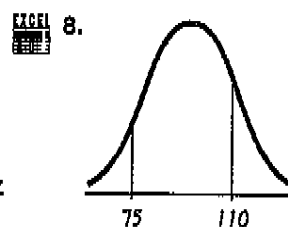
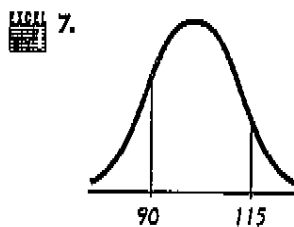
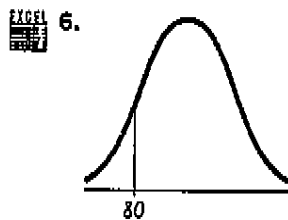
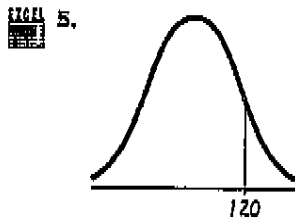


6-3 Applications of Normal Distributions

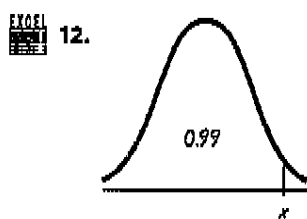
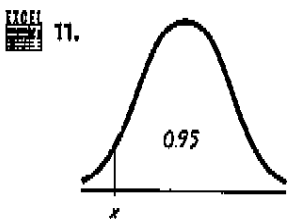
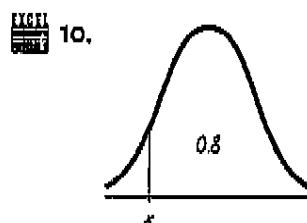
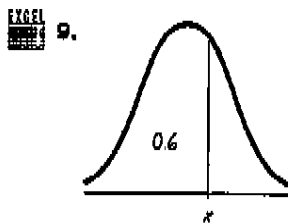
3. Normal Distributions The distribution of IQ scores is a nonstandard normal distribution with a mean of 100 and a standard deviation of 15. What are the values of the mean and standard deviation after all IQ scores have been standardized by converting them to z scores using $z = (x - \mu)/\sigma$?

4. Random Digits Computers are often used to randomly generate digits of telephone numbers to be called when conducting a survey. Can the methods of this section be used to find the probability that when one digit is randomly generated, it is less than 5? Why or why not? What is the probability of getting a digit less than 5?

IQ Scores. In Exercises 5–8, find the area of the shaded region. The graphs depict IQ scores of adults, and those scores are normally distributed with a mean of 100 and a standard deviation of 15 (as on the Wechsler test).



IQ Scores. In Exercises 9–12, find the indicated IQ score. The graphs depict IQ scores of adults, and those scores are normally distributed with a mean of 100 and a standard deviation of 15 (as on the Wechsler test).



GROUP 1
15, 25, 27, 30, 31

IQ Scores. In Exercises 13–20, assume that adults have IQ scores that are normally distributed with a mean of 100 and a standard deviation of 15 (as on the Wechsler test). (Hint: Draw a graph in each case.)

EXCEL 13. Find the probability that a randomly selected adult has an IQ that is less than 115.

EXCEL 14. Find the probability that a randomly selected adult has an IQ greater than 131.5 (the requirement for membership in the Mensa organization).

EXCEL 15. Find the probability that a randomly selected adult has an IQ between 90 and 110 (referred to as the *normal range*).

EXCEL 16. Find the probability that a randomly selected adult has an IQ between 110 and 120 (referred to as *bright normal*).



18. Find the first quartile Q_1 , which is the IQ score separating the bottom 25% from the top 75%.

19. Find the third quartile Q_3 , which is the IQ score separating the top 25% from the others.

20. Find the IQ score separating the top 37% from the others.

In Exercises 21–26, use this information (based on data from the National Health Survey):

• Men's heights are normally distributed with mean 69.0 in. and standard deviation 2.8 in.

• Women's heights are normally distributed with mean 63.6 in. and standard deviation 2.5 in.



21. Doorway Height The Mark VI monorail used at Disney World and the Boeing 757-200 ER airliner have doors with a height of 72 in.

- What percentage of adult men can fit through the doors without bending?
- What percentage of adult women can fit through the doors without bending?
- Does the door design with a height of 72 in. appear to be adequate? Explain.
- What doorway height would allow 98% of adult men to fit without bending?



22. Doorway Height The Gulfstream 100 is an executive jet that seats six, and it has a doorway height of 51.6 in.

- What percentage of adult men can fit through the door without bending?
- What percentage of adult women can fit through the door without bending?
- Does the door design with a height of 51.6 in. appear to be adequate? Why didn't the engineers design a larger door?
- What doorway height would allow 60% of men to fit without bending?



23. Tall Clubs International Tall Clubs International is a social organization for tall people. It has a requirement that men must be at least 74 in. tall, and women must be at least 70 in. tall.

- What percentage of men meet that requirement?
- What percentage of women meet that requirement?
- Are the height requirements for men and women fair? Why or why not?



24. Tall Clubs International Tall Clubs International has minimum height requirements for men and women.

- If the requirements are changed so that the tallest 4% of men are eligible, what is the new minimum height for men?
- If the requirements are changed so that the tallest 4% of women are eligible, what is the new minimum height for women?



25. U.S. Army Height Requirements for Women The U.S. Army requires women's heights to be between 58 in. and 80 in.

- Find the percentage of women meeting the height requirement. Are many women being denied the opportunity to join the Army because they are too short or too tall?
- If the U.S. Army changes the height requirements so that all women are eligible except the shortest 1% and the tallest 2%, what are the new height requirements?



26. Marine Corps Height Requirement for Men The U.S. Marine Corps requires that men have heights between 64 in. and 80 in.

- Find the percentage of men who meet the height requirements. Are many men denied the opportunity to become a Marine because they do not satisfy the height requirements?
- If the height requirements are changed so that all men are eligible except the shortest 3% and the tallest 4%, what are the new height requirements?



27. Birth Weights Birth weights in Norway are normally distributed with a mean of 3570 g and a standard deviation of 500 g.

- If the Ullevål University Hospital in Oslo requires special treatment for newborn babies weighing less than 2700 g, what is the percentage of newborn babies requiring special treatment?

* b. If the Ullevål University Hospital officials plan to require special treatment for the lightest 3% of newborn babies, what birth weight separates those requiring special treatment from those who do not?

c. Why is it not practical for the hospital to simply state that babies require special treatment if they are in the bottom 3% of birth weights? **(NO NOT ANSWER C)**



28. Weights of Water Taxi Passengers It was noted in the Chapter Problem that when a water taxi sank in Baltimore's Inner Harbor, an investigation revealed that the safe passenger load for the water taxi was 3500 lb. It was also noted that the mean weight of a passenger was assumed to be 140 lb. Assume a "worst case" scenario in which all of the passengers are adult men. (This could easily occur in a city that hosts conventions in which people of the same gender often travel in groups.) Based on data from the National Health and Nutrition Examination Survey, assume that weights of men are normally distributed with a mean of 172 lb and a standard deviation of 29 lb.



a. If one man is randomly selected, find the probability that he weighs less than 174 lb (the new value suggested by the National Transportation and Safety Board).

b. With a load limit of 3500 lb, how many men passengers are allowed if we assume a mean weight of 140 lb?

c. With a load limit of 3500 lb, how many men passengers are allowed if we use the new mean weight of 174 lb?

d. Why is it necessary to periodically review and revise the number of passengers that are allowed to board?



29. Body Temperatures Based on the sample results in Data Set 2 of Appendix B, assume that human body temperatures are normally distributed with a mean of 98.20°F and a standard deviation of 0.62°F.

a. Bellevue Hospital in New York City uses 100.6°F as the lowest temperature considered to be a fever. What percentage of normal and healthy persons would be considered to have a fever? Does this percentage suggest that a cutoff of 100.6°F is appropriate?

b. Physicians want to select a minimum temperature for requiring further medical tests. What should that temperature be, if we want only 5.0% of healthy people to exceed it? (Such a result is a *false positive*, meaning that the test result is positive, but the subject is not really sick.)



* **30. Aircraft Seat Width** Engineers want to design seats in commercial aircraft so that they are wide enough to fit 99% of all males. (Accommodating 100% of males would require very wide seats that would be much too expensive.) Men have hip breadths that are normally distributed with a mean of 14.4 in. and a standard deviation of 1.0 in. (based on anthropometric survey data from Gordon, Clauser, et al.). Find P_{99} . That is, find the hip breadth for men that separates the smallest 99% from the largest 1%.



* **31. Lengths of Pregnancies** The lengths of pregnancies are normally distributed with a mean of 268 days and a standard deviation of 15 days.

a. One classical use of the normal distribution is inspired by a letter to "Dear Abby" in which a wife claimed to have given birth 308 days after a brief visit from her husband, who was serving in the Navy. Given this information, find the probability of a pregnancy lasting 308 days or longer. What does the result suggest?

b. If we stipulate that a baby is *premature* if the length of pregnancy is in the lowest 4%, find the length that separates premature babies from those who are not premature. Premature babies often require special care, and this result could be helpful to hospital administrators in planning for that care.



32. Sitting Distance A common design requirement is that an item (such as an aircraft or theater seat) must fit the range of people who fall between the 5th percentile for women and the 95th percentile for men. If this requirement is adopted, what is the minimum sitting distance and what is the maximum sitting distance? For the sitting distance, use the buttock-to-knee length. Men have buttock-to-knee lengths that are normally distributed with a mean of 23.5 in. and a standard deviation of 1.1 in. Women have buttock-to-knee lengths that are normally distributed with a mean of 22.7 in. and a standard deviation of 1.0 in.

Group 2

Questions 9, 10, 11, and 12.

6-4 Sampling Distributions and Estimators

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7. **Sampling Distribution of the Mean** Samples of size $n = 1000$ are randomly selected from the population of the last digits of telephone numbers. If the sample mean is found for each sample, what is the distribution of the sample means?

8. **Sampling Distribution of the Proportion** Samples of size $n = 1000$ are randomly selected from the population of the last digits of telephone numbers, and the proportion of even numbers is found for each sample. What is the distribution of the sample proportions?

In Exercises 9–12, refer to the population and list of samples in Example 4.

9. Sampling Distribution of the Median In Example 4, we assumed that samples of size $n = 2$ are randomly selected without replacement from the population consisting of 2, 3, and 10, where the values are the numbers of people in households. Table 6-4 lists the nine different possible samples.

a. Find the median of each of the nine samples, then summarize the sampling distribution of the medians in the format of a table representing the probability distribution. (*Hint:* Use a format similar to Table 6-5).

b. Compare the population median to the mean of the sample medians.

c. Do the sample medians target the value of the population median? In general, do sample medians make good estimators of population medians? Why or why not?

10. Sampling Distribution of the Standard Deviation Repeat Exercise 9 using standard deviations instead of medians.

11. Sampling Distribution of the Variance Repeat Exercise 9 using variances instead of medians.

12. Sampling Distribution of the Mean Repeat Exercise 9 using means instead of medians.

13. Assassinated Presidents: Sampling Distribution of the Mean The ages (years) of the four U.S. presidents when they were assassinated in office are 56 (Lincoln), 49 (Garfield), 58 (McKinley), and 46 (Kennedy).

a. Assuming that 2 of the ages are randomly selected with replacement, list the 16 different possible samples.

b. Find the mean of each of the 16 samples, then summarize the sampling distribution of the means in the format of a table representing the probability distribution. (Use a format similar to Table 6-5 on page 296).

c. Compare the population mean to the mean of the sample means.

d. Do the sample means target the value of the population mean? In general, do sample means make good estimators of population means? Why or why not?

14. Sampling Distribution of the Median Repeat Exercise 13 using medians instead of means.

15. Sampling Distribution of the Range Repeat Exercise 13 using ranges instead of means.

16. Sampling Distribution of the Variance Repeat Exercise 13 using variances instead of means.

17. Sampling Distribution of Proportion Example 4 referred to three randomly selected households in which the numbers of people are 2, 3, and 10. As in Example 4, consider the values of 2, 3, and 10 to be a population and assume that samples of size $n = 2$ are randomly selected with replacement. Construct a probability distribution table that describes the sampling distribution of the proportion of odd numbers when samples of size $n = 2$ are randomly selected. Does the mean of the sample proportions equal the proportion of odd numbers in the population? Do the sample proportions target the value of the population proportion? Does the sample proportion make a good estimator of the population proportion?

18. Births: Sampling Distribution of Proportion When 3 births are randomly selected, the sample space is bbb, bbg, bgb, bgg, gbb, gbg, ggb, and ggg. Assume that those 8 outcomes are equally likely. Describe the sampling distribution of the proportion of girls from 3 births as a

6-4 Sampling Distributions and Estimators

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large samples, so s is often used to estimate even though s is a biased estimator of σ .)

The preceding three examples all involved rolling a die 5 times, so the number of different possible samples is $6 \times 6 \times 6 \times 6 \times 6 = 7776$. Because there are 7776 different possible samples, it is not practical to manually list all of them. The next example involves a smaller number of different possible samples, so we can list them and we can then describe the sampling distribution of the range in the format of a table for the probability distribution.

for Question 9-12


EXAMPLE 4

Sampling Distribution of the Range Three randomly selected households are surveyed as a pilot project for a larger survey to be conducted later. The numbers of people in the households are 2, 3, and 10 (based on Data Set 22 in Appendix B). Consider the values of 2, 3, and 10 to be a population. Assume that samples of size $n = 2$ are randomly selected with replacement from the population of 2, 3, and 10.

- List all of the different possible samples, then find the range in each sample.
- Describe the sampling distribution of the ranges in the format of a table summarizing the probability distribution.
- Describe the sampling distribution of the ranges in the format of a probability histogram.
- Based on the results, do the sample ranges target the population range, which is $10 - 2 = 8$?
- What do these results indicate about the sample range as an estimator of the population range?

SOLUTION

- In Table 6-4 we list the nine different possible samples of size $n = 2$ selected with replacement from the population of 2, 3, and 10. Table 6-4 also shows the range for each of the nine samples.
- The nine samples in Table 6-4 are all equally likely, so each sample has a probability of $1/9$. The last two columns of Table 6-4 list the values of the range along with the corresponding probabilities, so the last two columns constitute a table summarizing the probability distribution, which can be condensed as shown in Table 6-5. Table 6-5 therefore describes the *sampling distribution* of the sample ranges.
- Figure 6-17 is the probability histogram based on Table 6-5.
- The mean of the nine sample ranges is 3.6, but the range of the population is 8. Consequently, the sample ranges do not target the population range.
- Because the mean of the sample ranges (3.6) does not equal the population range (8), the sample range is a biased estimator of the population range. We can also see that the range is a biased estimator by simply examining Table 6-5 and noting that most of the time, the sample range is well below the population range of 8.

continued



Table 6-4 Sampling Distribution of the Range

Sample Range	Frequency	Probability
2, 2	0	1/9
2, 3	1	1/9
2, 10	8	1/9
3, 2	1	1/9
3, 3	0	1/9
3, 10	7	1/9
10, 2	8	1/9
10, 3	7	1/9
10, 10	0	1/9

Mean of the sample ranges = 3.6 (rounded)

Table 6-5 Probability Distribution for the Range

Sample Range	Probability
0	3/9
1	2/9
7	2/9
8	2/9

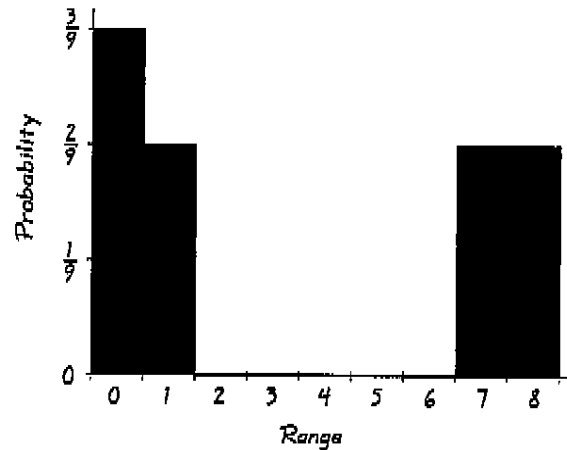


Figure 6-17 Probability Histogram: Sampling Distribution of the Sample Ranges

INTERPRETATION

In this example, we conclude that the sample range is a biased estimator of the population range. This implies that, in general, the sample range should not be used to estimate the value of the population range.

EXAMPLE 5

Sampling Distribution of the Proportion In a study of gender selection methods, an analyst considers the process of generating 2 births. When 2 births are randomly selected, the sample space is bb, bg, gb, gg. Those 4 outcomes are equally likely, so the probability of 0 girls is 0.25, the probability of 1 girl is 0.5, and the probability of 2 girls is 0.25. Describe the sampling distribution of the proportion of girls from 2 births as a probability distribution table and also describe it as a probability histogram.

Group 3 Question 9 and 11

6-5 The Central Limit Theorem

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3. **Notation** What does the notation $\mu_{\bar{x}}$ represent? What does the notation $\sigma_{\bar{x}}$ represent?
4. **Distribution of Incomes** Assume that we collect a large ($n > 30$) simple random sample of annual incomes of adults in the United States. Because the sample is large, can we approximate the distribution of those incomes with a normal distribution? Why or why not?

Using the Central Limit Theorem. In Exercises 5–8, assume that SAT scores are normally distributed with mean $\mu = 1518$ and standard deviation $\sigma = 325$ (based on data from the College Board).



5. a. If 1 SAT score is randomly selected, find the probability that it is less than 1500.
b. If 100 SAT scores are randomly selected, find the probability that they have a mean less than 1500.



6. a. If 1 SAT score is randomly selected, find the probability that it is greater than 1600.
b. If 64 SAT scores are randomly selected, find the probability that they have a mean greater than 1600.



7. a. If 1 SAT score is randomly selected, find the probability that it is between 1550 and 1575.
b. If 25 SAT scores are randomly selected, find the probability that they have a mean between 1550 and 1575.

c. Why can the central limit theorem be used in part (b), even though the sample size does not exceed 30?



8. a. If 1 SAT score is randomly selected, find the probability that it is between 1440 and 1480.
b. If 16 SAT scores are randomly selected, find the probability that they have a mean between 1440 and 1480.

c. Why can the central limit theorem be used in part (b), even though the sample size does not exceed 30?



9. **Water Taxi Safety** Based on data from the National Health and Nutrition Examination Survey, assume that weights of men are normally distributed with a mean of 172 lb and a standard deviation of 29 lb.

- a. Find the probability that if an *individual* man is randomly selected, his weight will be greater than 180 lb.
b. Find the probability that 20 *randomly selected men* will have a mean weight that is greater than 180 lb.
c. If 20 men have a mean weight greater than 180 lb, the total weight exceeds the 3500 lb safe capacity of a particular water taxi. Based on the preceding results, is this a safety concern? Why or why not?



10. **Mensa Membership** In Mensa requires an IQ score above 131.5. Nine candidates take IQ tests, and their summary results indicated that their mean IQ score is 133. (IQ scores are normally distributed with a mean of 100 and a standard deviation of 15.)

- a. If 1 person is randomly selected from the general population, find the probability of getting someone with an IQ score of at least 133.
b. If 9 people are randomly selected, find the probability that their mean IQ score is at least 133.

c. Although the summary results are available, the individual IQ test scores have been lost. Can it be concluded that all 9 candidates have IQ scores above 131.5 so that they are all eligible for Mensa membership?



11. **Gondola Safety** A ski gondola in Vail, Colorado, carries skiers to the top of a mountain. It bears a plaque stating that the maximum capacity is 12 people or 2004 lb. That capacity will be exceeded if 12 people have weights with a mean greater than $2004/12 = 167$ lb. Because men tend to weigh more than women, a "worst case" scenario involves 12 passengers who are all men. Men have weights that are normally distributed with a mean of 172 lb and a standard deviation of 29 lb (based on data from the National Health Survey).

- ~~a. Find the probability that if an individual man is randomly selected, his weight will be greater than 167 lb.~~
- ~~b. Find the probability that 12 randomly selected men will have a mean that is greater than 167 lb (so that their total weight is greater than the gondola maximum capacity of 2004 lb).~~
- ~~c. Does the gondola appear to have the correct weight limit? Why or why not?~~



12. Effect of Diet on Length of Pregnancy The lengths of pregnancies are normally distributed with a mean of 268 days and a standard deviation of 15 days.

- a. If 1 pregnant woman is randomly selected, find the probability that her length of pregnancy is less than 260 days.
- b. If 25 randomly selected women are put on a special diet just before they become pregnant, find the probability that their lengths of pregnancy have a mean that is less than 260 days (assuming that the diet has no effect).
- c. If the 25 women do have a mean of less than 260 days, does it appear that the diet has an effect on the length of pregnancy, and should the medical supervisors be concerned?



13. Blood Pressure For women aged 18–24, systolic blood pressures (in mm Hg) are normally distributed with a mean of 114.8 and a standard deviation of 13.1 (based on data from the National Health Survey). Hypertension is commonly defined as a systolic blood pressure above 140.

- a. If a woman between the ages of 18 and 24 is randomly selected, find the probability that her systolic blood pressure is greater than 140.
- b. If 4 women in that age bracket are randomly selected, find the probability that their mean systolic blood pressure is greater than 140.
- c. Given that part (b) involves a sample size that is not larger than 30, why can the central limit theorem be used?
- d. If a physician is given a report stating that 4 women have a mean systolic blood pressure below 140, can she conclude that none of the women have hypertension (with a blood pressure greater than 140)?



14. Designing Motorcycle Helmets Engineers must consider the breadths of male heads when designing motorcycle helmets. Men have head breadths that are normally distributed with a mean of 6.0 in. and a standard deviation of 1.0 in. (based on anthropometric survey data from Gordon, Churchill, et al.).

- a. If one male is randomly selected, find the probability that his head breadth is less than 6.2 in.
- b. The Safeguard Helmet company plans an initial production run of 100 helmets. Find the probability that 100 randomly selected men have a mean head breadth less than 6.2 in.
- c. The production manager sees the result from part (b) and reasons that all helmets should be made for men with head breadths less than 6.2 in., because they would fit all but a few men. What is wrong with that reasoning?



15. Doorway Height The Boeing 757-200 ER airliner carries 200 passengers and has doors with a height of 72 in. Heights of men are normally distributed with a mean of 69.0 in. and a standard deviation of 2.8 in.

- a. If a male passenger is randomly selected, find the probability that he can fit through the doorway without bending.
- b. If half of the 200 passengers are men, find the probability that the mean height of the 100 men is less than 72 in.
- c. When considering the comfort and safety of passengers, which result is more relevant: The probability from part (a) or the probability from part (b)? Why?
- d. When considering the comfort and safety of passengers, why are women ignored in this case?



16. Labeling of M&M Packages M&M plain candies have a mean weight of 0.8565 g and a standard deviation of 0.0518 g (based on Data Set 18 in Appendix B). The M&M candies used in Data Set 18 came from a package containing 465 candies, and the package label stated that the net weight is 396.9 g. (If every package has 465 candies, the mean weight of the candies must exceed $396.9/465 = 0.8535$ g for the net contents to weigh at least 396.9 g.)

EXCEL 17. **Mail Survey** In Example 1 it was noted that the author was mailed a survey from Viking River Cruises, and it included a request for an e-mail address. As in Example 1, assume that the survey was sent to 40,000 people and that for such surveys, the percentage of responses with an e-mail address is 3%. If the goal of the survey was to acquire a bank of at least 1300 e-mail addresses, find the probability of getting at least 1300 responses with e-mail addresses. Is it likely that the goal will be reached?

EXCEL 18. **Internet Penetration Survey** In Example 2, it was noted that a recent Pew Research Center survey showed that among 2822 randomly selected adults, 2060 (or 73%) stated that they are Internet users. A technology specialist claims that 75% of adults use the Internet, and the results from the survey show a lower percentage because of the random chance variation in surveys. Assuming that the 75% rate is correct, is a result of 2060 Internet users an unusually low number when 2822 adults are randomly selected? Explain.

EXCEL 19. **Gender Selection** The Genetics & IVF Institute developed its XSORT method to increase the probability of conceiving a girl. Among 574 women using that method, 525 had baby girls. Assuming that the method has no effect so that boys and girls are equally likely, find the probability of getting at least 525 girls among 574 babies. Does the result suggest that the XSORT method is effective? Why or why not?

EXCEL 20. **Gender Selection** The Genetics & IVF Institute developed its YSORT method to increase the probability of conceiving a boy. Among 152 women using that method, 127 had baby boys. Assuming that the method has no effect so that boys and girls are equally likely, find the probability of getting at least 127 boys among 152 babies. Does the result suggest that the YSORT method is effective? Why or why not?

EXCEL 21. **Mendel's Hybridization Experiment** When Mendel conducted his famous hybridization experiments, he used peas with green pods and yellow pods. One experiment involved crossing peas in such a way that 25% (or 145) of the 580 offspring peas were expected to have yellow pods. Instead of getting 145 peas with yellow pods, he obtained 152. Assume that Mendel's 25% rate is correct.

- ✓ a. Find the probability that among the 580 offspring peas, exactly 152 have yellow pods.
- ✓ b. Find the probability that among the 580 offspring peas, at least 152 have yellow pods.
- ✓ c. Which result is useful for determining whether Mendel's claimed rate of 25% is incorrect? (Part (a) or part (b)?)
- ✓ d. Is there strong evidence to suggest that Mendel's rate of 25% is incorrect?

EXCEL 22. **Voters Lying?** In a survey of 1002 people, 701 said that they voted in a recent presidential election (based on data from ICR Research Group). Voting records show that 61% of eligible voters actually did vote. Given that 61% of eligible voters actually did vote, find the probability that among 1002 randomly selected eligible voters, at least 701 actually did vote. What does the result suggest?

EXCEL 23. **Cell Phones and Brain Cancer** In a study of 420,095 cell phone users in Denmark, it was found that 135 developed cancer of the brain or nervous system. Assuming that the use of cell phones has no effect on developing such cancers, there is a 0.000340 probability of a person developing cancer of the brain or nervous system. We therefore expect about 143 cases of such cancer in a group of 420,095 randomly selected people. Estimate the probability of 135 or fewer cases of such cancer in a group of 420,095 people. What do these results suggest about media reports that cell phones cause cancer of the brain or nervous system?

EXCEL 24. **Employee Hiring** There is an 80% chance that a prospective employer will check the educational background of a job applicant (based on data from the Bureau of National Affairs, Inc.). For 100 randomly selected job applicants, find the probability that exactly 85 have their educational backgrounds checked.

EXCEL 25. **Universal Donors** Six percent of typical people have blood that is group O and type Rh⁻. These people are considered to be universal donors, because they can give blood to anyone. Providence Memorial Hospital is conducting a blood drive because it needs blood from at least 10 universal donors. If 200 volunteers donate blood, what is the probability that the number of universal donors is at least 10? Is the pool of 200 volunteers likely to be sufficient?

Group 4
Questions
21 and 27



EXCEL **26. Acceptance Sampling** With the procedure called *acceptance sampling*, a sample of items is randomly selected and the entire batch is either rejected or accepted, depending on the results. The Teletronics Company has just manufactured a large batch of backup power supply units for computers, and 7.5% of them are defective. If the acceptance sampling plan is to randomly select 80 units and accept the whole batch if at most 4 units are defective, what is the probability that the entire batch will be accepted? Based on the result, does the Teletronics Company have quality control problems?

EXCEL **27. M&M Candies: Are 24% Blue?** According to Mars (the candy company, not the planet), 24% of M&M plain candies are blue. Data Set 18 in Appendix B shows that among 100 M&Ms chosen, 27 are blue. Assuming that the claimed blue M&Ms rate of 24% is correct, find the probability of randomly selecting 100 M&Ms and getting 27 or more that are blue. Based on the result, is 27 an unusually high number of blue M&Ms when 100 are randomly selected?

EXCEL **28. Detecting Fraud** When working for the Brooklyn District Attorney, investigator Robert Burton analyzed the leading digits of amounts on checks from companies that were suspected of fraud. Among 784 checks, 479 had amounts with leading digits of 5, but checks issued in the normal course of honest transactions were expected to have 7.9% of the checks with amounts having leading digits of 5. Is there strong evidence to indicate that the check amounts are significantly different from amounts that are normally expected? Explain?

EXCEL **29. Cholesterol Reducing Drug** The probability of flu symptoms for a person not receiving any treatment is 0.019. In a clinical trial of Lipitor (atorvastatin), a drug commonly used to lower cholesterol, 863 patients were given a treatment of 10-mg atorvastatin tablets, and 19 of those patients experienced flu symptoms (based on data from Pfizer, Inc.). Assuming that these tablets have no effect on flu symptoms, estimate the probability that at least 19 of 863 people experience flu symptoms. What do these results suggest about flu symptoms as an adverse reaction to the drug?

EXCEL **30. Polygraph Accuracy** Polygraph experiments conducted by researchers Charles R. Honts (Boise State University) and Gordon H. Barland (Department of Defense Polygraph Institute) showed that among 57 polygraph indications of a lie, the truth was told 15 times, so the proportion of *false positive* results among the 57 positive results is 15/57. Assuming that the polygraph makes random guesses, determine whether 15 is an unusually low number of false positive results among the 57 positive results. Does the polygraph appear to be making random guesses? Explain.




EXCEL **31. Overbooking a Boeing 767-300** A Boeing 767-300 aircraft has 213 seats. When someone buys a ticket for a flight, there is a 0.0995 probability that the person will not show up for the flight (based on data from an IBM research paper by Lawrence, Hong, and Cherrier). A ticket agent accepts 236 reservations for a flight that uses a Boeing 767-300. Find the probability that not enough seats will be available. Is this probability low enough so that overbooking is not a real concern?

EXCEL **32. Passenger Load on a Boeing 767-300** An American Airlines Boeing 767-300 aircraft has 213 seats. When fully loaded with passengers, baggage, cargo, and fuel, the pilot must verify that the gross weight is below the maximum allowable limit, and the weight must be properly distributed so that the balance of the aircraft is within safe acceptable limits. When considering the weights of passengers, their weights are estimated according to Federal Aviation Administration rules. Men have a mean weight of 172 lb, whereas women have a mean weight of 143 lb, so disproportionately more male passengers might result in an unsafe overweight situation. Assume that if there are at least 122 men in a roster of 213 passengers, the load must be somehow adjusted. Assume that passengers are booked randomly, and that male passengers and female passengers are equally likely. If the aircraft is full of adults, find the probability that a Boeing 767-300 with 213 passengers has at least 122 men. Based on the result, does it appear that the load must be adjusted often?

6-6 Beyond the Basics





EXCEL **33. Gambling Strategy** Marc Taylor plans to place 200 bets of \$5 each on a game at the Mirage casino in Las Vegas.



continued

-  **10. Astronaut Flights** The numbers of flights by NASA astronauts, as listed in Data Set 10 in Appendix B.
-  **11. Heating Degree Days** The values of heating degree days, as listed in Data Set 12 in Appendix B.
-  **12. Generator Voltage** The measured voltage levels from a generator, as listed in Data Set 13 in Appendix B.



Using Technology to Generate Normal Quantile Plots. *In Exercises 13–16, use the data from the indicated exercise in this section. Use computer software (such as STATDISK or Excel) to generate a normal quantile plot or normal probability plot. Then determine whether the data come from a normally distributed population.*

*Group 5
Question 13
only*



-  **13. Exercise 9** *see reference*
-  **14. Exercise 10**
-  **15. Exercise 11**
-  **16. Exercise 12**

-  **17. Comparing Data Sets** Using the heights of women and the cholesterol levels of women, as listed in Data Set 1 in Appendix B, analyze each of the two data sets and determine whether each appears to come from a normally distributed population. Compare the results and give a possible explanation for any notable differences between the two distributions.
-  **18. Comparing Data Sets** Using the systolic blood pressure levels and the elbow breadths of women, as listed in Data Set 1 in Appendix B, analyze each of the two data sets and determine whether each appears to come from a normally distributed population. Compare the results and give a possible explanation for any notable differences between the two distributions.

Constructing Normal Quantile Plots. *In Exercises 19 and 20, use the given data values to identify the corresponding z scores that are used for a normal quantile plot. Then construct the normal quantile plot and determine whether the data appear to be from a population with a normal distribution.*

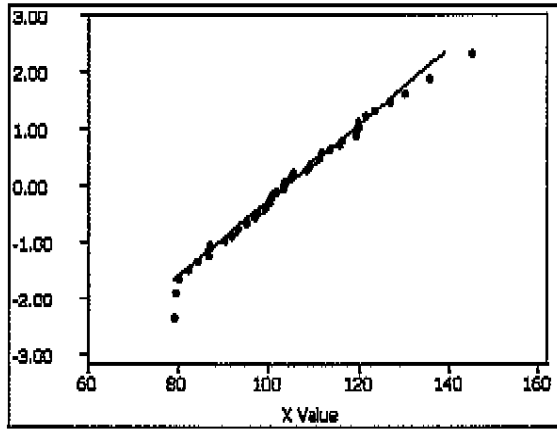
-  **19. Braking Distances** A sample of braking distances (in feet) measured under standard conditions for an Acura RL, Acura TSX, Audi A6, BMW 525i, and Buick LaCrosse: 131, 136, 129, 127, 146.
-  **20. Satellites** A sample of the numbers of satellites in orbit: 158 (United States); 17 (China); 18 (Russia); 15 (Japan); 3 (France); 5 (Germany).

6-7 Beyond the Basics

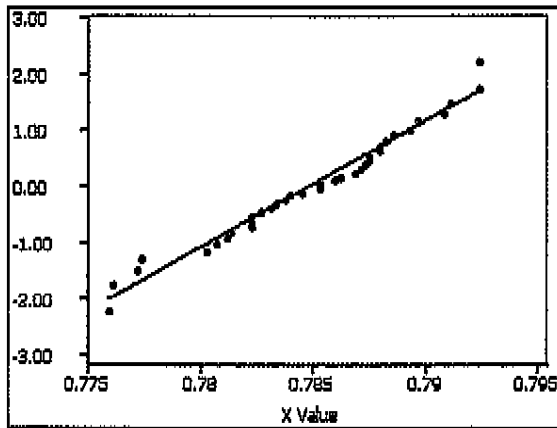
-  **21. Transformations** The heights (in inches) of men listed in Data Set 1 in Appendix B have a distribution that is approximately normal, so it appears that those heights are from a normally distributed population.
 - a. If 2 inches is added to each height, are the new heights also normally distributed?
 - b. If each height is converted from inches to centimeters, are the heights in centimeters also normally distributed?
 - c. Are the logarithms of normally distributed heights also normally distributed?
-  **22. Lognormal Distribution** The following values are the times (in days) it took for prototype integrated circuits to fail. Test these values for normality, then replace each x value with $\log(x + 1)$ and test the transformed values for normality. What can you conclude?

103	347	106	662	329	510	1169	267	1894	1065
106	207	267	1091	107	3877	547	725	4337	339

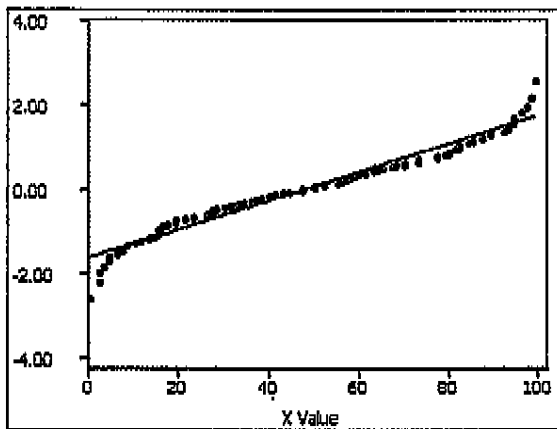
6. Heights of Women The normal quantile plot represents heights of women from Data Set 1 in Appendix B.



7. Weights of Diet Coke The normal quantile plot represents weights (in pounds) of diet Coke from Data Set 17 in Appendix B.



8. Telephone Digits The normal quantile plot represents the last two digits of telephone numbers of survey subjects.



Exercise 9.
Reference for question 13.

Determining Normality. In Exercises 9–12, refer to the indicated data set and determine whether the data have a normal distribution. Assume that this requirement is loose in the sense that the population distribution need not be exactly normal, but it must be a distribution that is roughly bell-shaped.



9. Space Shuttle Flights The lengths (in hours) of flights of NASA's Space Transport System (Shuttle) as listed in Data Set 10 in Appendix B.

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Appendix B

Reference for exercise 9 to answer question 13.

Data Set 10: NASA Space Transport System Data



STATDISK: Data set name is NASA.
 Minitab: Worksheet name is NASA.MTW.
 Excel: Workbook name is NASA.XLS.
 TI-83/84 Plus: App name is NASA and the file names are the same as for text files.
 Text file names: NASA1, NASA2.

Shuttle Flight Durations (hours)

54	54	192	169	122	120	146	145	247	191	167	144	197	191	73	167	168	169	190	170
97	168	165	146	0	97	105	119	96	121	119	120	261	106	121	98	117	215	143	199
218	213	128	166	193	214	213	331	191	190	236	175	143	222	239	239	236	336	259	174
335	269	353	262	269	262	198	399	235	214	260	381	196	214	377	221	240	405	243	423
244	239	95	221	376	284	259	376	211	381	235	213	283	235	118	191	269	237	283	309
259	309	307	285	306	285	283	262	259	332	259	330	382	333	306					

Numbers of Shuttle Flights by Astronauts

2	4	2	3	2	3	1	0	2	0	4	0	2	3	2	3	4	0	3	2
2	0	5	3	4	3	0	4	2	0	4	0	4	3	1	6	1	0	3	2
1	4	4	0	0	0	0	3	1	0	5	1	4	4	0	4	0	2	4	1
3	1	2	3	0	5	1	3	2	4	1	0	0	3	4	3	7	0	2	3
0	4	1	5	1	1	2	2	1	2	0	0	1	1	5	0	3	0	1	0
0	1	2	0	2	2	5	0	4	4	2	1	2	3	1	2	1	4	0	0
0	4	1	1	1	4	3	4	0	2	1	1	3	5	0	2	0	4	1	1
1	1	1	4	0	1	1	1	3	1	3	3	2	3	1	2	3	0	3	0
0	4	0	3	5	1	3	6	4	0	4	2	2	0	0	2	3	1	3	4
2	2	4	2	0	1	1	1	1	1	1	4	3	2	4	2	0	1	4	2
3	2	0	1	7	3	3	0	1	0	3	2	3	3	2	0	1	0	3	0
0	2	5	4	1	2	4	0	2	1	2	3	0	2	2	1	1	3	4	3
3	1	0	0	0	0	4	5	5	0	4	0	4	3	3	5	3	1	4	4
4	2	3	2	2	2	4	3	2	1	2	3	0	1	1	0	3	1	4	3
0	2	1	0	0	0	4	3	0	1	6	0	4	2	2	6	0	1	4	4

Determining Sample Size. In Exercises 41–44, find the minimum sample size required to estimate a population proportion or percentage.

41. Internet Use The use of the Internet is constantly growing. How many randomly selected adults must be surveyed to estimate the percentage of adults in the United States who now use the Internet? Assume that we want to be 99% confident that the sample percentage is within two percentage points of the true population percentage.

- Assume that nothing is known about the percentage of adults using the Internet.
- As of this writing, it was estimated that 73% of adults in the United States use the Internet (based on a Pew Research Center poll).


42. Cell Phones As the newly hired manager of a company that provides cell phone service, you want to determine the percentage of adults in your state who live in a household with cell phones and no land-line phones. How many adults must you survey? Assume that you want to be 90% confident that the sample percentage is within four percentage points of the true population percentage.

- Assume that nothing is known about the percentage of adults who live in a household with cell phones and no land-line phones.
- Assume that a recent survey suggests that about 8% of adults live in a household with cell phones and no land-line phones (based on data from the National Health Interview Survey).

43. Nitrogen in Tires A campaign was designed to convince car owners that they should fill their tires with nitrogen instead of air. At a cost of about \$5 per tire, nitrogen supposedly has the advantage of leaking at a much slower rate than air, so that the ideal tire pressure can be maintained more consistently. Before spending huge sums to advertise the nitrogen, it would be wise to conduct a survey to determine the percentage of car owners who would pay for the nitrogen. How many randomly selected car owners should be surveyed? Assume that we want to be 95% confident that the sample percentage is within three percentage points of the true percentage of all car owners who would be willing to pay for the nitrogen.


44. Name Recognition As this book was being written, former New York City mayor Rudolph Giuliani announced that he was a candidate for the presidency of the United States. If you were a campaign worker and needed to determine the percentage of people that recognized his name, how many people should have been surveyed to estimate that percentage? Assume that you wanted to be 95% confident that the sample percentage is in error by no more than two percentage points, and also assume that a recent survey indicated that Giuliani's name was recognized by 10% of all adults (based on data from a Gallup poll).

Using Appendix B Data Sets. In Exercises 45–48, use the indicated data set from Appendix B.

 **45. Green M&M Candies** Refer to Data Set 18 in Appendix B and find the sample proportion of M&Ms that are green. Use that result to construct a 95% confidence interval estimate of the population percentage of M&Ms that are green. Is the result consistent with the 16% rate that is reported by the candy maker Mars? Why or why not?

 **46. Freshmen 15 Weight Gain** Refer to Data Set 3 in Appendix B.

- Based on the sample results, find the best point estimate of the percentage of college students who gain weight in their freshman year.
- Construct a 95% confidence interval estimate of the percentage of college students who gain weight in their freshman year.
- Assuming that you are a newspaper reporter, write a statement that describes the results. Include all of the relevant information. (*Hint:* See Example 3 part (d).)

 **47. Precipitation in Boston** Refer to Data Set 14 in Appendix B, and consider days with precipitation values different from 0 to be days with precipitation. Construct a 95% confidence interval estimate of the proportion of Wednesdays with precipitation, and also construct a 95% confidence interval estimate of the proportion of Sundays with precipitation. Compare the results. Does precipitation appear to occur more on either day?

Group 6
Question 46
Only

Reference for question 4b

Data Set 3: Freshman 15 Data

Weights are in kilograms, and BMI denotes measured body mass index. Measurements were made in September of freshman year and then later in April of freshman year. Results are published in "Changes In Body Weight and Fat Mass of Men and Women in the First Year of College: A Study of the 'Freshman 15'" by Hoffman, Policastro, Quick, and Lee, *Journal of American College Health*, Vol. 55, No. 1. Reprinted with permission of the Helen Dwight Reid Educational Foundation. Published by Heldref Publications, 1319 Eighteenth St., NW, Washington, DC 20036-1802. Copyright © (2006).

SEX	Weight In September	Weight In April	BMI in September	BMI In April
M	72	59	22.02	18.14
M	97	86	19.70	17.44
M	74	69	24.09	22.43
M	93	88	26.97	25.57
F	68	64	21.51	20.10
F	59	55	18.69	17.40
F	64	60	24.24	22.88
F	56	53	21.23	20.23
F	70	68	30.26	29.24
F	58	56	21.88	21.02
F	50	47	17.63	16.89
M	71	69	24.57	23.85
M	67	66	20.68	20.15
F	56	55	20.97	20.36
F	70	68	27.30	26.73
F	61	60	23.30	22.88
M	53	52	19.48	19.24
F	92	92	24.74	24.69
F	57	58	20.69	20.79
M	67	67	20.49	20.60
F	58	58	21.09	21.24
M	49	50	18.37	18.53
F	68	68	22.40	22.61
F	69	69	28.17	28.43
M	87	88	23.60	23.81
M	81	82	26.52	26.78
F	60	61	18.89	19.27
F	52	53	19.31	19.75
M	70	71	20.96	21.32
F	63	64	21.78	22.22
F	56	57	19.78	20.23
M	68	69	22.40	22.82
M	68	69	22.76	23.19
F	54	56	20.15	20.69
M	80	82	22.14	22.57
M	64	66	20.27	20.76
F	57	59	22.15	22.93
F	63	65	23.87	24.67
F	54	56	18.61	19.34
F	56	58	21.73	22.58
M	54	56	18.93	19.72
M	73	75	25.88	26.72
M	77	79	28.59	29.53
F	63	66	21.89	22.79
F	51	54	18.31	19.28
F	59	62	19.64	20.63
F	65	68	23.02	24.10
F	53	56	20.63	21.91
F	62	65	22.61	23.81
M	55	58	22.03	23.42
M	74	77	20.31	21.34
M	74	78	20.31	21.36
M	64	68	19.59	20.77
M	64	68	21.05	22.31
F	57	61	23.47	25.11
F	64	68	22.84	24.29
M	60	64	19.50	20.90
M	64	68	18.51	19.83
F	66	71	21.40	22.97
M	52	57	17.72	19.42
F	71	77	22.26	23.87
M	55	60	21.64	23.81
M	65	71	22.51	24.45
F	75	82	23.69	25.80
M	42	49	15.08	17.74
M	74	82	22.64	25.33
M	94	105	36.57	40.86



- STATDISK:** Data set name is Freshman15.
- Minitab:** Worksheet name is FRESH15.MTW.
- Excel:** Workbook name is FRESH15.XLS.
- TI-83/84 Plus:** App name is FRESH and the file names are the same as for text files.
- Text file names:** WTSEP, WTAPR, BMISP, BMIAP.

EXCEL 23. **Global Warming** Find the best predicted temperature for a recent year in which the concentration (in parts per million) of CO₂ is 370.9. Is the predicted temperature close to the actual temperature of 14.5° (Celsius)?

CO ₂	314	317	320	326	331	339	346	354	361	369
Temperature	13.9	14.0	13.9	14.1	14.0	14.3	14.1	14.5	14.5	14.4

EXCEL 24. **Costs of Televisions** Find the best predicted quality score of a Hitachi television with a price of \$1900. Is the predicted quality score close to the actual quality score of 56?

Price	2300	1800	2500	2700	2000	1700	1500	2700
Quality Score	74	73	70	66	63	62	52	68

EXCEL 25. **Baseball** Listed below are statistics from seven baseball teams. The statistics consist of the proportions of wins and the result of this difference: Difference = (number of runs scored) - (number of runs allowed) for a recent year. Find the best predicted winning proportion for San Diego, which has a difference of 52 runs. Is the predicted proportion close to the actual proportion of 0.543?

Difference	163	55	-5	88	51	16	-214
Wins	0.599	0.537	0.531	0.481	0.494	0.506	0.383

EXCEL 26. **Crickets and Temperature** Find the best predicted temperature (in °F) at a time when a cricket chirps 3000 times in one minute. What is wrong with this predicted value?

Chirps in 1 min	882	1188	1104	864	1200	1032	960	900
Temperature (°F)	69.7	93.3	84.3	76.3	88.6	82.6	71.6	79.6

EXCEL 27. **Brain Size and Intelligence** Find the best predicted IQ score of someone with a brain size of 1275 cm³.

Brain Size	965	1029	1030	1285	1049	1077	1037	1068	1176	1105
IQ	90	85	86	102	103	97	124	125	102	114

EXCEL 28. **Ages of Best Actresses and Actors** Find the best predicted age of the Best Actor at the time that the age of the Best Actress is 75 years.

Best Actresses

26	80	42	29	33	35	45	49	39	34
26	25	33	35	35	28	30	29	61	

Best Actors

51	32	42	54	52	37	38	32	45	60
46	40	36	47	29	43	37	38	45	

Large Data Sets. Exercises 29–32 use the same Appendix B data sets as Exercises 29–32 in Section 10-2. In each case, find the regression equation, letting the first variable be the predictor (x) variable. Find the indicated predicted values following the prediction procedure summarized in Figure 10-5.

EXCEL 29. **Movie Budgets and Gross** Refer to Data Set 9 in Appendix B and use the paired data consisting of movie budget amounts and the amounts that the movies grossed. Find the best predicted amount that a movie will gross if its budget is \$120 million.

EXCEL 30. **Car Weight and Braking Distance** Refer to Data Set 16 in Appendix B and use the weights of cars and the corresponding braking distances. Find the best predicted braking distance for a car that weighs 4000 lb.

EXCEL 31. **Word Counts of Men and Women** Refer to Data Set 8 in Appendix B and use the word counts measured for men and women from the couples listed in the first two columns of

Group 7
Question 29
only

Reference for *ghestum*
Appendix B
29

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Data Set 9: Movies



STATDISK:
Minitab:
Excel:
TI-83/84 Plus:
Text file names:

Data set name is Movies.
Worksheet name is MOVIES.MTW.
Workbook name is MOVIES.XLS.
App name is MOVIES and the file names are the same as for text files.
MVBUD, MVGRS, MVLEN, MVRAT.

Title	MPAA Rating	Budget (\$) in Millions	Gross (\$) in Millions	Length (min)	Viewer Rating
8 Mile	R	41.0	117	110	6.7
Alone in the Dark	R	20.0	5	96	2.2
Aviator	PG-13	116.0	103	170	7.6
Big Fish	PG-13	70.0	66	125	8.0
Bourne Identity	PG-13	75.0	121	119	7.4
Break-Up	PG-13	52.0	116	105	5.8
Charlie's Angels: Full Throttle	PG-13	120.0	101	106	4.8
Collateral	R	65.0	100	120	7.7
Crash	R	6.5	55	113	8.3
Daddy Day Care	PG	60.0	104	92	5.7
DaVinci Code	PG-13	125.0	213	149	6.5
Eternal Sunshine	R	20.0	34	108	8.6
From Justin to Kelly	PG	5.0	12	81	1.9
Harry Potter Goblet of Fire	PG-13	150.0	290	157	7.8
Hostel	R	4.5	47	94	5.8
House of the Dead	R	7.0	10	90	2.0
Last Samurai	R	100.0	111	154	7.8
Million Dollar Baby	PG-13	30.0	100	132	8.4
Pirates of the Caribbean (II)	PG-13	225.0	322	150	7.5
Rollerball	PG-13	70.0	19	97	2.7
S.W.A.T.	PG-13	80.0	117	117	6.0
Secret Window	PG-13	40.0	48	96	6.3
Signs	PG-13	70.0	228	106	7.0
Silent Hill	R	50.0	47	127	6.6
Son of the Mask	PG	74.0	17	94	2.0
Spider-Man 2	PG-13	200.0	373	127	7.8
Star Wars III	PG-13	113.0	380	140	8.0
Sum of All Fears	PG-13	68.0	118	124	6.4
The Pianist	R	35.0	33	150	8.5
The Village	PG-13	72.0	114	108	6.6
Van Helsing	PG-13	160.0	120	132	5.3
Vanilla Sky	R	68.0	101	136	6.8
Walk the Line	PG-13	29.0	120	136	8.1
War of the Worlds	PG-13	132.0	234	116	6.7
Wedding Crashers	R	40.0	209	119	7.3