

**Instructions:** This exam is a tool to help me (and you) assess how well you are learning the course material. As such, you should report enough written detail for me to understand how you are thinking about each problem. (100 points total)

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1. Here's a recent piece from the *New York Times*:

Women over 70 who get five hours of sleep a night or less may be more likely to fall than those who sleep seven to eight hours, according to a new study.

Researchers measured the sleep time of 2,978 women by equipping them with an actigraph, a watch-size device worn on the wrist that measures periods of activity and inactivity. Then they tracked them for an average of 12 months, recording the number of falls each suffered. The study is in the Sept. 8 issue of *The Archives of Internal Medicine*.

After controlling for age, body mass, alcohol use, sleep medications and many other variables, they found that women who slept less than five hours a night were about 47 percent more likely to have fallen twice or more in the course of the study.

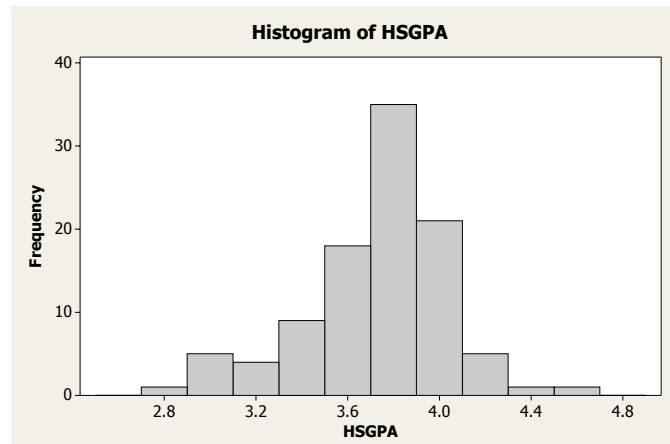
Analysis showed that while a variety of factors associated with poor sleep might increase the risk of falls — depression, balance or gait problems — these things explained some, but not all, of the relationship. The association with shorter nighttime sleep remained an independent risk factor.

- (a) Identify a quantitative variable mentioned in this piece. Give a precise description of the variable. Also describe the possible values for this variable, including units if relevant. (5 points)
- (b) Identify a categorical variable that might be relevant to the study described in this piece. This categorical variable might be mentioned in the piece or might be something you come up with on your own. Give a precise description of the variable. Also describe some possible values for this variable. (5 points)
2. Here are the unemployment rates (as a percentage) in the United States for the twenty year period 1988 to 2007:

5.5	5.3	5.6	6.8	7.5	6.9	6.1	5.6	5.4	4.9
4.5	4.2	4.0	4.7	5.8	6.0	5.5	5.1	4.6	4.6

- (a) Make two stemplots for this distribution, one without splitting stems and one with splitting stems. (6 points)
- (b) Which of the stems plots from (a) is most informative. Briefly explain why. (4 points)
- (c) Find the five-number summary for this distribution. (5 points)
- (d) Make a boxplot for this distribution. (4 points)
- (e) Determine if the value of 7.5 in this distribution is an outlier according to the  $1.5 \times \text{IQR}$  rule. (5 points)
- (f) Describe the significant features of this distribution. (5 points)

3. One of the questions on the survey of MATH 160 students asks for high school GPA. Here is a histogram for the distribution of 189 high school GPA values reported this fall:



- (a) Describe the significant features of this distribution. (5 points)
- (b) For this distribution, the median is 3.67. Is the mean for this distribution less than 3.67, equal to 3.67, or greater than 3.67? Explain how you reach your conclusion. (5 points)

4. Here are hand spans (in centimeters) for 14 female college students:

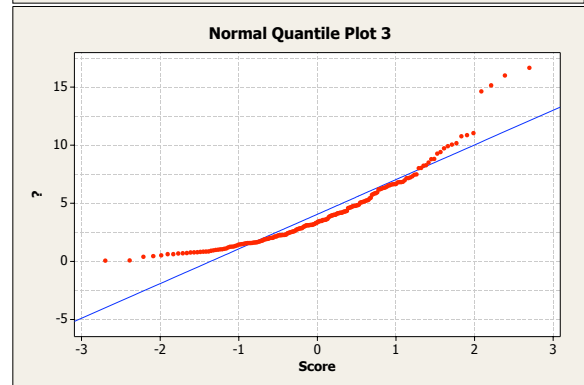
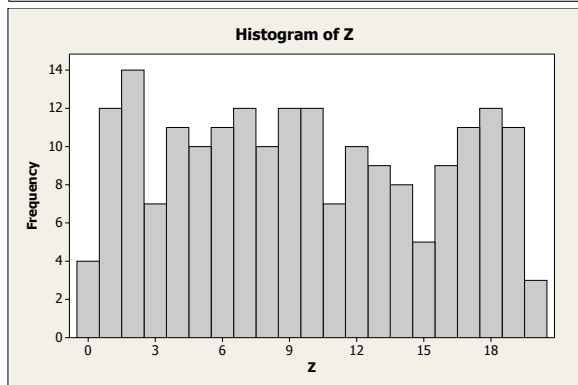
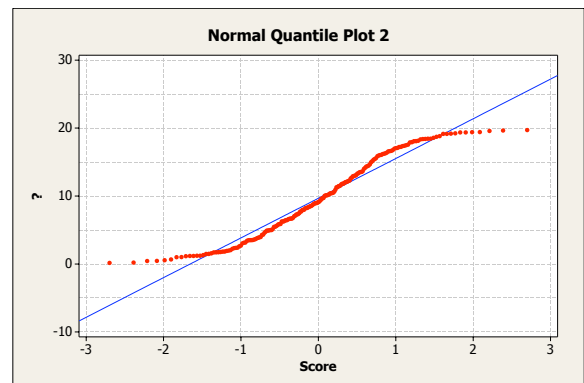
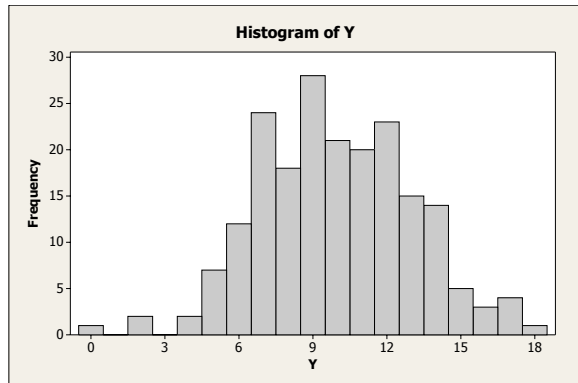
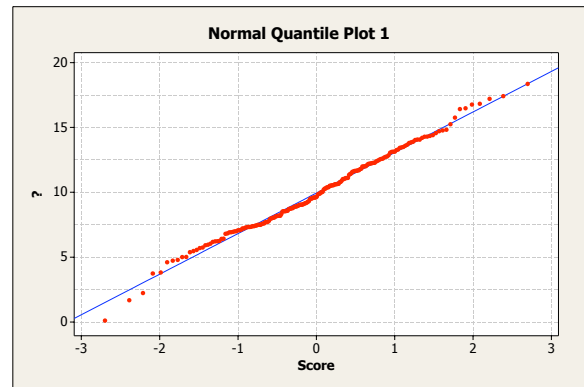
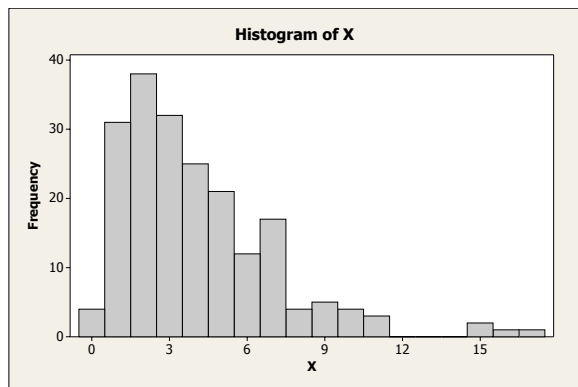
15.9 18.5 18.5 18.7 19.5 20.0 20.0 20.0 20.1 20.3 20.5 21.0 21.2 21.5

For this distribution, the mean is 19.7 cm and the standard deviation is 1.4 cm.

- (a) Show how to calculate the mean and standard deviation. (6 points)
- (b) A larger study gathers hand spans for 100 students. The mean of the new distribution is 19.1 cm and the standard deviation is 1.2 cm. The researcher measures one more hand span and it turns out to be 19.1 cm. Is the mean of the new distribution (with 101 values) less than, equal to, or greater than 19.1 cm? Is the standard deviation of the new distribution (with 101 values) less than, equal to, or greater than 1.2 cm? Explain the reasoning you use to reach each conclusion. (6 points)
5. A manufacturer produces metal rods that will be used as part of an airplane. The cutting process results in rods with a distribution of lengths. The distribution is normal with a mean of 20 centimeters and a standard deviation of 0.03 centimeters.
- (a) Sketch this normal distribution. Mark relevant values on the horizontal scale. (5 points)
- (b) On your plot from (a), shade the area that corresponds to lengths less than 20.06 centimeters and then use the 68-95-99.7 rule to determine the proportion of rods that have a length less than 20.06 centimeters. Briefly explain how you reach your conclusion here. (7 points)
- (c) In the quality control process, any rod with a length less than 19.95 cm must be rejected. What proportion of rods are rejected? (5 points)
- (d) What length of rod is longer than 80% of all rods made in this process? (5 points)

6. Heights of humans are approximately normally distributed with a mean of 65 inches and a standard deviation of 4 inches. Aliens from a faraway planet also have heights that are approximately normally distributed. The aliens measure lengths in a unit called a *blarg*. The distribution of alien heights has a mean of 4.6 blargs and a standard deviation of 1.4 blargs. Who would stand out more in a crowd of their own kind between a human of height 72 inches and an alien of height 6.2 blargs? (6 points)

7. Below on the left are histograms for three different distributions, each with 200 values. Below on the right are normal quantile plots for the same distributions but not necessarily in the same order.



- (a) Match each normal quantile plot with the corresponding histogram. (4 points)
- (b) Which distribution is best approximated as normal? (3 points)
- (c) For each of the two other distributions, describe in what way the distribution is not well represented by a normal distribution. (4 points)