1. I once collected data in class on how long (in seconds) it took for a chocolate chip to melt in your mouth and for a peanut butter chip to melt in your mouth. I took the differences in these times (chocolate minus peanut butter) for each person. The sorted data, and a dotplot, for the 31 differences appear below:

![Dotplot of difference in melt times (Choc - PB) in seconds]

-41 -36 -35 -33 -31 -28 -25 -25 -20 -20
-17 -17 -16 -14 -11 -7 -6 -5 -5 -4
-4 -2 1 3 6 15 17 21 30 36
67

a) Explain what the value -41 means in terms of the student who produced that value and his/her melting times.

The mean of these 31 differences is -6.65 seconds, and the standard deviation is 23.61 seconds.

b) Conduct a test of whether the sample data provide strong evidence of a difference in melting times of chocolate and peanut butter chips on average. Report the hypotheses, test statistic, and p-value as accurately as you can.

c) Determine and interpret a 95% confidence interval based on the 31 differences.

d) Summarize your conclusion from this analysis.

e) Now suppose that you were to re-do this analysis after removing the outlier value of 67. Indicate how each of the following would change. Circle your answers. Do not bother to explain or perform any calculations.

- Mean: Decrease  Increase  Remain the same
- Standard deviation: Decrease  Increase  Remain the same
- Test statistic: Decrease (more negative)  Increase (less negative)  Remain the same
- p-value: Decrease  Increase  Remain the same

2. (10 pts) Students in an introductory statistics class were asked how many states they have visited. The following output pertains to the sample results:
a) (3 pts) Determine a 90% confidence interval for the population mean number of states visited among all students at this university.

b) (2 pts) Check and comment on whether the technical conditions of this confidence interval are satisfied.

c) (1 pts) For what proportion of students in the sample is the number of states visited within the interval from a)?

d) (2 pts) Should you expect your answer to c) to be close to 90%? Explain why or why not.

e) (2 pts) Based on your interval, what can you say about the $p$-value if you were to conduct a two-sided significance test of whether the population mean differs from 10? Explain briefly, without conducting a test or doing new calculations.

3. In a recent study, researchers investigated possible biochemical mechanisms that could be involved in the early stages of romantic love. They measures plasma level of neurotrophins for a sample of 58 subjects who had recently fallen in love. They also asked each subject to rate his/her level of passionate love feelings on a numerical scale. Researchers calculated the correlation coefficient between the level of passionate love and plasma level of neurotrophins to be $r = 0.34$.

Conduct the appropriate test of whether this sample provides strong evidence (at the $\alpha = .05$ level) of a positive correlation between these variables in the population. Report the relevant hypotheses, test statistic, $p$-value, test decision, and conclusion.

4. Between the months of September 1990 and May 1997, a statistics teacher gathered data on the average temperature for that month (in degrees Fahrenheit) and the amount of gas usage in his home for that month (in units called therms). Summary statistics for these variables follow:

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Mean</th>
<th>SE Mean</th>
<th>StDev</th>
<th>Median</th>
<th>IQR</th>
</tr>
</thead>
<tbody>
<tr>
<td>avg temp</td>
<td>71</td>
<td>46.35</td>
<td>1.80</td>
<td>15.16</td>
<td>45.00</td>
<td>26.00</td>
</tr>
<tr>
<td>gas usage per day</td>
<td>71</td>
<td>5.311</td>
<td>0.420</td>
<td>3.538</td>
<td>5.000</td>
<td>6.600</td>
</tr>
<tr>
<td>Pearson correlation of avg temp and gas usage per day</td>
<td>$= -0.930$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a) Determine and report the equation of the least squares line for predicting a month’s gas usage per day based on its average temperature.
b) In the following scatterplot with the least squares line superimposed, circle the point corresponding to the month with the largest positive residual:

![Scatterplot with least squares line](scatterplot.png)

c) Calculate the value of $r^2$, and write a sentence interpreting what this value means.

d) Predict the gas usage per day for a month in which the average temperature is 50 degrees Fahrenheit.

e) A significance test or confidence interval for the slope coefficient will be based on how many degrees of freedom?

f) Computer software reports the standard error of the sample slope coefficient to be 0.01036. Use this information to produce a 95% confidence interval for the population slope coefficient.

g) Write a sentence interpreting this interval, including what the slope coefficient means.

5. A recent study investigated whether seat position within a bus may be related to whether a passenger experiences motion sickness. The following table classifies each person in a random sample of bus riders by the location of his or her seat and whether nausea was reported:

<table>
<thead>
<tr>
<th></th>
<th>Front</th>
<th>Middle</th>
<th>Rear</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nausea</td>
<td>58</td>
<td>166</td>
<td>193</td>
</tr>
<tr>
<td>No nausea</td>
<td>870</td>
<td>1163</td>
<td>806</td>
</tr>
</tbody>
</table>

a) What proportion of those who rode in the front experienced nausea?

b) Determine the expected count for the (middle, no nausea) cell of the table. (Show your work.)

Consider the following output (notice that one entry has been replaced by **xxx**):
c) What conclusion would you draw from the above chi-square output? Explain briefly.

d) Which seating position seems to be the worst with respect to nausea? Explain how you conclusion follows from the chi-square analysis.

6. Researchers studied heart rates after engaging in physical exercise for adults who were also classified according to whether and how much they smoke. Data were collected to investigate whether there are differences in mean heart rates among various smoking classifications (heavy, light, moderate, non-smoker). The output below pertains to an ANOVA analysis addressing this issue:

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>smoking status</td>
<td>3</td>
<td>1464.1</td>
<td>488.0</td>
<td>6.08</td>
<td>0.004</td>
</tr>
<tr>
<td>Error</td>
<td>20</td>
<td>1604.8</td>
<td>80.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>23</td>
<td>3069.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a) State the appropriate null hypothesis in symbols. Also explain what the symbols mean.

b) Summarize the conclusion that you would draw from the ANOVA F-test.

7. Some of the statistical inference techniques we have studied include:
   A. One-sample z-procedures for a proportion
   B. Two-sample z-procedures for comparing proportions
   C. One-sample t-procedures for a mean
   D. Two-sample t-procedures for comparing means
   E. Paired-sample t-procedures
   F. Chi-square procedures for two-way tables
   G. ANOVA procedures
   H. Linear regression procedures

For each of the following research questions, indicate (by letter) the appropriate statistical inference procedure for investigating the question.

a) A researcher used data from the American Time Use Survey (ATUS) to investigate whether high school math teachers spend more time working per day than high school history teachers.

b) Biologists recorded the frequency of a cricket’s chirps (in chirps per minute) and also the temperature (in degrees Fahrenheit) when the cricket measurement was recorded. They investigated whether chirp frequency is a significant predictor of temperature.

c) Economists compared starting salaries of new employees across three different groups: those with graduate degrees, those with only bachelor’s degrees, and those with no higher education degrees.
d) A researcher investigated whether laughter increases blood flow by having subjects watch a humorous movie and a stressful movie, randomly deciding which movie the subject would see first, measuring the blood flow through the person’s blood vessels while watching the movie.

e) Do more than two-thirds of Cal Poly students have at least one class on Fridays this quarter?

f) Is there an association between a college student’s level of drinking alcohol (classified as none, some, or considerable) and her/his residence situation (classified as living on-campus, off-campus with parents, or off-campus but not with parents)?