Graphical Analysis and a Water Quality Problem

Riverwood USA has experienced a fish kill at a near by river. Hundreds of fish are dying and city/county officials are involved in solving the reason for the fish deaths. Joseph Fisker of the County Sanitation Commission has measured dissolved oxygen levels in the Snake River for 18 months. These data help the Sanitation Commission monitor the river's water quality. Fisker takes daily measurements at 9 A.M. under the bridge near Riverwood Hospital, at a water depth of one-half meter.

In addition, Fisker records the water temperature and consults a table to find the dissolved oxygen (DO) that would produce a saturated water solution at that temperature. Let's examine Snake River data for last year and also for this summer (Tables 6 and 7).

1. Construct table 6-7 on the stat editor of the calculator by assigning:
   - L1 = (table 6) Dissolved Oxygen (ppm)
   - L2 = (table 6) Water Temperature (°C)
   - L3 = (table 7) Dissolved Oxygen (ppm)
   - L4 = (table 7) Water Temperature (°C)

DIRECTIONS FOR TI-82/83

[Y=] Clear all equations
[STAT] EDIT

2. Construct a xyplot (connected points) of temperature versus dissolved oxygen for last year's data and sketch the graph.

3. How is the dissolved oxygen level related to the water temperature?

DIRECTIONS FOR TI-82/83

[2nd] [Y=]
Plots Off
[ENTER]
[2nd] [Y=]
Plot1
ON
Xlist=L2 Ylist=L1 Mark: box
[ZOOM]
ZoomStat

4. On the same graph, plot the dissolved oxygen levels and river temperatures collected during this year's summer months (Table 7). Use different plotting symbol for this set of points.

5. Sketch the graph.

[2nd] [Y=]
Plot2
ON
Xlist=L4 Ylist=L3 Mark: +
[ZOOM]
ZoomStat

(Table 6) Last Year's DOs

Month	Water Temperature (°C)	Dissolved Oxygen (ppm)
January	2	12.7
February	3	12.5
March	7	11.0
April	8	10.6
May	9	10.4
June	11	9.8
July	19	9.2
August	20	9.2
September	19	9.2
October	11	10.6
November	7	11.0
December	7	11.0

(Table 7) This Years DOs

Month	Water Temperature (°C)	Dissolved Oxygen (ppm)
June	14	10.2
July	16	9.6
August	18	9.6

6. a. Compare the dissolved oxygen concentrations measured in December and June. How do you explain this difference?
   b. How do you account for the similar concentrations in March and November?

7. Compare the average dissolved oxygen concentration in August of this year with that of August last year. What reasons might explain the difference?

In September, soon after the Riverwood fish kill, the County Sanitation Commission invited the Environmental Protection Agency to help with the river water analysis. The EPA sent Marilyn Crocker to measure dissolved oxygen in the Snake River hourly for one day. The goal was to detect any short-term changes in either the temperature or the dissolved oxygen concentration. Crocker decided to measure dissolved oxygen at the same location used by Fisker. Her data listed in Table 8.

table 8

Time	Water Temperature (degrees C)	Dissolved Oxygen (ppm)
0800 A.M.	21	9.1
0900	21	9.1
1000	21	9.1
1100	21	9.1
1200	22	9.2
1300 P.M.	23	9.3
1400	23	9.3
1500	23	9.2
1600	23	9.2
1700	23	9.2
1800	23	9.2
1900	23	9.2
2000	22	9.2
2100	22	9.2
2200	22	9.2
2300	21	9.1
2400	21	9.1
0100 A.M.	21	9.1
0200	19	9.0
0300	19	9.0
0400	19	9.0
0500	19	9.0
0600	19	9.0
0700	19	9.0

table 9 *DO NEEDED*

Water Temperature (degrees C)	100% Oxygen Saturation (ppm)
0	14.6
1	14.2
2	13.9
3	13.5
4	13.2
5	12.8
6	12.5
7	12.2
8	11.9
9	11.6
10	11.3
11	11.1
12	10.8
13	10.6
14	10.4
15	10.2
16	9.9
17	9.7
18	9.5
19	9.3
20	9.2
21	9.0
22	8.8
23	8.7
24	8.5
25	8.4

8. Construct table 8 on the stat editor of the calculator by assigning:
   L1 = Military time
   L2 = Water Temperature (°C)
   L3 = Dissolved Oxygen (ppm)

DIRECTIONS FOR TI-82/83

[Y=] Clear all equations
[STAT] EDIT

9. Construct a xyplot (connected points) of temperature versus time.

10. On the same graph, plot the dissolved oxygen levels versus time. Use different plotting symbol for this set of points.

11. Sketch the graph.

DIRECTIONS FOR TI-82/83

2nd Y=
Plots Off
ENTER
2nd Y=
Plot1
ON
Xlist=L1 Ylist=L2 Mark: box
2nd Y=
Plot2
ON
Xlist=L1 Ylist=L3 Mark: +
ZOOM
ZoomStat

Findings

1. a. Compare the two graphs. Is any pattern apparent in either graph?
   b. Can you explain any pattern that you detect?
   c. Compare the DO levels during daylight and nighttime hours. How do you account for this difference?

2. Calculate the average water temperature and the average concentration of DO for this one-day period.

3. No daily water temperatures of DO levels were reported during September this year. Thus the only possible comparison is between the average for one day in September this year and the monthly average for all of September last year. Is this a valid comparison? Why or why not?

4. Now consider the one-day Snake River measurements. Which do you think provides more useful information- the average temperature and DO values, or the maximum and minimum values? Give reasons to support your answer.

5. The DO concentrations needed for saturated water solutions at various temperatures are provided in Table 9. Use this table to decide whether the DO is below, at, or above the saturation level for each measurement in Table 8.

You'll also need the following formula:

Percent of saturation = (ppm DO measured / ppm DO for saturation) x 100%

For example, at 8 a.m. during the one-day measurements (table 8), the water temperature was 21° C and the dissolved oxygen concentration was 9.1 ppm. According to table 9, 9.0 ppm dissolved oxygen is a saturated solution at 21° C.

Percent of saturation = (9.1ppm / 9.0ppm) x 100% = *101%*

So at 8 A.M., the saturation level of dissolved oxygen was *101%- slightly supersaturated.*

6. Acceptable and unacceptable dissolved oxygen levels in river water of fish life are given below:

125% or more of saturation	Too high for survival of some fish species
80-124%	Excellent for survival of most fish species
60-79%	Adequate for survival of most fish species
Below 60%	Too low; most fish species die

7. Based on this information, do the collected data suggest that Snake River's dissolved oxygen level range is acceptable of supporting fish life?

8. Is the amount of dissolved oxygen in the Snake River a likely cause of the Riverwood fish kill? Explain.