Instructions: Do 6 out of the following 7 problems. However you must do questions 1 and 2. You must show your work and justify all your answers.

1) Do piano lesson improve the spatial-temporal reasoning of preschool children? A study designed to test this hypothesis measured the spatial-temporal reasoning of 30 preschool children before and after six months of piano lesson. The changes in the reasoning scores are

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<tbody>
<tr>
<td>-5</td>
<td>-2</td>
<td>-2</td>
<td>-1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
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<td>12</td>
<td>8</td>
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\[ x_1 + \ldots + x_{30} = 102, (x_1 - \bar{x})^2 + \ldots + (x_{30} - \bar{x})^2 = 445.2. \]

a) Find the 98% confidence interval for the mean improvement in the reasoning scores? Can you conclude that the spatial-temporal reasoning improve? By how much? (8 points)

b) Compute the median, and the quartiles. Are there possible outliers? What does this say about the accuracy of the conclusion in a)? (9 points)

c) Make a box plot for the distribution of readings. Is the five number summary a better numerical description than the mean and the standard deviation? (5 points)

2) A study was designed to find reasons why patients leave a health maintenance organization (HMO). In the year of the study 16 out an SRS of 200 patients who filed a complain left the HMO voluntarily. On the other hand 4 out of an SRS of 150 patients who did not file a complain left the HMO voluntarily.

a) Is there significant evidence that the proportion of patients that filed a complained and left the HMO voluntarily is higher than the proportion of patients that did not file a complained and left the HMO voluntarily? (10 points)

b) Find the 96% confidence interval for the difference in the two proportions. What is your conclusion? (8 points)
3) A box contains 3 balls marked with a one, 2 marked with a two, 5 balls marked with a three, 3 balls marked with a four, 5 balls marked with a five, 3 balls marked with a six, and 4 balls marked with a seven. One ball is selected from the box its number $X$ is noted, and the ball is then replaced in the urn.

<table>
<thead>
<tr>
<th>values of $X$</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
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<td>probability</td>
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a) Complete the table. (3.5 points)

b) Find $P(2.5 < X), P(X \leq 2), P(3 < X \leq 6)$. (4.5 points)

A second ball is selected from the box, its color is noted and the ball is then replaced in the urn.

c) What is the probability that none of the two balls are marked with a seven? (2 points)

d) What is the probability that one ball is marked with a one and the other ball is marked with a six? (2 points)

e) What is the probability that at least one ball is marked with a two? (3 points)

4) A manufacturer company wants to determine if its production line is producing more than 15 % of defective items. A random sample of 100 items was monitor and 18 items were defective.

1. Perform a test and clearly state your conclusion.

2. Assume no previous knowledge of the proportion of defective items. What sample size would be required to obtain a margin of error of 0.01, in a 99 % confidence interval for the proportion of defective items?

3. Assume that you have reliable information indicating that $p^* = 0.15$ is a good guess for the proportion of defective items. What sample size would be required to obtain a margin of error of 0.01, in a 99 % confidence interval for the proportion of defective items?

5) Does cocaine use by pregnant women cause their babies to have low birth weight? To study this question, birth weights of babies of women who tested positive for cocaine/crack during a drug-screening test were compared with the birth weights of babies of women who tested negative. Here are the summary statistics ( the birth weights are measure in grams):


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<thead>
<tr>
<th>Line</th>
<th>n</th>
<th>( \bar{x} )</th>
<th>s</th>
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<tbody>
<tr>
<td>Positive test</td>
<td>134</td>
<td>2733</td>
<td>599</td>
</tr>
<tr>
<td>Negative test</td>
<td>5974</td>
<td>3118</td>
<td>672</td>
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a) Formulate appropriate hypothesis and carry out a significant test. What is your conclusion? (12 points)

b) Clearly state the assumptions that your procedures in (a) require in order to be valid. (3 points)

c) **Extra credit:** How much heavier are the babies of women that tested negative? (4 points)

6) The Survey of Study Habits and Attitudes (SSHA) is a psychological test that measures the motivation and study habits of students. Scores range from 0 to 200. The mean scores for all U.S. college students is about 115, and the standard deviation is about 30. A teacher suspects that older students have better attitudes toward school. He gives the SSHA to an SRS of 20 students who are at least 30 years of age. Their mean score is 128.5.

a) Assuming that \( \sigma = 30 \). Perform a test to study the question of interest. What is your conclusion? (8 points)

b) What is the exact level of significance? Is your result significant at level 1% ? 3% ? (3 points)

c) How large a sample would be required to obtain a margin of error of 2 in a 95% confidence interval for the mean score? (4 points)

7) In the U.S. approximately 900 people die in bicycle accidents each year. One study examined the records of 1711 bicyclist who were fatally injured in bicycle accidents and were tested for alcohol. Of these byciclist, 542 tested positive for alcohol.

a) Find a 97.5% confidence interval for the proportion of bicyclist that tested positive for alcohol? (8 points)

b) Explain your conclusion to somebody that does not know any statistics? (3 points)

c) Clearly state the assumptions that your procedures in (a) require in order to be valid. (4 points)
1) a) $\bar{x} = 3.4$, $s = 3.9181$, 29 df, CI (1.639, 5.161). b) $Q_1 = 2$, $Q_3 = 5$, median=3.5, $1.5IQR = 4.5$, $Q_1 - 1.5IQR = -2.5$, $Q_3 + 1.5IQR = 9.5$, -5 and 12 are possible outliers. c) Since we have possible outliers the 5 number summary is better.

2) a) $z = 2.1285$, P-value=0.0166. Proportion of patients that filled a complain and left the HMO is higher. b) CI (0.0056, 0.10107).

3) b) 0.8, 0.2, 0.44. c) 0.7056 d) 0.0288 e) 0.2256

4) a) $z = 0.840$, P-value=0.2005. We cannot reject. The data does not give enough evidence that the proportion of defective item is less than 15. b) 16590 c) 8461

5) a) $t = 7.3373$, P-value $< 0.0005$. Thus the older students have a better attitude. b) exact level of significance 2.22. c) $n = 865$.

6) a) $z = 2.0124$, P-value=0.0222. Proportion of patients that filled a complain and left the HMO is higher. b) CI (0.0056, 0.10107).

7) a) $z* = 2.24$ CI (0.2876, 0.3419). c) Size of population is 10 time bigger than the size of the sample. $n\hat{p} \geq 10$ and $n(1 - \hat{p}) \geq 10$. 