Water Quality C - Water Quality- Division C - Rickards Invitational Div. C - 12-05-2020

- **Teams may have the following:**
  - **One stand-alone, non-programmable, non-graphing calculator.**
  - **One hard copy 8.5" x 11" sheets of paper with information from any source. Electronic notes are fine to use.**
- **Partial credit will be awarded accordingly.**
- **If you are not certain as to what you should be doing, or if a question does not make sense to you, ask the event superviso what to do.**
- **For fill-in-the-blank questions, assume your answer to be singular unless you're given different instructions.**
- **You have 50 minutes to complete this test. Good luck!**

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Part I: Marine & Estuary Ecology

1. (2.00 pts)   Select all the appropriate compounds that are responsible for most HABs?

(Mark **ALL** correct answers)
- ☐ A) Carbon dioxide
- ☐ B) Nitrates
- ☐ C) Sulphates
- ☐ D) Phosphates

2. (1.00 pts)   Which of the following symbiotic relationships describes the following image of these two organisms:

- ○ A) Commensalism
- ○ B) Mutualism
- ○ C) Parasitism
- ○ D) Predator-Prey

3. (1.00 pts)   Which of the following is biologically unobtainable in regards to the water cycle?

○ A) Soil

○ B) Plant bodies

○ C) Ground water

○ D) Surface water

4. (2.00 pts)
A 55.3 mL water sample was found to contain 0.734 mg of sodium. What is the concentration of sodium in the sample, in **molarity**? Use the appropriate number of significant figures in your answer. ^ = "power of" , x = "times", and M = molarity. **Spacing** will matter. **Example answer: 2.51 x 10^-5 M**

[   ]

5. (2.00 pts)   What is the concentration of the sample in question 4, in parts per million (ppm)? Round if necessary.

○ A) 5.77 ppm
○ B) 4.71 ppm

○ C) 13.3 ppm
○ D) 8.75 ppm

6. (1.00 pts)   Which of the following answer choices is not a nonpoint source pollution?

○ A) Runoff from a farming field.

○ B) Company workers dredging a harbor.

○ C) Suburban dwellers dumping battery acid.

○ D) Bass boats leaking motor oil.

7. (1.00 pts)   What type of device is a Septic Snooper?

○ A) Thermometer

○ B) Seeepage meter

○ C) Mini-piezometer

○ D) Fluorometer

8. (1.00 pts)   Which of the following answers correctly orders the soil horizon from top-down?

○ A) O, E, B, C, A, R

○ B) R, C, B, E, A, O
○ C) O, E, A, B, R, C

○ D) O, A, E, B, C, R

9. (1.00 pts)   Phosphates leach more readily into surface and groundwaters than nitrates.

○ True   ○ False

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10. (2.00 pts)   Which of the following answers highlights the effects of high dissolved oxygen concentration in wastewater treatments?

(Mark **ALL** correct answers)

☐ A) Favors filamentous organisms that won't settle in clarifiers.

☐ B) Insufficient BOD removal.

☐ C) Wastes energy.

☐ D) Odors.

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11. (1.00 pts)
Which of the following answers highlights the effects of a low F/M, or Food to Mass Ratio- ratio of influent BOD/ day to mass of microorganisms in a sequential batch reactor?

○ A) Microorganisms can't handle all the "food".

○ B) Insufficient BOD removal.

○ C) Favors filamentous microorganisms causing poor settling.

○ D) Viscous bulking causing poor settling.

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12. (1.00 pts)   Which of the following characteristics about K strategists is false?

○ A) Large size, slow growth.

○ B) Long life span.

○ C) Opportunistic species.

○ D) Few offspring with low mortality and care-taking of young.

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13. (1.00 pts)   The strongest change in salinity over a certain depth occurs in which oceanic water column?

○ A) Thermocline

○ B) Pycnocline

○ C) Halocline

○ D) Deep Layer

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14. (1.00 pts)   The most common wastewater treatment disinfection process is:

○ A) Ultraviolet light

○ B) Ozonation

○ C) Chlorination

○ D) Sterilization

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15. (2.00 pts)   Which of the following is the geometric mean of the following fecal coliform sample counts: 12, 573, 2500?

○ A) 1,028

○ B) 984

○ C) 3,085

○ D) 258

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16. (1.00 pts) What will happen to the pH of water if chlorine gas was injected into it?

○ A) Increase in pH

○ B) Decrease in pH

○ C) Fluctuates in pH

○ D) No change in pH

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17. (1.00 pts) The nitrogen cycle process that converts NO_3^- to N_2 is called:

○ A) Nitrification

○ B) Ammonification

○ C) Denitrification

○ D) Assimilation

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18. (1.00 pts) What does a Secchi disk measure?

○ A) Total solids

○ B) Fecal coliforms

○ C) Turbidity

○ D) Dissolved oxygen

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19. (2.00 pts) Which of the following compound(s) would not be categorized as PFAS chemicals?

○ A) Perfluoroocotanesulfonic acid

○ B) GenX

○ C) Ammonium perfluorononanesulfonate

○ D) Perfluoro-4-(perfluoroethyl)cyclohexylsulfonate
○ E) Dichlorobiphenyl

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20. (1.00 pts) What is the MCL for Arsenic?

○ A) 1 mg/L

○ B) 0.1 mg/L

○ C) 0.01 mg/L

○ D) 0.001 mg/L

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21. (1.00 pts)   Under a pH of 6, which of the following processes is inhibited?

○ A) Nitrification

○ B) Dentrification

○ C) Ammonification

○ D) Assimilation

**22. (1.00 pts)**   Which of the following diseases is captured on the following image:

○ A) White Plague

○ B) White Band

○ C) White Pox

○ D) Aspergillosis

23. (1.00 pts)

Many scientists categorize the distribution of estuary organisms to better understand an estuary community. Which category would an organism that can tolerate living in the estuary's mouth at 20% salinity:

○ A) Euryhaline marine organisms

○ B) Estuarine organisms

○ C) Oligohaline organism

○ D) Stenohaline marine organisms

24. (1.00 pts)   Which of the following coral reefs identifies the image below:
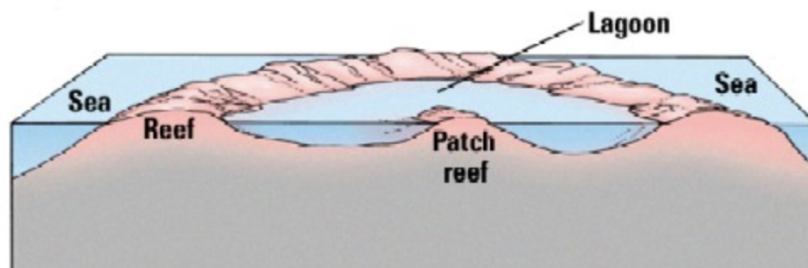
○ A) Barrier

○ B) Atoll

○ C) Fringing

○ D) Bar-built

Soil plays an important role in septic systems for wastewater treatment once effluent contacts the soil and microbes feed on wastewater nutrients to form microbial mats. Soil type plays a role in effluent rates. Use the soil textural triangle below to answer the following questions:

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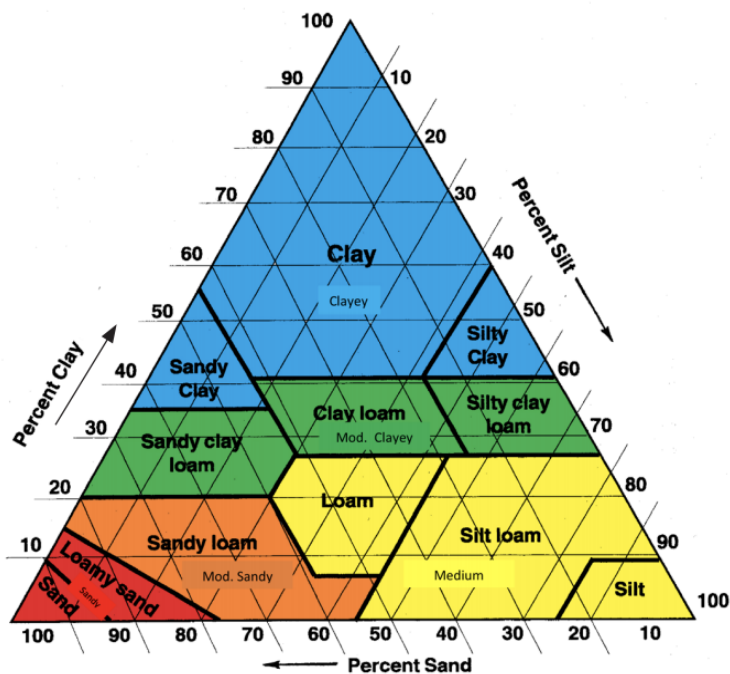
25. (1.00 pts) A soil composition of 18% sand, 37% silt, and 45% clay will have which of the following texture:

○ A) Clay

○ B) Clay Loam

○ C) Silty Clay

○ D) Silty Clay Loam

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26. (1.00 pts) Determine the soil texture based on thee following properties:

- Aeration: Medium
- Water-holding capacity: Poor
- Water-infiltration capacity: Good
- Nutrient-holding capacity: Poor
- Workability: Good

○ A) Clay

○ B) Silt

○ C) Sand

○ D) Loam

There are many other sources of chloride ions such as runoff from salted roads or the mixing of seawater with freshwater. An experiment was conducted to measure the salinity of an estuary, specifically it's chloride concentration from $CaCl_2$, using a

- Chloride ISE. Salinity (ppt) = 0.0018066 * Cl⁻ (mg/L). The data that scientists acquired:

27. (2.00 pts)
Determine the salinity of water in terms of chloride concentration (ppt). **Hint: 1 mL/L = 1000 mg/kg.** Two sig figs. Round if necessary. **Example answer: 0.053 ppt**

> [_____]

28. (1.00 pts)   The food chain concept involves the flow of energy and the recycling of nutrients. Based on the following image, the planktivorous fish can be categorized as:
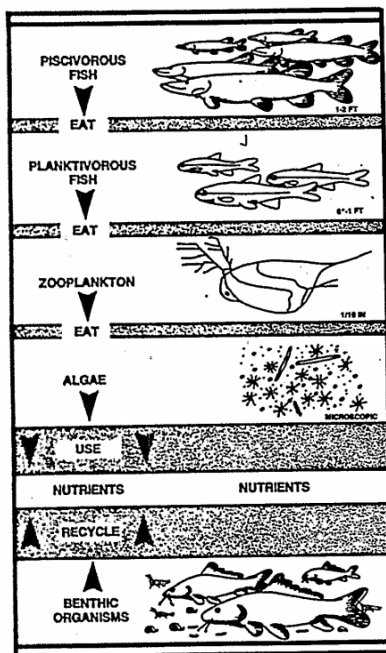
○ A) Detritivores

○ B) Quaternary Consumers

○ C) Secondary Consumers

○ D) Producers

○ E) Tertiary Consumers

Imagine an aquaculture site near a farmer's field (now eroding) that was infested with DDT. Wind blows some of the pesticide into the lake, threatening the above food chain with DDT. Each zooplankton receives 1 unit of DDT. Answer the following questions pertaining to this biomagnification.

29. (2.00 pts)   If each planktivorous fish eats 150 zooplankton in a year, how many DDT units will the fish accumulate? **Example answer: 790 units of DDT**

> [_____]

30. (2.00 pts)   If each piscivorous fish eats 70 planktivorous fish in a year, how many DDT units will the piscivorous fish accumulate? **Example answer: 790 units of DDT**

Use a comma in your answer if needed.

[   ]

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31. (1.00 pts)   Wastewater is 99.9% water while the 0.1% remaining contains organic matter, inorganic compounds, and microorganisms.

○ True   ○ False

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32. (1.00 pts)   Finish the following equation by balancing the coefficient: $NH_4 + \_\_ O_2 \gg NO_2^{2-} + 2H^+ + H_2O$ | Numerical answer only. No decimals, spaces or letters.

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33. (2.00 pts)   Which of the following compounds is the most expensive chlorine-releasing compound used for chlorination processes?

○ A) $NaOCl$

○ B) $Ca(OCl)2$

○ C) $Cl2$

○ D) $KOCl$

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34. (1.00 pts)   Which of the following correctly exemplifies a Type I, II, and II organism in that order?

○ A) Rhino, Trees, Wrasse

○ B) Hydra, Human, Oyster

○ C) Humpback Whale, Warbler, Dandelion

○ D) Tree, Squirrel, Human

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35. (1.00 pts)   A sample of water has a pH of 1.0. A doubling of the pH from 1.0 to 3.0 would change the acidity by a factor of:

○ A) 3

○ B) 1/3

○ C) 1,000

○ D) 0.01

○ E) 0.001

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36. (2.00 pts)   **Describe** why the term garbage "patch" is misleading when understanding its environmental impact?

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37. (3.00 pts) **What** does GPGP stand for? Besides location, **why** is it unique compared to other gyres?

38. (1.00 pts) An increase in surface seawater CO_2 levels results in a:

○ A) Increase in Ω.

○ B) Decrease in Ω.

○ C) Ω equals to 1.

○ D) No change to Ω.

39. (2.00 pts) What can you conclude if in the Lotka-Volterra equations that x or y equal to zero?

Refer to the below population age structure when answering the following questions.
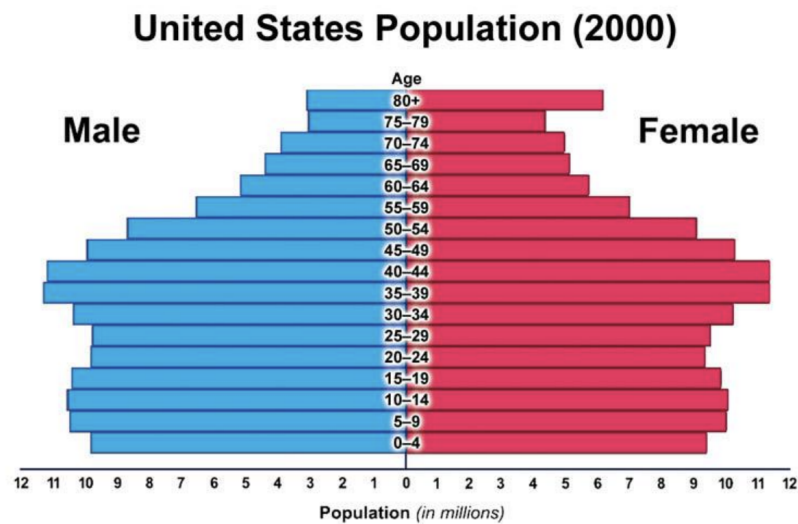
40. (3.00 pts) What type of population pyramid is this? In which categories are the populations the highest?

41. (2.00 pts) In which age category is the population of males and females the most different? Why do you think that is?
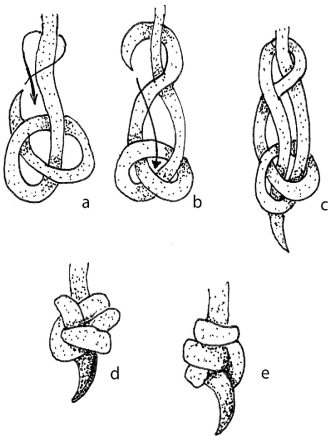
42. (1.00 pts)   How many millions of males and females are shown in your age category?

Part II: Coral Reef Fauna & Fauna Identification

Figure A

Figure B

43. (2.00 pts)   Identify the above image (**Figure A**) (Don't worry, it doesn't bite, or does it…). **Common name only.**

44. (2.00 pts)   Which of the following correlates to this organism's embryonic development?
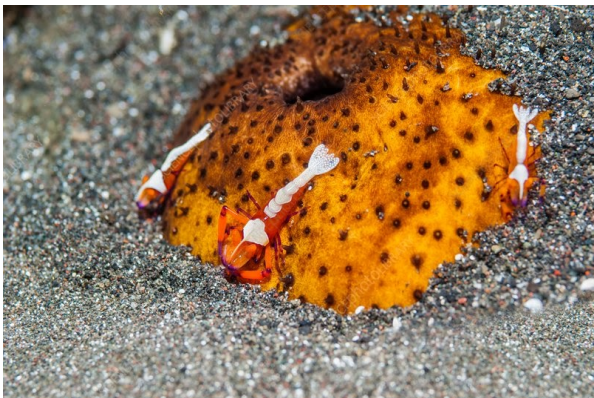
○ A) Ovoviviparous

○ B) Viviparous

○ C) Oviparous

○ D) Matritrophous

45. (3.00 pts) **Describe** the process behind the organism's feeding behavior in **Figure B**. **Why** does **Figure B** do this?

Figure C

Figure D

46. (2.00 pts) Identify the above image (**Figure C**). **Common name only.**

47. (3.00 pts)
- **What** is the scientific name for the creatures on another kind of **Figure C**?
- **Describe** the symbiotic relationship in the **Figure D**.

48. (2.00 pts)   How does this organism (**Figure C**) play a role in a pearl fish's life cycle?

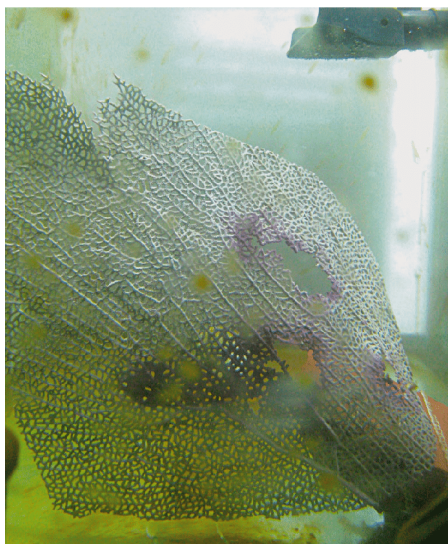**49. (1.00 pts)**   Which of the following organisms are predators?

(Mark **ALL** correct answers)

☐ A) Flamingo Snail

☐ B) Humans

☐ C) Tuns

☐ D) Polynoids

50. (4.00 pts)   • The toxic chemical that it releases as a defense mechanism is similar to what group of compounds?
   • What are those white expelled contents called? Describe the purpose for them.

Figure E

51. (2.00 pts)   Identify the above organism. **Two-word answer**. **Common name only.**

52. (2.00 pts)   What disease does this organism have?

53. (6.00 pts)
- What structure acts as a holdfast organ as the base expands?
- **Describe** the relationship between **Figure E** and zooxanthellae?
- As an adult, how does **Figure E** maximize food exposure?

Figure F

54. (5.00 pts)
- **Identify** the above organism.
- **Identify** this organism's active prey.
- **Describe** the gripping, killing, and consumption.
- **Where** in the prey does the organism began consumption?

55. (7.00 pts)
- **Identify** and **describe** the structure that helps **Figure F** prevent dehydration?
- **What** is the structure made out of?
- **Describe** the other purpose that it serves?
- **Name** the alternative structure that many pulmonate species create?

Figure G

56. (2.00 pts)   Identify the above organism by its **scientific family name**.
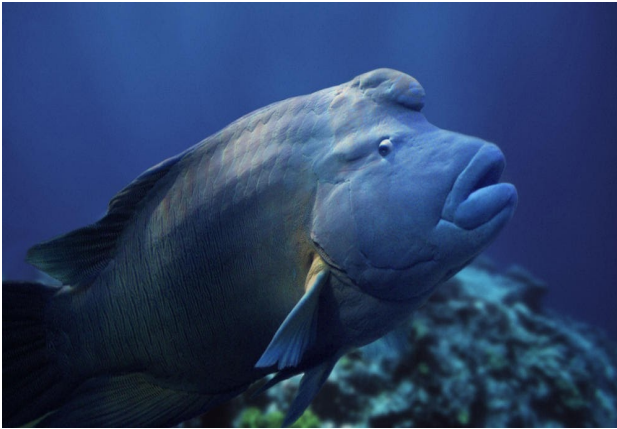
Figure H

Figure I

57. (4.00 pts)
- **Identify** the above organism (**Figure H**).
- **What** is the fisherman (**Figure I**) spraying?
- **What** type of fishing is this called?
- **Identify** one of this organism's prey from the SciOly Water Quality rules.

Part III: Water Monitoring

58. (3.00 pts)
A baby lives in a rural region where their only source of water is from an unregulated well. The baby drinks the water and presents to the village clinic, lethargic and cyanotic. What is the name of the underlying medical condition called? **Three-word answer.**

[ ] [ ] [ ]

59. (3.00 pts)   What does WAS stand for?

[ ] [ ] [ ]

60. (2.00 pts)   What is a temporary solution for acidification in digester operations?

**61. (2.00 pts)**   What is the name of the device below?

62. (4.00 pts)
A chlorine feed system uses this device (from #10). It is set at 60 lb/day. If the chlorine gas is applied for 30 minutes to a 40-foot diameter tank containing water to the 20-feet level, what is the **chlorine dosage** in mg/L? **1 sig fig**. **Partial credit is possible.**

- Dose, mg/L = (Pounds of Chemical, lbs)/(8.34 lbs/gal) (gallons, in millions)
- 1 day = 1,440 minutes
- 1 cu ft. = 7.48 gallons
- V = ($\pi/4$ * D^2 * H); D = Diameter; H = Height

63. (2.00 pts)   Calculate the **chlorine demand** if the measured chlorine residual test after thirty minutes of contact time is 0.5 mg/L. **Partial credit is possible.**

64. (4.00 pts)   The following questions will ask you to identify the following type of treatment plant, its parts, and relevant water quality questions:

- Identify the type of water treatment plant pictured below (Label A)?
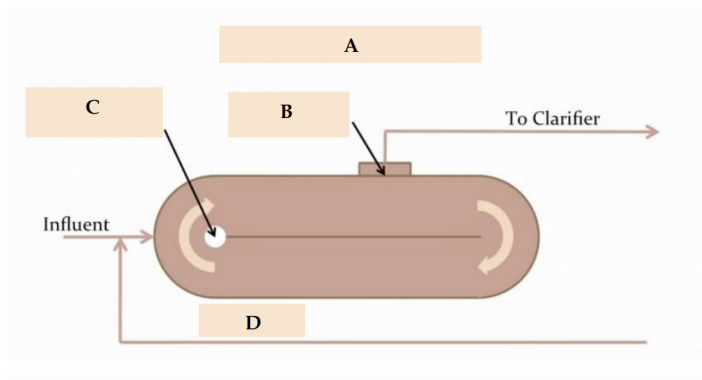
- Use that image to correctly **identify** B, C, and D.

A water sample is taken from a stream that passes through soils containing gypsum ($CaSO_4$), some of which dissolves. The stream already carries some Ca^{2+} and some SO_4^{2-} dissolved from other mineral sources. Laboratory analysis of the water shows SO_4^{2-} = 347 mg/L; Ca^{2+} = 562 mg/L. The solubility product is $2.4 * 10^{-8}$.

65. (2.00 pts)   Calculate the concentration of Ca^{2+} in **2 sig figs** and **"M" units**. **Example answer: 2.6 x 10^-9 M. No "." after M. Be careful with spacing.**

> [   ]

66. (2.00 pts)   Calculate the concentration of SO_4^{2-} in **2 sig figs** and **"M" units**. **Example answer: 2.6 x 10^-9 M. No "." after M. Be careful with spacing.**

> [   ]

67. (2.00 pts)   Will gypsum precipitate develop in the stream? **True** for **Yes**, **False** for **No**.

○ True   ○ False

A 50.0 mL sample of wastewater from a conventional household septic tank was placed into a 300 mL BOD beaker. The rest of the bottle is filled with aerated dilution water. The initial dissolved oxygen was 7.60 mg/L and after 5 days the dissolved oxygen was 3.80 mg/L.

68. (2.00 pts)   **What** is the BOD_5 of the water sample in mg/L? **Round** your answer to the nearest whole number.

> [   ]

69. (2.00 pts)
- **What** is the typical BOD_5 concentration found in a conventional household septic tank?
- **Determine** whether or not the calculated sample concentration is more or less than found in a typical household septic tank.

> [   ]

Part IV: Free Response

70. (8.00 pts)
Describe the physical and chemical process behind the primary and secondary wastewater treatment system. **Give** at least three physical/chemical components for **each** treatment.

Hydraulic residence time (HRT) is an important factor to consider in restoration programs to prevent odors, fishkills, increased phosphorus and ammonia concentrations, and other undesirable effects. Use the following image to answer the first question:

Inflow =

Water volume =

Outflow =
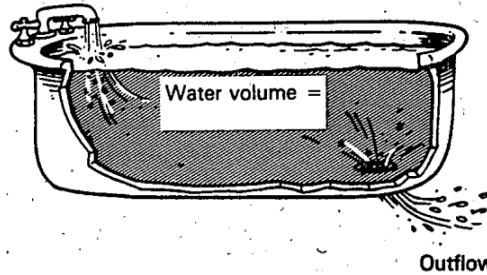
71. (2.00 pts)
Calculate the HRT of this bathtub if the drain was only **half-opened** Include the correct units. **1 sig fig**. **Example answer: 3 minutes. Include "minutes" not min. in your answer.**

72. (6.00 pts)   Pretend that the bathtub is a lake basin. **Describe** what would happen to an aquatic ecosystem's <u>algal cell count</u>, <u>nutrient supply</u>, and <u>BOD</u>, if you compare:

- HRT was short (10 days or less)
- HRT was long (100 days to several years)

A Minnesota community is considering a potential design of a wastewater treatment plant made by a famous engineer. The community raw sewage has an average of 220 mg/l BOD_5 and 280 mg/L of suspended solids. Assume that the primary sedimentation process removes 50% of the suspended solids (SS) and 30% of the raw sewage BOD_5.

- 1 gal = 3.785 L
- 1 lb = 453,592 mg = 0.4536 kg.

73. (4.00 pts)   **Determine** the SS and BOD_5 concentrations in the primary sedimentation effluent flow **(mg/L)**.

74. (1.00 pts)   Is the BOD_5 concentration within range of the U.S. municipal influent? **True** means **Yes**, **False** means **No**

○ True ○ False

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75. (2.00 pts)
Determine the mass of primary sludge produced per day as <u>dry solids</u> **(lb/day)**. **Use the comma if necessary in your answer. Example answer: 2,975 lb/day. No spaces between "lb" and "day". 4 sig figs.**

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76. (3.00 pts)
Use the dry mass flow answer to find the wet sludge flow **(gallons/day)**. **Hint:** First calculate SS_{wet}. **Partial credit is possible! Round** your answer to the nearest whole number.

- Sludge concentration of 6% solids
- Specific gravity = 1.03.

[   ]

Biomanipulation was first suggested by Shapiro et al. (1975), where they believed that manipulating the ecosystem can greatly improve lake quality without the use of chemicals and machines. For example, in some lakes, the amount of algae is controlled by grazing zooplankton rather than the quantity of nutrients.

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77. (4.00 pts)
- **Describe** what may happen to higher trophic level organisms if grazed zooplankton continued to proliferate.
- **Identify** two causes of zooplankton mortality.

[   ]

- **Congratulations, you have finished the water quality examination.**
- **Feel free to fill out this test feedback survey: tinyurl.com/RateMySciolyTests.**
- **Interested in Science Olympiad-related classes? Email me, mayurchhitu@gmail.com, for more information and be sure to check out: https://sciovirtual.org/registration.**