STATISTICS
SECTION II
Part A
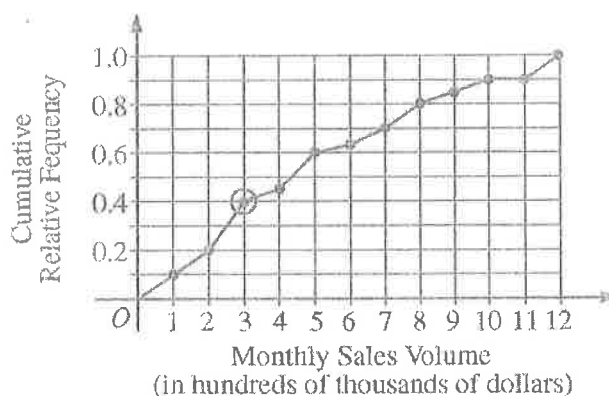Questions 1-5
Spend about 65 minutes on this part of the exam.
Percent of Section II grade—75

Directions: Show all your work. Indicate clearly the methods you use, because you will be graded on the correctness of your methods as well as on the accuracy and completeness of your results and explanations.

1. A large regional real estate company keeps records of home sales for each of its sales agents. Each month, the company publishes the sales volume for each agent. Monthly sales volume is defined as the total sales price of all homes sold by the agent during a month. The figure below displays the cumulative relative frequency plot of the most recent monthly sales volume (in hundreds of thousands of dollars) for these agents.


(a) In the context of this question, explain what information is conveyed by the circled point.

(b) What proportion of sales agents achieved monthly sales volumes between $700,000 and $800,000 ?

(c) For values between 10 and 11 on the horizontal axis, the cumulative relative frequency plot is flat. In the context of this question, explain what this means.

(d) A bonus is to be given to 20 percent of the sales agents. Those who achieved the highest monthly sales volume during the preceding month will receive a bonus. What is the minimum monthly sales volume an agent must have achieved to qualify for the bonus?

GO ON TO THE NEXT PAGE.

2. A plot of the number of defective items produced during 20 consecutive days at a factory is shown below.
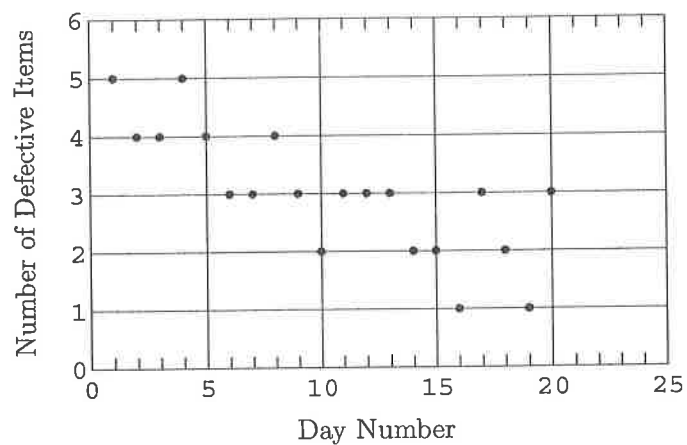
(a) Draw a histogram that shows the frequencies of the number of defective items.

(b) Give one fact that is obvious from the histogram but is not obvious from the scatterplot.

(c) Give one fact that is obvious from the scatterplot but is not obvious from the histogram.

2005 AP® STATISTICS FREE-RESPONSE QUESTIONS

STATISTICS

SECTION II

Part A

Questions 1-5

Spend about 65 minutes on this part of the exam.

Percent of Section II grade—75

Directions: Show all your work. Indicate clearly the methods you use, because you will be graded on the correctness of your methods as well as on the accuracy of your results and explanation.

1. The goal of a nutritional study was to compare the caloric intake of adolescents living in rural areas of the United States with the caloric intake of adolescents living in urban areas of the United States. A random sample of ninth-grade students from one high school in a rural area was selected. Another random sample of ninth graders from one high school in an urban area was also selected. Each student in each sample kept records of all the food he or she consumed in one day.

   The back-to-back stemplot below displays the number of calories of food consumed per kilogram of body weight for each student on that day.

Urban		Rural
9 9 9 9 8 8 7 6	2	
4 4 3 1 0	3	2 3 3 4
9 7 6 6 5	3	5 6 6 6 7
2 0	4	0 2 2 2 4
	4	5 6 8 8 9
	5	1

   Stem: tens
   Leaf: ones

   (a) Write a few sentences comparing the distribution of the daily caloric intake of ninth-grade students in the rural high school with the distribution of the daily caloric intake of ninth-grade students in the urban high school.

   (b) Is it reasonable to generalize the findings of this study to all rural and urban ninth-grade students in the United States? Explain.

   (c) Researchers who want to conduct a similar study are debating which of the following two plans to use.

   Plan I: Have each student in the study record all the food he or she consumed in one day. Then researchers would compute the number of calories of food consumed per kilogram of body weight for each student for that day.

   Plan II: Have each student in the study record all the food he or she consumed over the same 7-day period. Then researchers would compute the average daily number of calories of food consumed per kilogram of body weight for each student during that 7-day period.

   Assuming that the students keep accurate records, which plan, I or II, would better meet the goal of the study? Justify your answer.

GO ON TO THE NEXT PAGE.

4

STATISTICS
## SECTION II
Part A
Questions 1-5
Spend about 65 minutes on this part of the exam.
Percent of Section II grade—75

Directions: Show all your work. Indicate clearly the methods you use, because you will be graded on the correctness of your methods as well as on the accuracy and completeness of your results and explanations.

1. Two parents have each built a toy catapult for use in a game at an elementary school fair. To play the game, students will attempt to launch Ping-Pong balls from the catapults so that the balls land within a 5-centimeter band. A target line will be drawn through the middle of the band, as shown in the figure below. All points on the target line are equidistant from the launching location.
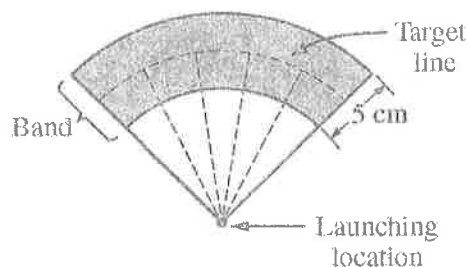
If a ball lands within the shaded band, the student will win a prize.

The parents have constructed the two catapults according to slightly different plans. They want to test these catapults before building additional ones. Under identical conditions, the parents launch 40 Ping-Pong balls from each catapult and measure the distance that the ball travels before landing. Distances to the nearest centimeter are graphed in the dotplots below.
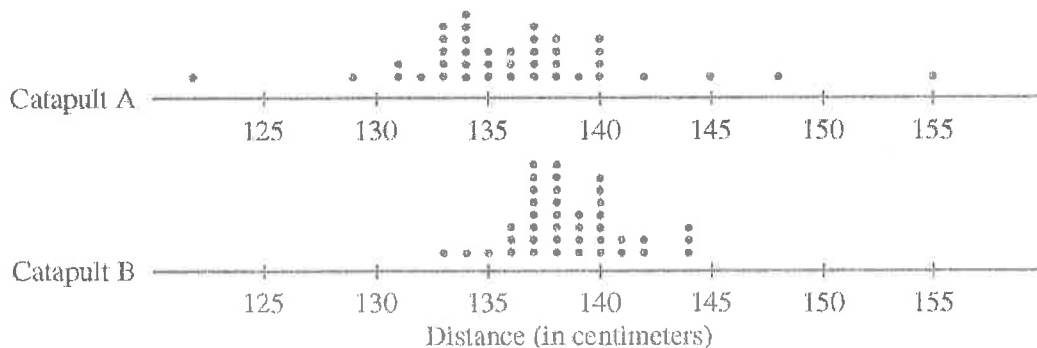
(a) Comment on any similarities and any differences in the two distributions of distances traveled by balls launched from catapult A and catapult B.

(b) If the parents want to maximize the probability of having the Ping-Pong balls land within the band, which one of the two catapults, A or B, would be better to use than the other? Justify your choice.

(c) Using the catapult that you chose in part (b), how many centimeters from the target line should this catapult be placed? Explain why you chose this distance.

GO ON TO THE NEXT PAGE.

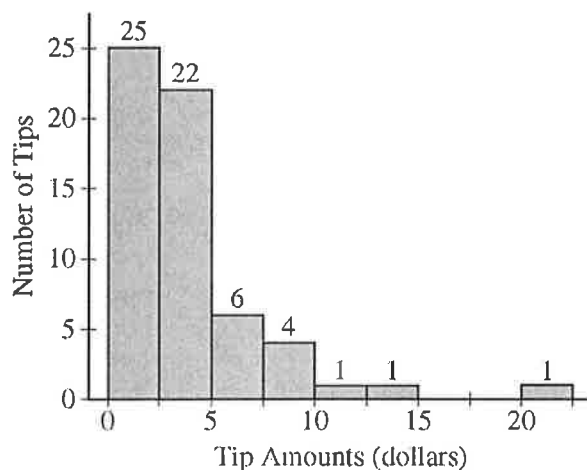**STATISTICS**

SECTION II

Part A

Questions 1-5

Spend about 65 minutes on this part of the exam.

Percent of Section II score—75

Directions: Show all your work. Indicate clearly the methods you use, because you will be scored on the correctness of your methods as well as on the accuracy and completeness of your results and explanations.

1. Robin works as a server in a small restaurant, where she can earn a tip (extra money) from each customer she serves. The histogram below shows the distribution of her 60 tip amounts for one day of work.

(a) Write a few sentences to describe the distribution of tip amounts for the day shown.

(b) One of the tip amounts was $8. If the $8 tip had been $18, what effect would the increase have had on the following statistics? Justify your answers.

The mean:

The median:

GO ON TO THE NEXT PAGE.

STATISTICS
SECTION II
Part A
Questions 1-5
Spend about 65 minutes on this part of the exam.
Percent of Section II score—75

Directions: Show all your work. Indicate clearly the methods you use, because you will be scored on the correctness of your methods as well as on the accuracy and completeness of your results and explanations.

1. An environmental group conducted a study to determine whether crows in a certain region were ingesting food containing unhealthy levels of lead. A biologist classified lead levels greater than 6.0 parts per million (ppm) as unhealthy. The lead levels of a random sample of 23 crows in the region were measured and recorded. The data are shown in the stemplot below.

Lead Levels

```
2 | 8
3 | 0
3 | 5 8 8
4 | 1 1 2
4 | 6 8 8
5 | 0 1 2 2 3 4
5 | 9 9
6 | 3 4
6 | 6 8
```

Key: $2|8 = 2.8$ ppm

(a) What proportion of crows in the sample had lead levels that are classified by the biologist as unhealthy?

(b) The mean lead level of the 23 crows in the sample was 4.90 ppm and the standard deviation was 1.12 ppm. Construct and interpret a 95 percent confidence interval for the mean lead level of crows in the region.

GO ON TO THE NEXT PAGE.

STATISTICS
SECTION II
Part A
Questions 1-5
Spend about 65 minutes on this part of the exam.
Percent of Section II grade—75

Directions: Show all your work. Indicate clearly the methods you use, because you will be graded on the correctness of your methods as well as on the accuracy and completeness of your results and explanations.

1. The Better Business Council of a large city has concluded that students in the city's schools are not learning enough about economics to function in the modern world. These findings were based on test results from a random sample of 20 twelfth-grade students who completed a 46-question multiple-choice test on basic economic concepts. The data set below shows the number of questions that each of the 20 students in the sample answered correctly.

   12 16 18 17 18 33 41 44 38 35
   19 36 19 13 43 8 16 14 10 9

   (a) Display these data in a stemplot.

   (b) Use your stemplot from part (a) to describe the main features of this score distribution.

   (c) Why would it be misleading to report only a measure of center for this score distribution?

GO ON TO THE NEXT PAGE.

STATISTICS
SECTION II
Part A
Questions 1-5
Spend about 65 minutes on this part of the exam.
Percent of Section II grade—75

Directions: Show all your work. Indicate clearly the methods you use, because you will be graded on the correctness of your methods as well as on the accuracy of your results and explanation.

1. The summary statistics for the number of inches of rainfall in Los Angeles for 117 years, beginning in 1877, are shown below.

N	MEAN	MEDIAN	TRMEAN	STDEV	SE MEAN
117	14.941	13.070	14.416	6.747	0.624

MIN	MAX	Q1	Q3
4.850	38.180	9.680	19.250

(a) Describe a procedure that uses these summary statistics to determine whether there are outliers.

(b) Are there outliers in these data?   _____

Justify your answer based on the procedure that you described in part (a).

(c) The news media reported that in a particular year, there were only 10 inches of rainfall. Use the information provided to comment on this reported statement.

STATISTICS
SECTION II
Part A
Questions 1-5
Spend about 65 minutes on this part of the exam.
Percent of Section II grade—75

Directions: Show all your work. Indicate clearly the methods you use, because you will be graded on the correctness of your methods as well as on the accuracy of your results and explanation.

1. A consumer advocate conducted a test of two popular gasoline additives, A and B. There are claims that the use of either of these additives will increase gasoline mileage in cars. A random sample of 30 cars was selected. Each car was filled with gasoline and the cars were run under the same driving conditions until the gas tanks were empty. The distance traveled was recorded for each car.

   Additive A was randomly assigned to 15 of the cars and additive B was randomly assigned to the other 15 cars. The gas tank of each car was filled with gasoline and the assigned additive. The cars were again run under the same driving conditions until the tanks were empty. The distance traveled was recorded and the difference in the distance with the additive minus the distance without the additive for each car was calculated.

   The following table summarizes the calculated differences. Note that negative values indicate less distance was traveled with the additive than without the additive.

Additive	Values Below Q_1	Q_1	Median	Q_3	Values Above Q_3
A	$-10, -8, -2$	1	3	4	5, 7, 9
B	$-5, -3, -3$	-2	1	25	35, 37, 40

   (a) On the grid below, display parallel boxplots (showing outliers, if any) of the differences of the two additives.
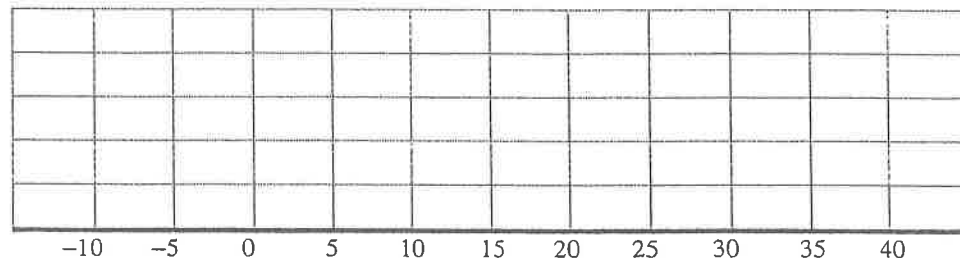
   (b) Two ways that the effectiveness of a gasoline additive can be evaluated are by looking at either

   - the proportion of cars that have increased gas mileage when the additive is used in those cars
       or
   - the mean increase in gas mileage when the additive is used in those cars.

   i. Which additive, A or B, would you recommend if the goal is to increase gas mileage in the highest proportion of cars? Explain your choice.

   ii. Which additive, A or B, would you recommend if the goal is to have the highest mean increase in gas mileage? Explain your choice.

GO ON TO THE NEXT PAGE.

STATISTICS
SECTION II
**Part A**
Questions 1-5
Spend about 65 minutes on this part of the exam.
Percent of Section II score—75

Directions: Show all your work. Indicate clearly the methods you use, because you will be scored on the correctness of your methods as well as on the accuracy and completeness of your results and explanations.

1. As a part of the United States Department of Agriculture's Super Dump cleanup efforts in the early 1990s, various sites in the country were targeted for cleanup. Three of the targeted sites—River X, River Y, and River Z—had become contaminated with pesticides because they were located near abandoned pesticide dump sites. Measurements of the concentration of aldrin (a commonly used pesticide) were taken at twenty randomly selected locations in each river near the dump sites.

   The boxplots shown below display the five-number summaries for the concentrations, in parts per million (ppm) of aldrin, for the twenty locations that were sampled in each of the three rivers.

   Concentrations of Aldrin (ppm)
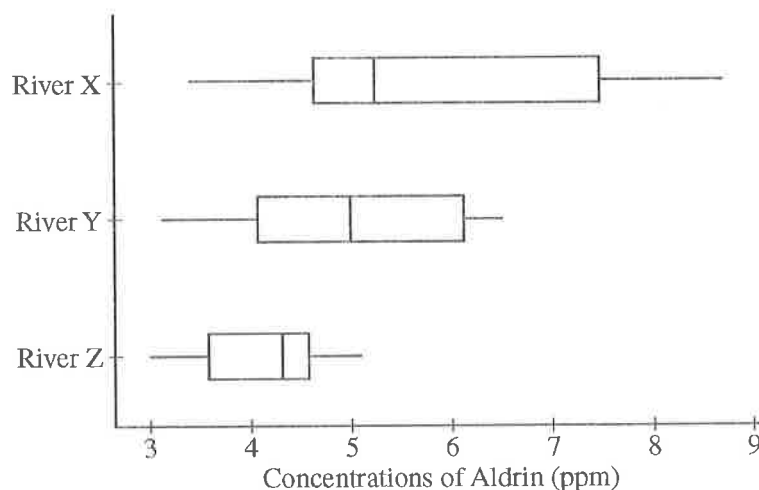
   (a) Compare the distributions of the concentration of aldrin among the three rivers.

   (b) The twenty concentrations of aldrin for River X are given below.

3.4	4.0	5.6	3.7	8.0	5.5	5.3	4.2	4.3	7.3
8.6	5.1	8.7	4.6	7.5	5.3	8.2	4.7	4.8	4.6

   Construct a stemplot that displays the concentrations of aldrin for River X.

   (c) Describe a characteristic of the distribution of aldrin concentrations in River X that can be seen in the stemplot but cannot be seen in the boxplot.

5. At a school field day, 50 students and 50 faculty members each completed an obstacle course. Descriptive statistics for the completion times (in minutes) for the two groups are shown below.

	Students	Faculty Members
Mean	9.90	12.09
Median	9.25	11.00
Minimum	3.75	4.50
Maximum	16.50	25.00
Lower quartile	6.75	8.75
Upper quartile	13.75	15.75

(a) Use the same scale to draw boxplots for the completion times for students and for faculty members.

(b) Write a few sentences comparing the variability of the two distributions.

(c) You have been asked to report on this event for the school newspaper. Write a few sentences describing student and faculty performances in this competition for the paper.
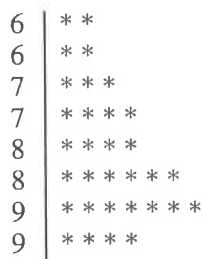
STATISTICS
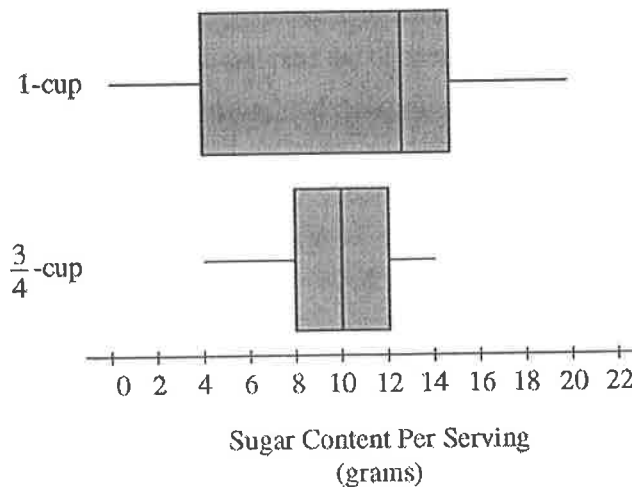**SECTION II**
Part A
Questions 1-5
Spend about 65 minutes on this part of the exam.
Percent of Section II grade—75

Directions: Show all your work. Indicate clearly the methods you use, because you will be graded on the correctness of your methods as well as on the accuracy of your results and explanation.

1. The graph below displays the scores of 32 students on a recent exam. Scores on this exam ranged from 64 to 95 points.

```
6 | * *
6 | * *
7 | * * *
7 | * * * *
8 | * * * *
8 | * * * * * *
9 | * * * * * * *
9 | * * * *
```

(a) Describe the shape of this distribution.

(b) In order to motivate her students, the instructor of the class wants to report that, overall, the class's performance on the exam was high. Which summary statistic, the mean or the median, should the instructor use to report that overall exam performance was high? Explain.

(c) The midrange is defined as $\dfrac{\text{maximum} + \text{minimum}}{2}$. Compute this value using the data on the preceding page.

Is the midrange considered a measure of center or a measure of spread? Explain.

After analyzing the boxplots on the preceding page, the student decided that instead of a comparison of sugar content per recommended serving, it might be more appropriate to compare sugar content for equal-size servings. To compare the amount of sugar in serving sizes of one cup each, the amount of sugar in each of the cereals showing three-quarter-cup servings on their side panels was multiplied by $\frac{4}{3}$. The bottom boxplot shown below displays sugar content (in grams) per cup for those cereals that showed a serving size of three-quarter-cup on their side panels.

Adjusted Sugar Content Per Cup
(grams)
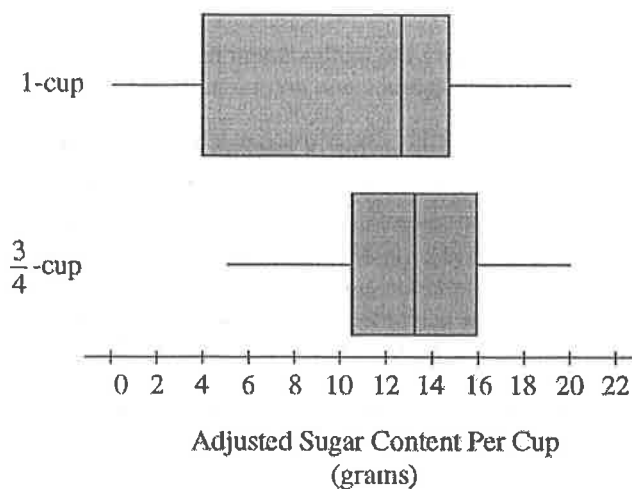
(b) What new information about sugar content do the boxplots above provide?

(c) Based on the boxplots shown above on this page, how would you expect the mean amounts of sugar per cup to compare for the different recommended serving sizes? Explain.

4. A company is considering implementing one of two quality control plans for monitoring the weights of automobile batteries that it manufactures. If the manufacturing process is working properly, the battery weights are approximately normally distributed with a specified mean and standard deviation.

Quality control plan A calls for rejecting a battery as defective if its weight falls more than 2 standard deviations below the specified mean.

Quality control plan B calls for rejecting a battery as defective if its weight falls more than 1.5 interquartile ranges below the lower quartile of the specified population.

Assume the manufacturing process is under control.

a. What proportion of batteries will be rejected by plan A ?

b. What is the probability that at least 1 of 2 randomly selected batteries will be rejected by plan A ?

c. What proportion of batteries will be rejected by plan B ?

STATISTICS

SECTION II

Part A

Questions 1-5

Spend about 65 minutes on this part of the exam.

Percent of Section II score—75

Directions: Show all your work. Indicate clearly the methods you use, because you will be scored on the correctness of your methods as well as on the accuracy and completeness of your results and explanations.

1. A professional sports team evaluates potential players for a certain position based on two main characteristics, speed and strength.

   (a) Speed is measured by the time required to run a distance of 40 yards, with smaller times indicating more desirable (faster) speeds. From previous speed data for all players in this position, the times to run 40 yards have a mean of 4.60 seconds and a standard deviation of 0.15 seconds, with a minimum time of 4.40 seconds, as shown in the table below.

	Mean	Standard Deviation	Minimum
Time to run 40 yards	4.60 seconds	0.15 seconds	4.40 seconds

   Based on the relationship between the mean, standard deviation, and minimum time, is it reasonable to believe that the distribution of 40-yard running times is approximately normal? Explain.

   (b) Strength is measured by the amount of weight lifted, with more weight indicating more desirable (greater) strength. From previous strength data for all players in this position, the amount of weight lifted has a mean of 310 pounds and a standard deviation of 25 pounds, as shown in the table below.

	Mean	Standard Deviation
Amount of weight lifted	310 pounds	25 pounds

   Calculate and interpret the z-score for a player in this position who can lift a weight of 370 pounds.

   (c) The characteristics of speed and strength are considered to be of equal importance to the team in selecting a player for the position. Based on the information about the means and standard deviations of the speed and strength data for all players and the measurements listed in the table below for Players A and B, which player should the team select if the team can only select one of the two players? Justify your answer.

	Player A	Player B
Time to run 40 yards	4.42 seconds	4.57 seconds
Amount of weight lifted	370 pounds	375 pounds

GO ON TO THE NEXT PAGE.

3. Golf balls must meet a set of standards in order to be used in professional tournaments. One of these standards is distance traveled. When a ball is hit by a mechanical device, Iron Byron, with a 10-degree angle of launch, a backspin of 42 revolutions per second, and a ball velocity of 235 feet per second, the distance the ball travels may not exceed 291.2 yards. Manufacturers want to develop balls that will travel as close to the 291.2 yards as possible without exceeding that distance. A particular manufacturer has determined that the distances traveled for the balls it produces are normally distributed with a standard deviation of 2.8 yards. This manufacturer has a new process that allows it to set the mean distance the ball will travel.

   (a) If the manufacturer sets the mean distance traveled to be equal to 288 yards, what is the probability that a ball is randomly selected for testing will travel too far?

   (b) Assume the mean distance traveled is 288 yards and that five balls are independently tested. What is the probability that at least one of the five balls will exceed the maximum distance of 291.2 yards?

   (c) If the manufacturer wants to be 99 percent certain that a randomly selected ball will not exceed the maximum distance of 291.2 yards, what is the largest mean that can be used in the manufacturing process?

18

3. Five hundred randomly selected middle-aged men and five hundred randomly selected young adult men were rated on a scale from 1 to 10 on their physical flexibility, with 10 being the most flexible. Their ratings appear in the frequency table below. For example, 17 middle-aged men had a flexibility rating of 1.

Physical Flexibility Rating	Frequency of Middle-Aged Men	Frequency of Young Adult Men
1	17	4
2	31	17
3	49	29
4	71	39
5	70	54
6	87	69
7	78	83
8	54	93
9	34	73
10	9	39

(a) Display these data graphically so that the flexibility of middle-aged men and young adult men can be easily compared.

(b) Based on an examination of your graphical display, write a few sentences comparing the flexibility of middle-aged men with the flexibility of young adult men.