Name: Date: Class:

O_3 Activity Worksheet Answer Key

For this activity, you need the *O3-case-study-data.xls* file, which is available from your teacher. Begin by opening this document in Excel or Google Sheets. Then work either individually or in groups to complete this worksheet. Remember to use the *Excel Reference Sheet* for help.

Background Information: This data was collected in Delta, CO, one data set from May and one from October. Both data sets include four days of minute-averaged data—in other words, each data point is the average of all data recorded during that minute.

1. Develop a **hypothesis** that explains how you expect the O_3 data to differ in the two months, and why. Record your hypothesis below. *(Hint: Think about how ozone is formed and how the required "ingredients" vary seasonally.)*

   Expect student responses to include both a prediction and an explanation.

Data Statistics

1. Calculate the following using Excel (*use Table 1 on the Excel sheet*):

	May	October
Mean (ppb)	37.1	18.4
Median (ppb)	41.8	15.3
Standard deviation (ppb)	20.3	12.5

2. Create a ***bar graph*** of the data from Table 1. *(Hint: Highlight the entire table, then click "insert," then choose the "column chart.")* Place the chart in the allocated space; label the axes and chart title.

3. Below, list two observations regarding these statistics.
   Examples responses:
   - The May mean is higher than the mean for October.
   - The median is higher in May than October.
   - The standard deviation is larger for May than October.

Visualizing the Data in Time

1. Make a ***time series*** of the data. Use the "Index Minute" values for the x-axis values and the O_3 data from the y-axis data, which lets you overlay both data sets on one graph. Also, choose the "scatter with smooth lines" option. Place the chart in the allocated space; label the axes and chart title.

2. List one similarity between the two data sets. *(Hint: Are there any patterns?)*
   Both data sets display a similar daily trend; during both months, O_3 is higher during the day and lower at night.

3. List one difference between the two data sets.
   The periods of elevated O_3 during the day are much higher in May than in October, although the minimums are similar. This also results in greater variance in the May data set.

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Examining Relationships in the Data

1. Make 2 *scatter plots* of temperature vs. O_3, one for the May data and one for the October data.
   Plot temperature on the x-axis and O_3 on the y-axis. Place the charts in the allocated space; label the axes and chart titles.

2. Do you see a relationship between O_3 concentrations and temperature?
   Is the relationship stronger for one month or the other? If so, which one?

   A positive correlation exists between temperature and O_3 concentrations; in other words, O_3 is higher at high temperatures and O_3 is lower at low temperatures. This relationship appears to be slightly stronger in May.

3. Fit a linear relationship to each scatterplot and find the R^2 value. Do the R^2 values confirm your answer to the previous question? ❑ Yes ❑ No If not, check your values.

   R^2 for May = .89 R^2 for October = .81

Final Conclusions

1. *Complete the following*: O_3 concentrations in May are generally higher than October.
   This means that O_3 appears to be greater in the spring season.

2. Based on your analysis, was your hypothesis correct? If not, explain where your analysis and your hypothesis conflict.

   Answers will vary, depending on students' original hypotheses.

3. **Putting it all together:** Temperature does not control O_3, so why do we see a correlation? Give two explanations for seasonal differences in O_3 concentrations *(Hint: Again, think what is required to form ozone, how these vary seasonally, and how they explain your analysis.)*

   In order to form ozone, we need volatile organic compounds, nitrogen oxides and sunlight. The sunlight requirement explains the daily trend: ozone forming when the sun comes out, peaking in the afternoon, and destroyed after dark. It also explains the seasonal differences: in May we have more hours of sunlight resulting in more ozone production and higher concentrations.