Station 1

1) Which of the following can be considered an ecosystem?
    a) Neuse River basin
    b) a small pond
    c) the entire planet
    d) all of the above

For Questions 2-4, write the element on your answer sheet that best matches the description given in the question. Your choices are: Carbon / Oxygen / Phosphorus / Sulfur / Nitrogen

2) Required nutrient found in relatively short supply, made available to plants via bacteria
3) Required nutrient found in relatively short supply, enters ecosystems via the erosion of rocks
4) Drives the chemical reaction by which most organisms obtain energy via breaking down sugars

5) Which location pictured below is most likely to support the greatest diversity of autotrophs?

River A

River B

River C

River D

(Images: https://www.nps.gov/buff/planyourvisit/upper-district-floating.htm, https://www.videoblocks.com/video/aerial-amazing-shot-of-rafting-boats-on-a-calm-desert-river-in-utah-ruwm_jvugiyvyes7r, https://www.shutterstock.com/image-photo/muddy-river-water-flow-surrounded-by-674318503, https://www.videoblocks.com/video/aerial-crystal-clear-river-with-kayakers-and-whitewater-rafters-in-patagonia-2k-s_ixizltitjg8cx9)

6) Incremental increase in biomass generated by organisms over a period of time is called _____.

7) Wetlands can develop into _____ through the deposition of organic debris over time.
    a) Bogs
    b) Peatlands
    c) Swamps

d) Estuaries

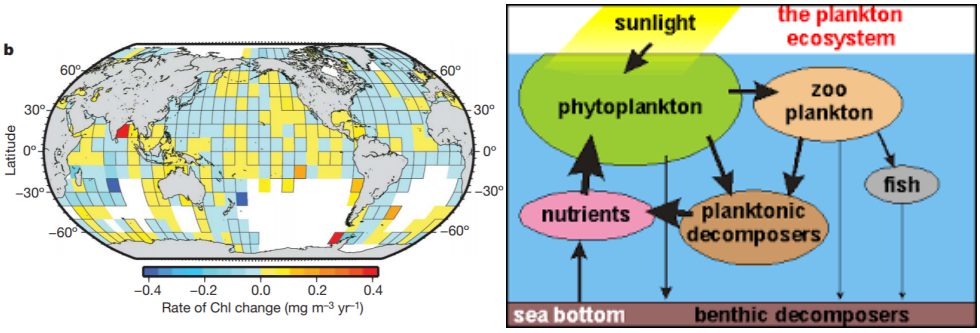
Station 1 – page 2

8) An ecologist identifies an aquatic organism with adaptations to low dissolved oxygen including large gill surface area and short distance between gills and the bloodstream. The organism is most likely native to which of the following locations?
   a) Lake
   b) River
   c) Estuary
   d) Tide Pool

9) The process by which atmospheric nitrogen (N_2) is converted into a form useable by plants is called _____.

10) What environmental phenomenon can convert N_2 directly into NO_{3-} ?

For Questions 11-12, examine the food web and map below.



(map: Boyce, Lewis, and Worm, "Global phytoplankton decline over the last century," Nature)
(food web: https://www.nano-reef.com/forums/topic/381556-phytoplankton-zooplankton-and-the-food-web/)

The map on the left shows global rates of change in the phytoplankton population. Most regions show a decline in phytoplankton.

11) What is the likely effect of this decline on the population of planktonic decomposers?
   a) Increase
   b) Decrease
   c) Stay the same
   d) Not enough information

12) The change in the population of planktonic decomposers will likely cause the phytoplankton population to _____. This is an example of _____ feedback.
   a) Increase, positive
   b) Increase, negative
   c) Decrease, positive
   d) Decrease, negative

Station 2

13) A scientist testing water deemed to have "high quality" discovers that his sample contains several impurities. Is it possible for this water to truly be "high quality"?
    a) No, only completely pure water can be called "high quality"
    b) No, the scientist must have introduced the impurities by human error
    c) Yes, even high quality water contains other molecules
    d) Yes, the impurities were introduced by human error and therefore the original water is pure

14) Ecologists analyzing a lake notice that its pH changes very little in response to acidic runoff or acid rain. The lake is probably rich in which of the following molecules/ions, which act as buffers, preventing rainwater from becoming acidic?
    a) Carbonate and bicarbonate
    b) Hydroxide
    c) Nitrates and phosphates
    d) Carbon dioxide

15) What law requires the EPA to periodically report a list of contaminants which are currently not subject to any restrictions but which may require regulations?

16) If 0.10 g of a pollutant are found in 2.0 kg of freshwater, what is the concentration of the pollutant in g/ml?

17) An increase in temperature usually causes dissolved oxygen to _____.
    a) Increase
    b) Decrease
    c) Stay the same
    d) Not enough information

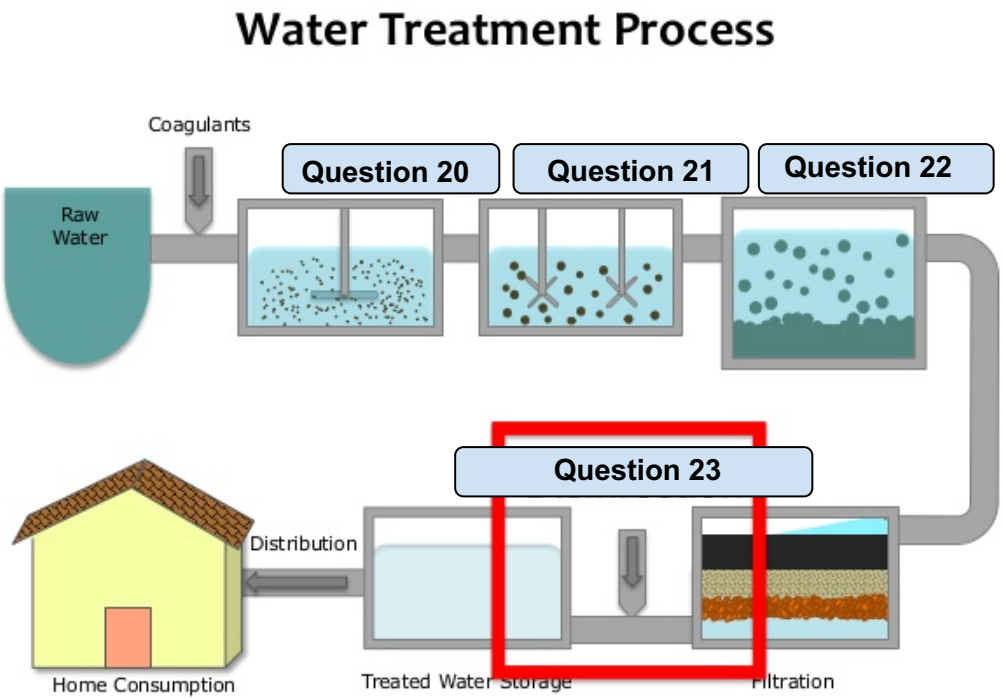
18) Given the following chemical equation, how does an increase in pH impact water fertility (dissolved carbon ions)?
    $CO_2 + H_2O \rightleftharpoons H_2CO_3 \rightleftharpoons H^+ + HCO_3^- \rightleftharpoons 2H^+ + CO_3^{2-}$
    a) Increase
    b) Decrease
    c) Stay the same
    d) Not enough information

19) Given the following chemical equation, degradation of biomass within a body of water is likely to _____ water hardness
    $CaCO_3(s) + CO_2 + H_2O$ <--> $Ca^{+2} + 2\ HCO_3^-$

a) Increase
b) Decrease
c) Stay the same
d) Not enough information

Station 3

For the following questions, use the diagram below.



20) This stage combines small particles into large particles using charge. What step in the water treatment process is this?
a) Coagulation
b) Filtration
c) Flocculation
d) Sedimentation

21) This stage combines small particles into large particles via slow and gentle mixing. What step in the water treatment process is this?
a) Coagulation
b) Filtration
c) Flocculation
d) Sedimentation

22) In this stage, large particles settle on the bottom of the tank. What step in the water treatment process is this?
    a) Coagulation
    b) Filtration
    c) Flocculation
    d) Sedimentation

Station 3 – page 2

23) This stage requires periodic backwash. What step in the water treatment process is this?
    a) Coagulation
    b) Filtration
    c) Flocculation
    d) Sedimentation

24) A North Carolina town wants to reduce the cost of drinking water treatment for their residents. They plan to switch from using a local river as a source of water to an underground aquifer and ask you to review their plans. Is this change likely to reduce cost in the long run?
    a) Yes; groundwater tends to require less treatment than surface water
    b) No; groundwater tends to require more treatment than surface water
    c) No; water from almost any source requires the same amount of treatment
    d) Not enough information

25) Which of the following is NOT a reason to use home drinking water treatment?
    a) Remove a specific contaminant
    b) Family member has a compromised immune system
    c) Remove fluoride
    d) Improve taste

26) A chemical plant treating water to remove contaminants before discharge is an example of point of _____ filtration.

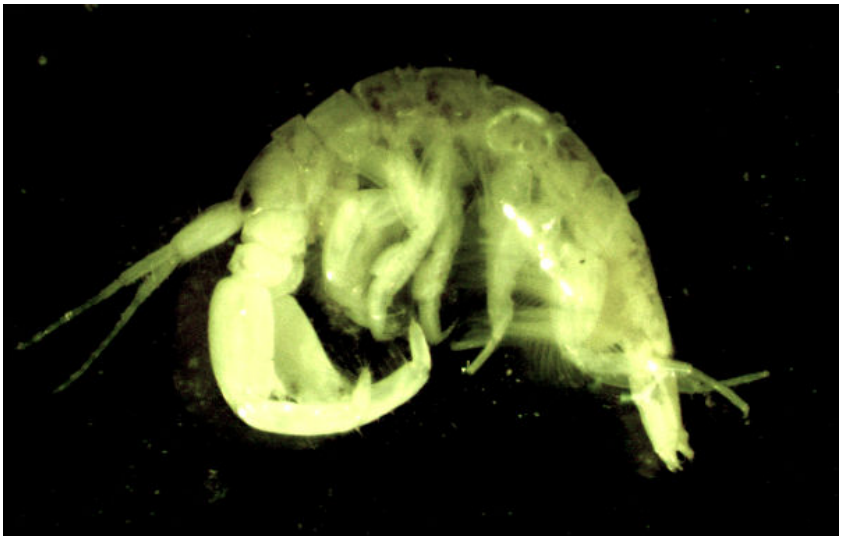
27) Which step of wastewater treatment prevents clogging of treatment machines by debris?
    a) Primary treatment
    b) Secondary treatment
    c) Tertiary treatment
    d) Screening

28) Which step of wastewater treatment involves separation of macrobiotic solid matter?
    a) Primary treatment
    b) Secondary treatment
    c) Tertiary treatment
    d) Screening

29) Which step of wastewater treatment most closely resembles drinking water treatment procedures?

a) Primary treatment
b) Secondary treatment
c) Tertiary treatment
d) Screening

Station 4



Source: (https://nas.er.usgs.gov/queries/greatlakes/FactSheet.aspx?SpeciesID=56&Potential=Y&Type=2&HUCNumber=)
Credit: Trent Henry & Gabrielle Habeeb

30) Identify the organism in the image above.

31) If an abundance of these organisms is found, what does this indicate about water quality?

32) True or False: Water bodies in which an abundance of this organism is found may contain large quantities of heavy metals

33) These organisms are
a) producers
b) carnivores
c) herbivores
d) omnivores

Source: https://fullserviceaquatics.com/

34) Identify the organism in the image to the right.

35) This organism is native to what country?

36) The mats shown in the image block the air/water interface, resulting in the reduction of _____.

Station 5

Source: https://nature.mdc.mo.gov/discover-nature/field-guide

37) Identify the organism in the image above.

38) True or False: These organisms are indicators of good water quality

39) True or False: These organisms are known to transmit harmful viruses like Zika and West Nile

40) Where do the larvae of this organism develop?

Source: https://www.wsaw.com/home/headlines/9537182.html

41) Identify the organism in the image above.

42) T/F: These organisms are indicators of good water quality.

43) Why are these organisms a poor food source for fish?

44) Under poor conditions, how does this organism reproduce?

Station 6

45) Identify the organism who makes the case shown in the image above.

46) If this organism is making a silk case, what does that indicate about the water quality?

47) This is a leech. How can you distinguish juveniles from adults for this organism?

48) True or False: If you find the organism in the water, it is considered low quality polluted water with low oxygen.

49) True or False: This organism is rarely found in fine sediments

50) In what season is this organism dormant?

Source: http://somethingscrawlinginmyhair.com

51) Identify the organism in the image above.

52) True or False: This organism is indicative of an acidic pH.

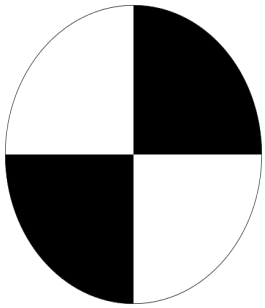
53) How does this organism sense its prey?

Station 7

54) Which of the following is the NOT a common source of phosphate pollution?

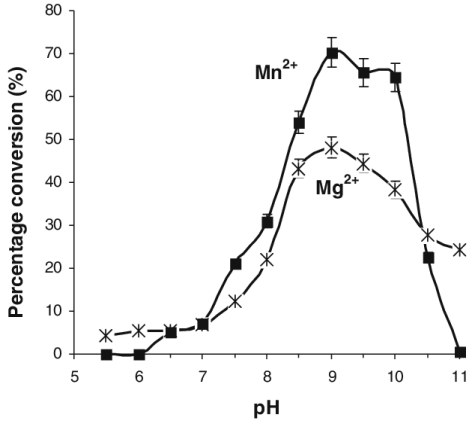
a) Poor agricultural practices
b) Septic leakage
c) Fertilizer runoff
d) Algal blooms

55) Examine the pictures below.



The person in the image above is working on a global citizen science project using the instrument depicted on the right. This instrument is called a(n) __A__ and it is used to measure ___B____.

For Questions 56-57, examine the graph below, which shows the activity of CMP-sialic acid synthetase, an enzyme involved in producing the outer layers of animal cells, at different pH ranges an in the presence of different ions.



56) What is the pH that causes the peak activity of the enzyme in the presence of Mg^{2+}?

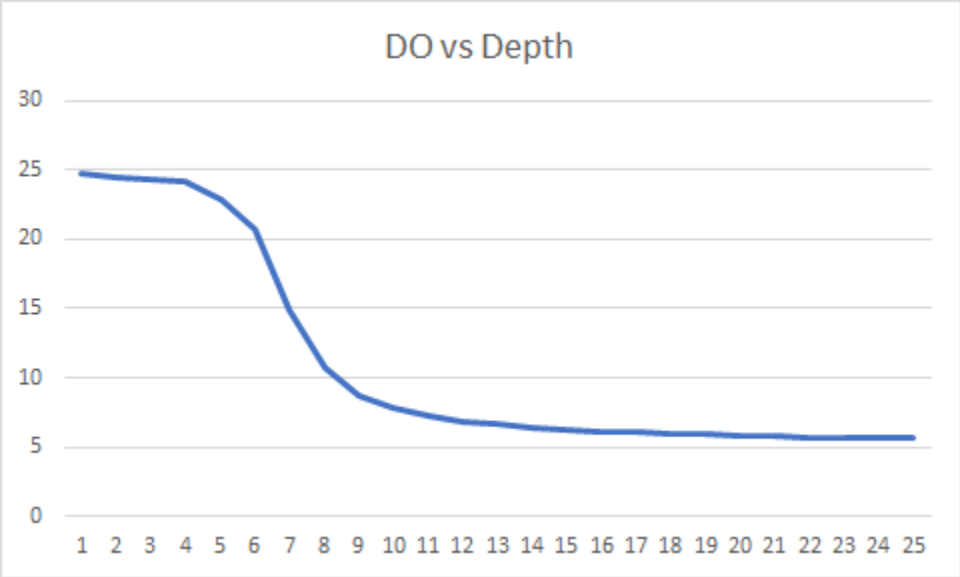
57) Based on the graph above, which of the following is true?

a) A high concentration of Mn^{2+} ions is effective in mitigating the effects of a low pH
b) Ocean acidification can harm aquatic organisms by lowering the activity of critical enzymes
c) Most rivers and streams have a pH of 8 or above due to the presence of Mn^{2+} and Mg^{2+} ions

d) At high pH levels, outer layers of animal cells are rapidly converted into their constituent ions

Station 7 – page 2

Examine the chart below:



(NLA 2007 Water Chemistry Profile)

58) Why is this trend observed?

a) Dissolved oxygen tends to dissipate over time
b) Deeper water tends to be colder, resulting in lower dissolved oxygen levels
c) Organisms deeper in the water column tend to consume more oxygen
d) Shallower depths tend to have greater aeration

Station 8


Images: https://www.nytimes.com/2018/09/19/climate/florence-hog-farms.html https://www.newsweek.com/pollution-hurricane-florence-so-bad-you-can-see-it-space-1137656

The image on the left shows a North Carolina hog farm's waste lagoon overflowing due to flooding during Hurricane Florence. Hurricanes such as Florence have the potential to cause major environmental damage by releasing contaminants from agriculture and industry into water systems; such release is shown in the image on the right.

59) Waste from livestock often contains large quantities of nitrates and other nutrients. When these nutrients enter the water supply and cause rapid growth of bacteria and algal blooms, this situation is known as _____.

60) On the axes below, sketch the general trend you would expect for dissolved oxygen over time in this scenario.

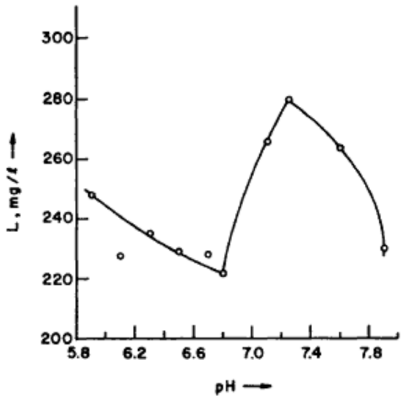
61) Overflow from waste lagoons will likely cause the water surrounding plant roots to be _____ compared to the fluid within the cells, resulting in the plants _____ water.
    a) hypertonic, gaining
    b) hypertonic, losing
    c) hypotonic, gaining
    d) hypotonic, losing

62) Which of the following environmental conditions would minimize fecal coliform contamination of surface water resulting from overflow?
    a) Aeration
    b) Cloud cover
    c) Cold front
    d) High salinity

63) Organic debris from the lagoons would be classified in what category of total solids?

Station 8- page 2

For the following questions, examine the graph below, which depicts the relationship between pH and biochemical oxygen demand at room temperature.



(Effect of pH on the Rate of BOD of Wastewater, S. K. Mukherjee, A. K. Chatterji and I. P. Saraswat)

64) The greatest dissolved oxygen will be present in wastewater with a pH of _____.
   a) 5.8-6.0
   b) 6.7-6.9
   c) 7.2-7.4
   d) 7.6-7.8

65) Assume the water was initially at a pH of 6.8 before it was contaminated with acidic fertilizer runoff. How will fertilizer contamination affect the rate of decomposition of organic matter in the floodwaters?
   a) Increase the rate
   b) Decrease the rate
   c) The rate will stay the same
   d) Not enough information

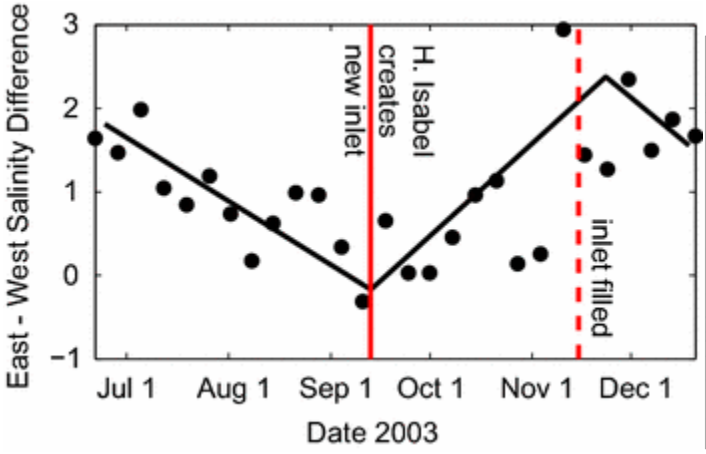
Station 9

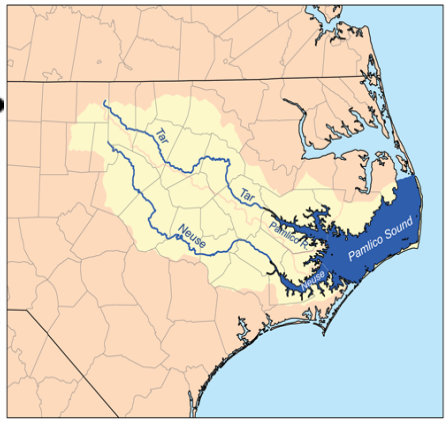
66) Use your salinometer to measure the salinity of the sample given. Record this value on your answer sheet.

67) The salinity value you measured is most characteristic of an _____.
   a) Ocean
   b) Estuary
   c) Lake
   d) Bog

Station 9 – page 2

For Questions 68-69, examine the graph below.





(Paerl et. al, Journal of Biochemistry)
(map: https://en.wikipedia.org/wiki/Pamlico_Sound#/media/File:Pamlicorivermap.png)

The graph above shows the relative difference in salinity between the eastern and western basins of the Pamlico Sound. Prior to the impact of Hurricane Isabel in September 2003, the salinity of the eastern basin was decreasing relative to the western basin because of unusually high freshwater discharge into the eastern basin.

68) When Hurricane Isabel hit North Carolina, it created a inlet resulting in the increase in East - West Salinity Difference shown on the graph. Based on the resulting trend shown in the graph, where was this inlet created and why did it result in the trend shown on the graph?
    a) Between the eastern and western basin, because exchange between the basins will increase the salinity of the eastern basin
    b) Between the eastern and western basin, because exchange between the basins will decrease the salinity of the eastern basin
    c) Between the eastern basin and the Atlantic Ocean, because exchange with ocean water will increase salinity of the eastern basin
    d) Between the eastern basin and the Atlantic Ocean, because exchange with ocean water will decrease salinity of the eastern basin

69) The inlet was filled by the NC Department of Transportation in November 2003. If the inlet remains filled, what do you predict will happen to the East - West Salinity Difference in the Pamlico Sound following 2003?
    a) It will increase
    b) It will decrease
    c) It will remain the same
    d) It is impossible to predict

Page 1 Total: _____ + Page 2 Total: _____ = _____/107
Tiebreakers: _____. Final Score: _____

2019 Regional Water Quality Division C - Student Answer Sheet

School: _____ V JV1 JV2 JV3

Student Names_____

Station 1

1. A B C D
2. (2pts) _____
3. (2pts) _____
4. (2pts) _____
5. A B C D
6. (2pts) _____
7. A B C D
8. A B C D
9. (2pts) _____
10. (2pts) _____
11. A B C D
12. A B C D

Station 2

13. A B C D
14. A B C D
15. (2pts) _____
16. (2pts) _____
17. A B C D
18. A B C D
19. A B C D

Column total: _____/27

Station 3

20. A B C D
21. A B C D
22. A B C D
23. A B C D
24. A B C D
25. A B C D
26. (2pts) _____
27. A B C D
28. A B C D
29. A B C D

Station 4

30. (2pts) _____
31. (2pts) _____
_____
32. TRUE or FALSE
33. A B C D
34. (2pts) _____
35. (2pts) _____
36. (2pts) _____

Station 5

37. (2pts) _____
38. TRUE or FALSE
39. TRUE or FALSE
40. (2pts) _____
41. (2pts) _____
42. TRUE or FALSE
43. (2pts)_____
_____
44. (2pts) _____

Column total: _____/37

Page total: _____

Station 6

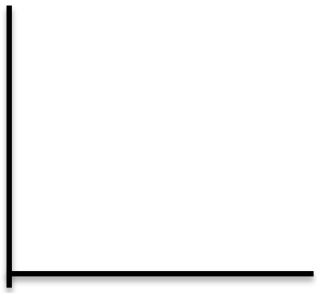
45. (2pts) _____
46. (2pts) _____
47. (2pts) _____
48. TRUE or FALSE
49. TRUE or FALSE
50. (2pts) _____
51. 2pts) _____
52. TRUE or FALSE
53. 2pts) _____

Station 7

54. A B C D
55. A.(2pts) _____
    B.(2 pts)_____
56. (2pts) _____
57. A B C D
58. A B C D

Station 8

59. (2pts) _____
60. (4 pts)



61. A B C D
62. A B C D
63. _____
64. A B C D
65. A B C D

Station 9

66. (5 pts)_____
67. A B C D
68. A B C D
69. A B C D

Tiebreakers: Best at Stations in reverse order: ie, best at station 9, then 8th

Column total: _____/24

Column total: _____/19

Page total: _____

2019 Regional Water Quality Division C - Student Answer Key

Each question worth 1 point unless noted. High Score wins.

Tiebreakers: Best at Stations in reverse order: ie, best at station 9, then 8, then 7 etc.

Station 1

1. A B C D
2. (2pts) __Nitrogen_____
3. (2pts) Phosphorus & Nitrogen both for credit
4. (2pts) __Oxygen_____
5. A B C D
6. (2pts) __Production_____
7. A B C D
8. A B C D
9. (2pts) ___Nitrogen fixation____
10. (2pts) ___Lightning_____
11. A B C D
12. A B C D

Station 2

13. A B C D
14. A B C D
15. (2pts) _Safe Drinking Water Act_
16. (2pts) ___5.0 x 10^{-5}_____
17. A B C D
18. A B C D
19. A B C D

Station 3

20. A B C D
21. A B C D
22. A B C D
23. A B C D
24. A B C D
25. A B C D
26. (2pts) ___entry__
27. A B C D
28. A B C D
29. A B C D

Station 4

30. (2pts) Scuds (Side Swimmers also acceptable)
31. (2pts) Water may be polluted. Also accept "not high levels of heavy metals or pesticides"
32. TRUE or FALSE
33. A B C D
34. (2pts) __Water Hyacinth___
35. (2pts) __Brazil_____
36. (2pts) ___Dissolved Oxygen_____

Station 5

37. (2pts) __ Horse Fly or Deer Fly _
38. TRUE or FALSE
39. TRUE or FALSE
40. (2pts) _Mud along streams, wetlands, seepage
41. (2pts) __spiny water flea_
42. TRUE or FALSE
43. (2pts)_They are spiky/hard to eat__
44. (2pts) __Sexually____

Station 6

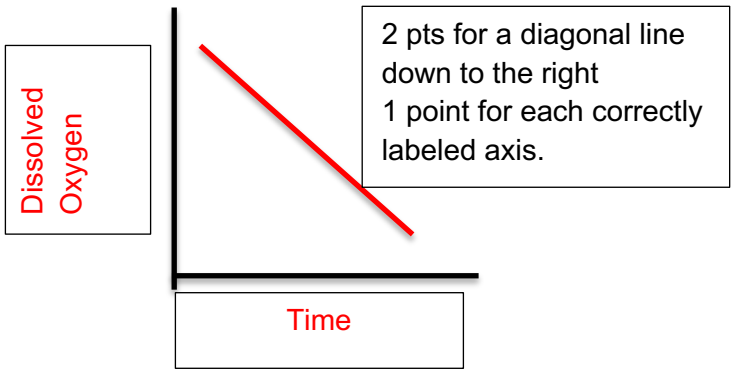
45. (2pts) ___Caddisfly_____
46. (2pts) ___low dissolved oxygen_
47. (2pts) No metamorphosis, so just size
48. TRUE or FALSE
49. TRUE or FALSE
50. (2pts) __Winter_____
51. 2pts) _ Common Backswimmer or Water Boatman _
52. TRUE or FALSE
53. (2pts) ___Vibrations___

Station 7

54. A B C D
55. A.(2pts) __Secchi Disk___
    B.(2 pts)__Turbidity_____
56. (2pts) __ Accept 8.5 – 9.5_____
57. A B C D
58. A B C D

Station 8

59. (2pts) __Euttrophication__
60. (4 pts)



61. A B C D
62. A B C D
63. __suspended_____
64. A B C D
65. A B C D

Station 9

66. (5 pts)1-3% for full credit, 0 or 5% for 1 pt
67. A B C D
68. A B C D
69. A B C D