge                                  D. None of the Above

266. Pure water has a pH very close to?

- A. 7    C. 7.7  
B. 7.5                                        D. None of the Above

267. \_\_\_\_\_ are determined using a concentration cell with transference, by measuring the potential difference between a hydrogen electrode and a standard electrode such as the silver chloride electrode.

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

268. Mathematically, pH is the negative logarithm of the activity of the (solvated) hydronium ion, more often expressed as the measure of the?

- A. Electron concentration
- B. Alkalinity concentration
- C. Hydronium ion concentration
- D. None of the Above

269. Which of the following for aqueous solutions can be done with a glass electrode and a pH meter, or using indicators?

- A. Primary sampling
- B. Measurement of pH
- C. Determining values
- D. None of the Above

270. The pH scale is logarithmic and therefore pH is?

- A. n universal indicator
- B. A dimensionless quantity
- C. An excess of alkaline earth metal concentrations
- D. None of the Above

271. Alkalinity in excess of which term is significant in determining the suitability of water for irrigation?

- A. 8
- B. pH of 7
- C. Alkaline earth metal concentrations
- D. None of the Above

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

- A. Chemical speciation
- B. Spectrophotometer
- C. Visual comparison
- D. None of the Above

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

- A. 1
- B. .1
- C. 10
- D. None of the Above

274. Which of the following measurements is used in the interpretation and control of water and wastewater treatment processes?

- A. Acid
- B. Alkalinity
- C. Hydrogen bond formation
- D. None of the Above

275. Which of the following are compounds that, for practical purposes, are completely dissociated in water?

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

276. The pH of a solution containing a \_\_\_\_\_ may require the solution of a cubic equation.

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

277. Sodium hydroxide, NaOH, is an example of a?

- A. Weak base
- B. Strong base
- C. Strong acid
- D. None of the Above

### **Dissolved Oxygen Testing Section**

278. Aerobic means without air and some bacteria thrive under these conditions and utilize the nutrients and chemicals available to exist.

- A. True
- B. False

279. At least two general forms of bacteria act in balance in a wastewater digester: Saprophytic organisms and?

- A. Methane Fermenters
- B. DO fermenters
- C. Butyric acid fermenters
- D. Carbon dioxide fermenters

280. Aerobes decompose inorganics in the water; the result is carbon dioxide and  $H_2SO_4$ .

- A. True
- B. False

281. Dissolved oxygen (DO) in water is considered a contaminant.

- A. True
- B. False

282. The saprophytes exist on dead or decaying materials.

- A. True
- B. False

283. The methane fermenting bacteria require a pH range of 6.6 to 7.6 to be able to live and reproduce.

- A. True
- B. False

284. Aerobic bacteria do not require oxygen to live and thrive.

- A. True
- B. False

285. Dissolved oxygen level is important because too much or not enough dissolved oxygen can create \_\_\_\_\_?

- A. Unfavorable conditions
- B. DO analysis
- C. Frequent dissolved oxygen measurement
- D. None of the Above

286. A lack of Dissolved oxygen in natural waters creates?

- A. Anaerobic conditions
- B. Denitrification
- C. Aerobic Conditions
- D. None of the Above

287. Which of the following live on the volatile acids produced by these saprophytes?

- A. Butyric acid fermenters
- B. Methane fermenters
- C. VFAs
- D. None of the Above

288. Which of the following indicate that dissolved oxygen is present?

- A. Sample(s)
- B. DO analysis
- C. Aerobic conditions
- D. None of the Above

289. \_\_\_\_\_ in a water sample can be detrimental to metal pipes in high concentrations because oxygen helps accelerate corrosion.

- A. Carbon dioxide
- B. pH
- C. Dissolved Oxygen
- D. None of the Above

290. Oxygen is an important component in water plant operations. Its primary value is to oxidize iron and manganese into forms that will precipitate out of the water. It also removes excess \_\_\_\_\_.

- A. Carbon dioxide
- B. Water sample
- C. Molecular oxygen
- D. None of the Above

291. The amount of \_\_\_\_\_ in a water sample will affect the taste of drinking water also.

- A. Carbon dioxide
- B. Water
- C. Dissolved oxygen
- D. None of the Above

### Methods of Determination

292. There are two methods that we will be using in the lab. The membrane electrode method procedure is based on the rate of diffusion of \_\_\_\_\_ across a membrane. The other is a titrimetric procedure (Winkler Method) based on the oxidizing property of the (DO).

- A. Carbon dioxide
- B. Water
- C. Molecular oxygen
- D. None of the Above

293. Many factors determine the solubility of oxygen in a water sample. Temperature, atmospheric pressure, salinity, biological activity and pH all have an effect on the (DO) content.

- A. True
- B. False

### Iodometric Test

294. The iodometric (titration) test is not a very precise and reliable for (DO) analysis of samples.

- A. True
- B. False

295. Reactions take place with the addition of certain chemicals that liberate iodine equivalent to the?

- A. Original (DO) content
- B. Dissolved Oxygen
- C. Anaerobic conditions
- D. None of the Above

296. Which of the following can liberate iodine from iodides and some reducing agents reduce iodine to iodide?

- A. Ammonia oxidation
- B. Phosphorus removal
- C. Certain oxidizing agents
- D. None of the Above

297. Which of the following effectively removes interference caused by nitrates in the water sample, so a more accurate determination of (DO) can be made?

- A. Winkler Method
- B. Dissolved Oxygen
- C. The alkaline Iodide-Azide reagent
- D. None of the Above

298. Which of the following is highly dependent on the source and characteristics of the sample?

- A. Methods of analysis
- B. DO analysis
- C. Aerobic conditions
- D. None of the Above

299. Which of the following passes through the membrane and measured by the meter?

- A. Carbon dioxide
- B. Dissolved Oxygen
- C. Only molecular oxygen
- D. None of the Above

300. Membrane electrodes provide an excellent method for \_\_\_\_\_ in polluted, highly colored turbid waters and strong waste effluents.

- A. Sample(s)
- B. DO analysis
- C. Aerobic conditions
- D. None of the Above

301. Proper samples must be taken in \_\_\_\_\_ bottles where agitation or contact with air is at a minimum.

- A. BOD
- B. DO analysis
- C. MLSS measurement
- D. None of the Above

302. Which of the following—is the one of the most important analyses in determining the quality of natural waters?

- A. Anaerobic conditions
- B. Undissolved Oxygen
- C. The dissolved oxygen test
- D. None of the Above

303. Which of the following measurement is essential for adequate process control?

- A. Dissolved oxygen
- B. DO analysis
- C. Aerobic conditions
- D. None of the Above

**Total Dissolved Solids**

304. Which of the following refers to any minerals, salts, metals, cations or anions dissolved in water?

- A. Total Solids
- B. TDS
- C. Total Suspended solids
- D. Dissolved solids

305. Which of the following comprise inorganic salts and some small amounts of organic matter that are dissolved in water?

- A. Settleability
- B. Total dissolved solids (TDS)
- C. Quality of the water
- D. Total Solids

306. The TDS test does not provide us insight into the specific water quality issues, such as: Elevated Hardness, Salty Taste, or?

- A. Total Solids
- B. TDS
- C. Corrosiveness
- D. Alkalinity

**Total Solids**

307. Which of the following includes both total suspended solids, the portion of total solids retained by a filter and total dissolved solids?

- A. Total Solids
- B. TDS
- C. Corrosiveness
- D. Alkalinity

308. Which of the following can be measured by evaporating a water sample in a weighed dish, and then drying the residue in an oven at 103 to 105° C?

- A. Total Solids
- B. TDS
- C. Total Suspended solids
- D. Alkalinity

309. Which of the following refers to matter suspended or dissolved in water or wastewater, and is related to both specific conductance and turbidity?

- A. Total Solids
- B. TDS
- C. Corrosiveness
- D. Alkalinity

310. Which of the following are the term used for material left in a container after evaporation and drying of a water sample?

- A. Total Solids
- B. TDS
- C. Total Suspended solids
- D. Alkalinity

311. The increase in weight of the dish represents the total solids. Instead of total solids, laboratories often measure total suspended solids and/or total dissolved solids.

- A. True
- B. False

**Total Suspended Solids (TSS)**

312. Total Suspended Solids (TSS) are solids in water that can be trapped by a filter.

- A. True
- B. False

313. When suspended solids settle to the bottom of a water body, they can smother the eggs of fish and aquatic insects, as well as suffocate newly hatched insect larvae.

- A. True
- B. False



314. Which of the following can also cause an increase in surface water temperature, because the suspended particles absorb heat from sunlight?

- A. Total Solids
- B. High TSS
- C. Total Suspended solids
- D. Alkalinity

315. Which of the following can fill in spaces between rocks that could have been used by aquatic organisms for homes?

- A. Oxygen
- B. High TSS
- C. Settling sediments
- D. Suspended sediment

316. Which of the following can include a wide variety of material, such as silt, decaying plant and animal matter, industrial wastes, and sewage?

- A. Total Solids
- B. TDS
- C. Total Suspended solids
- D. Alkalinity

317. Which of the following can block light from reaching submerged vegetation?

- A. Oxygen
- B. High TSS
- C. Settling sediments
- D. Suspended sediment

318. Wastewater treatment plants are designed to function as "microbiology farms," where bacteria and other microorganisms are fed oxygen and organic waste.

- A. True
- B. False

#### **Settleometer Test**

319. A simple procedure called the Settleometer Test is used to determine the settling characteristics of mixed liquor.

- A. True
- B. False

320. The test requires a settleometer, which is typically a clear plastic cylinder with a capacity of 2 liters. Graduations on the cylinder range from 100 to 1000 cubic centimeters (or milliliters) of Settled sludge per liter.

- A. True
- B. False

321. A sample of nitrates should be obtained from the discharge end of the aeration tank, being careful not to include scum in the sampling container.

- A. True
- B. False

322. It is a good idea to occasionally record the MLSS concentration volume every 5 minutes while the flocs are settling and prepare a graph of settled activated sludge versus minutes. This allows the operator to see whether bugs are settling too quickly or slowly.

- A. True
- B. False

323. Do not allow the sample to set for more than a few minutes before the settling test is performed. Determine the \_\_\_\_\_ in milligrams per liter on a portion of this sample.

- A. MLSS concentration
- B. The solids
- C. Nitrates
- D. None of the Above

324. Solids that settle too quickly may be an indication of \_\_\_\_\_ that will probably leave straggler floc in the effluent, while solids that settle too slowly or do not compact well may be washed out of the clarifier during times of high hydraulic load.

- A. Settled sludge
- B. An old sludge
- C. Sludge volume
- D. None of the Above

## Advanced Wastewater Treatment Section

### Advanced Treatment Section

#### Types of Processes

325. Which of the following operate without heating and therefore use less energy than conventional thermal separation processes such as distillation, sublimation or crystallization?

- A. Cold separation
- B. Membrane separation processes
- C. Conventional thermal separation process(es)
- D. None of the Above

326. Which of the following uses membrane technology and is widely used in the food technology, biotechnology and pharmaceutical industries?

- A. Cold separation
- B. Membrane separation processes
- C. Conventional thermal separation process(es)
- D. None of the Above

327. According to the text, it is impossible to separate the constituents of azeotropic liquids or solutes which form isomorphous crystals by distillation or recrystallization but such separations can be achieved using \_\_\_\_\_.

- A. Membrane technology
- B. Macromolecule(s)
- C. Reverse osmosis
- D. None of the Above

#### Microfiltration

328. The current primary use of MF is by industries to remove very fine particles from process water, the process has also been used as a pretreatment for?

- A. Ultra/microfiltration
- B. Fractional distillation
- C. Other membrane processes
- D. None of the Above

329. RO membranes are susceptible to clogging or filter binding unless the \_\_\_\_\_ being processed is already quite clean.

- A. Process liquid
- B. Water
- C. Total dissolved solids (TDS)
- D. None of the Above

#### Ultrafiltration

330. The smaller pore size is designed to remove colloids and substances that have larger molecules, which are called?

- A. Equal to a certain molecular weight
- B. Microfiltration or MF
- C. High-molecular-weight materials
- D. None of the Above

331. UF membranes can be designed to pass material that weigh less than or?

- A. Equal to a certain molecular weight
- B. Microfiltration or MF
- C. High-molecular-weight materials
- D. None of the Above

#### Nanofiltration

332. Nanofiltration (NF) process has been used primarily for water softening and reduction of?

- A. Process liquid
- B. Total dissolved solids (TDS)
- C. Salt or dissolved solids
- D. None of the Above

#### Reverse Osmosis

333. RO membranes have very low MWC pore size that can reject ions at very high rates, including?

- A. Chloride and sodium
- B. Total dissolved solids (TDS)
- C. Salt or dissolved solids
- D. None of the Above

### Microfiltration Specific Process

334. Microfiltration is a type of physical filtration process where a contaminated fluid is passed through a special pore-sized membrane to separate microorganisms and suspended particles from?

- A. Chloride and sodium
- B. Process liquid
- C. Salt or dissolved solids
- D. None of the Above

### Common Applications

#### Water Treatment Process

335. Which of the following presents a physical means of separation (a barrier) as opposed to a chemical alternative?

- A. Fouling membranes
- B. MF membranes
- C. Batch or semi-continuous filtration
- D. None of the Above

### Driving Force, Retentate Stream and Permeate Streams

336. Which of the following can be distinguished by three major characteristics; Driving force, retentate stream and permeate streams?

- A. Membrane filtration processes
- B. Retentate and product streams
- C. Batch or semi-continuous filtration
- D. None of the Above

### Fouling

337. A major characteristic that limits the performance of microfiltration or any membrane technology is a process known as?

- A. Cross flow filtration
- B. Performance of microfiltration
- C. Fouling
- D. None of the Above

### Nanofiltration (NF) Section

338. Nanofiltration is a relatively recent membrane filtration process used most often with low total dissolved solids water with the purpose of softening (polyvalent cation removal) and removal of \_\_\_\_\_ such as natural organic matter and synthetic organic matter.

- A. Process liquid
- B. Chloride and sodium
- C. Disinfection by-product precursors
- D. None of the Above

339. Nanofiltration is also becoming more widely used in food processing applications and for \_\_\_\_\_ and partial (monovalent ion) demineralization.

- A. Simultaneous concentration
- B. Pore dimensions
- C. Natural organic matter and synthetic organic matter
- D. None of the Above

### Reverse Osmosis Process Section

340. Which of the following is determined by the total dissolved solids content of the saline solution, or contaminated solution on one side of the membrane?

- A. This pressure differential
- B. Osmotic pressure
- C. Virtually 100% of colloidal and suspended matter
- D. None of the Above

### Brine Channel

341. The membrane material itself is a special thin film composite (TFC) polyamide material, cast in a microscopically thin layer on another, thicker cast layer of Polysulfone called?

- A. Salt water source
- B. Microporous support layer
- C. The concentrate
- D. None of the Above

342. Each sheet of membrane material is inspected at special light tables to ensure the quality of the membrane coating, before being assembled into the?

- A. Spiral wound element design
- B. Microporous support layer
- C. Amount of permeate or product water
- D. None of the Above

343. The inverse occurs with lower temperatures, in that salt passage decreases (reducing the \_\_\_\_\_ in the permeate or product water), while operating pressures increase. Or, if operating pressures do not increase, then the amount of permeate or product water is reduced.

- A. TDS
- B. Raw water
- C. Concentrate
- D. None of the Above

344. The rejection rate is the percentage of \_\_\_\_\_ rejected, or prevented from passing through the membrane.

- A. Percentage of permeate
- B. Raw water
- C. Dissolved solids
- D. None of the Above

345. A membrane with a rejection rate of 99% (usually based on Na (Sodium)) will allow only 1% of the concentration of \_\_\_\_\_ to pass through into the permeate.

- A. Percentage of permeate
- B. Raw water
- C. Dissolved solids
- D. None of the Above

346. As the raw water is processed, the concentrations of \_\_\_\_\_ increase as it passes along the membrane's length and usually multiple membranes are employed, with each membrane in series seeing progressively higher dissolved solids levels.

- A. Percentage of permeate
- B. Raw water
- C. TDS
- D. None of the Above

347. Typically, starting with seawater of 36,000 PPM, standard rejection membranes produce?

- A. Permeate above 500 PPM
- B. Permeate below 500 PPM
- C. Amount of permeate or product water
- D. None of the Above

348. Optimum flows and pressures, optimum recovery rates (the \_\_\_\_\_ from a given stream of raw water), prefiltration and other pretreatment considerations, and so forth.

- A. Percentage of permeate
- B. Multi-media filtration
- C. Amount of permeate or product water
- D. None of the Above

349. Well-designed systems employ multiple stages of prefiltration, tailored to the application, including \_\_\_\_\_ and one or more stages of cartridge filtration.

- A. Percentage of permeate
- B. Multi-media filtration
- C. Amount of permeate or product water
- D. None of the Above

350. Which of the following has proved to be the most reliable and cost effective method of desalinating water, and hence its use has become more and more widespread?

- A. Reverse Osmosis
- B. Potable water treatment
- C. Direct filtration process
- D. None of the Above

351. Which of the following is usually some 70% less than for comparable evaporation technologies?

- A. Energy consumption
- B. Component parts
- C. Direct filtration process
- D. None of the Above

352. Which of the following have been improved as well, reducing maintenance and down time?

- A. Each sheet of membrane material
- B. Microporous support layer
- C. Component parts
- D. None of the Above

353. Which of the following delivers product water or permeate having essentially the same temperature as the raw water source?
- A. Reverse Osmosis                      C. Direct filtration process  
 B. Potable water treatment            D. None of the Above
354. R/O Systems can be designed to deliver virtually any?
- A. Required product water quality      C. Amount of permeate or product water  
 B. Microporous support layer            D. None of the Above
355. Reverse osmosis, also known as?
- A. Hyperfiltration                        C. Direct filtration process  
 B. Microfiltration or MF                D. None of the Above
356. Reverse osmosis is used to purify water and remove salts and other impurities in order to improve the color, taste, or properties of the?
- A. Cross-flow            C. Fluid  
 B. Concentrate        D. None of the Above
357. RO can be used to purify fluids such as ethanol and glycol, which will pass through the reverse osmosis membrane, while rejecting?
- A. Percentage of permeate            C. Ions and contaminants  
 B. Raw water                            D. None of the Above
358. RO is used to produce \_\_\_\_\_ that are currently in place.
- A. Permeate            C. Water that meets the most demanding specifications  
 B. Concentrate        D. None of the Above
359. Reverse osmosis technology uses a process known as \_\_\_\_\_ to allow the membrane to continually clean itself.
- A. Cross-flow            C. Fluid  
 B. Concentrate        D. None of the Above
360. Which of the following passes through the membrane the rest continues downstream, sweeping the rejected species away from the membrane?
- A. Some of the fluid                      C. Purify fluid(s)  
 B. The higher the pressure              D. None of the Above
361. According to the text, the process of reverse osmosis \_\_\_\_\_ through the membrane, and the most common force is pressure from a pump.
- A. Percentage of permeate            C. A driving force to push the fluid  
 B. Concentrate                          D. None of the Above
362. Which of the following of the fluid being rejected increases, the driving force required to continue concentrating the fluid increases?
- A. The concentration                    C. Purify fluid(s)  
 B. The higher the pressure              D. None of the Above
363. RO is capable of rejecting bacteria, salts, \_\_\_\_\_, proteins, particles, dyes, and other constituents that have a molecular weight of greater than 150-250 daltons.
- A. Charged Particles                    C. Sugars  
 B. Concentrate                          D. None of the Above

364. The separation of ions with reverse osmosis is aided by?

- A. Charged Particles
- B. Concentrate
- C. Electricity
- D. None of the Above

## Disinfection Section

### Chlorine's Appearance and Odor

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

- A. -29.2 degrees
- B. - 100 degrees
- C. 29 degrees
- D. None of the Above

366. Prolonged exposures to chlorine gas may result in?

- A. Moisture, steam, and water
- B. Odor thresholds
- C. Olfactory fatigue
- D. None of the Above

### Reactivity

367. Cylinders of chlorine may burst when exposed to elevated temperatures. When there is Chlorine in solution, this forms?

- A. Hydrogen sulfide
- B. Oxomonosilane
- C. A corrosive material
- D. None of the Above

368. What is formed when chlorine is in contact with combustible substances (such as gasoline and petroleum products, hydrocarbons, turpentine, alcohols, acetylene, hydrogen, ammonia, and sulfur), reducing agents, and finely divided metals?

- A. Fires and explosions
- B. Odor thresholds
- C. Moisture, steam, and water
- D. None of the Above

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

- A. Hydrogen sulfide
- B. Hydrochloric acid
- C. Chlorinates
- D. None of the Above

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

- A. Air
- B. Moisture, steam, and water
- C. Hydrogen sulfide
- D. None of the Above

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

- A. True
- B. False

### Flammability

372. When there is a fire that involves Chlorine, the fire fight should be fought downwind from the minimum distance possible.

- A. True
- B. False

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

- A. True
- B. False

374. The effectiveness of chlorination depends on the \_\_\_\_\_ of the water, the concentration of the chlorine solution added, the time that chlorine is in contact with the organism, and water quality.

- A. Chlorine residual
- B. Chlorine demand
- C. Oxygen
- D. None of the Above

375. Chlorine may not be available for disinfection because \_\_\_\_\_ in the water (like iron, manganese, hydrogen sulfide, and ammonia).

- A. pH increases
- B. Part of it combines with other chemicals
- C. Required contact time
- D. None of the Above

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

- A. Chlorine residual
- B. Chlorine demand
- C. Free chlorine residual
- D. None of the Above

377. Which term is used when disinfection decreases, as the concentration of the chlorine increases?

- A. pH increases
- B. Chlorine level and water quality
- C. Required contact time
- D. None of the Above

378. Chlorination is more effective as?

- A. Water temperature increases
- B. Chlorine demand
- C. Water cools down
- D. None of the Above

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

- A. Water's pH increases
- B. Water quality increases
- C. Required contact time is maximized
- D. None of the Above

380. Chlorination is less effective in?

- A. Clear water
- B. Cloudy (turbid) water
- C. Day time
- D. None of the Above

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

- A. pH increases
- B. A free chlorine residual
- C. Required contact time
- D. None of the Above

### **Chlorination Chemistry**

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

- A. True
- B. False

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

- A. True
- B. False

384. The disassociation of chlorine gas  
 ( $\text{OCI}^-$ ):  $\text{HOCl} \rightarrow \text{H}^+ + \text{OCI}^-$  Also expressed  $\text{HOCl} \rightarrow \text{H}^+ + \text{OCI}^-$   
 (hypochlorous acid) (hydrogen) (hypochlorite ion)  
 A. True B. False
385. All three forms of chlorine produce Sodium hypochlorite when added to water.  
 A. True B. False
386. Hypochlorous acid is a strong acid but a weak disinfecting agent. The amount of hypochlorous acid depends on the pH and temperature of the water.  
 A. True B. False
387. According to the text, pH and temperature affect the ratio of hypochlorous acid to hypochlorite ions. As the temperature is decreased, the \_\_\_\_\_ increases.  
 A. Reduction Ratio C. "CT" disinfection concept  
 B. Ratio of hypochlorous acid D. None of the Above
388. Although the ratio of \_\_\_\_\_ is greater at lower temperatures, pathogenic organisms are actually harder to kill.  
 A. Hypochlorous acid C. Total chlorine  
 B. The amount of chlorine D. None of the Above
389. If all other things were equal, \_\_\_\_\_ and a lower pH are more conducive to chlorine disinfection.  
 A. Lower pH C. Higher water temperatures  
 B. Hypochlorous acid D. None of the Above

### Alternative Disinfectants Sub-Section

390. It is recommended that Chloramine be used in conjunction with a stronger disinfectant. It is best utilized as a?  
 A. Chloramine C. Stable distribution system disinfectant  
 B. T10 value disinfectant D. None of the Above

### Chlorine Dioxide

391. Which term provides good Giardia and virus protection but its use is limited by the restriction on the maximum residual of 0.5 mg/L  $\text{ClO}_2$ /chlorite/chlorate allowed in finished water?  
 A. Chlorinated byproducts C. Ammonia residual(s)  
 B. Chlorine dioxide D. None of the Above
392. If chlorine dioxide is being used as an oxidant, the preferred method of generation is to entrain this term or substance into a packed reaction chamber with a 25% aqueous solution of sodium chlorite ( $\text{NaClO}_2$ ).  
 A. Chloramine C. Chlorine dioxide  
 B. Chlorine gas D. None of the Above
393. According to the text, which chemical is explosive and can cause fires in feed equipment if leaking solutions or spills are allowed to dry out?  
 A. Dry sodium chlorite C. Ammonia  
 B. Chlorine dioxide D. None of the Above



394. Chlorine dioxide may be used for either taste or odor control or as a?

- A. Chloramine
- B. Pre-disinfectant
- C. Gas
- D. None of the Above

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

- A. True
- B. False

**Ozone**

396. Ozone does not produce chlorinated byproducts (such as trihalomethanes) but it may cause an increase in such byproduct formation if it is fed ahead of free chlorine; ozone may also produce its own oxygenated byproducts such as  $Cl_2 + NH_4$ .

- A. True
- B. False

397. Ozonation must include adequate ozone leak detection alarm systems, and an ozone off-gas destruction system.

- A. True
- B. False

398. Ozone is a very effective disinfectant for both Giardia and viruses

- A. True
- B. False

399. Ozone does not provide a system residual and should be used as a primary disinfectant only in conjunction with?

- A. Dry sodium chlorite
- B. Chlorine dioxide
- C. Free and/or combined chlorine
- D. None of the Above

400. When determining Ozone CT (contact time) values must be determined for the ozone basin alone; an accurate \_\_\_\_\_ must be obtained for the contact chamber, and residual levels.

- A. Residual
- B. T10 value
- C. Contact time
- D. None of the Above

**When finished with your assignment.**

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