## Answer Key

### Section I

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|---|---|---|---|---|
| 1. D | 9. E | 17. C | 25. C | 33. D |
| 2. B | 10. E | 18. A | 26. C | 34. D |
| 3. B | 11. D | 19. B | 27. C | 35. E |
| 4. D | 12. B | 20. C | 28. B | 36. C |
| 5. E | 13. B | 21. D | 29. A | 37. E |
| 6. C | 14. E | 22. C | 30. A | 38. C |
| 7. C | 15. B | 23. C | 31. E | 39. E |
| 8. D | 16. A | 24. D | 32. D | 40. A |

## Answers Explained

### Section I

1. **(D)** Since (2, 7) is on the line $y = mx + 3$, we have $7 = 2m + 3$ and $m = 2$. Thus the regression line is $y = 2x + 3$. The point $(\bar{x}, \bar{y})$ is always on the regression line, and so we have $\bar{y} = 2\bar{x} + 3$.

2. **(B)** It could well be that conscientious students are the same ones who both study and do well on the basketball court. If students could be randomly assigned to study or not study, the results would be more meaningful. Of course, ethical considerations might make it impossible to isolate the confounding variable in this way.

3. **(B)** The critical $z$-score is 0.525. Thus $75 - \mu = 0.525(14)$ and $\mu = 67.65$.

4. **(D)** The slope of the regression line and the correlation are related by $b_1 = r\frac{s_y}{s_x}$. When using $z$-scores, the standard deviations $s_x$ and $s_y$ are 1. If $r = 0$, then $b_1 = 0$. Switching which variable is $x$ and which is $y$, or changing units, will not change the correlation.

5. **(E)** The median and interquartile range are specifically used when outliers are suspected of unduly influencing the mean, range, or standard deviation.

6. **(C)** $2.576\left(\frac{2.4}{\sqrt{n}}\right) \le 0.6$, which gives $\sqrt{n} \ge 10.304$ and $n \ge 106.2$.

7. **(C)** This is a hypothesis test with $H_0$: tissue strength is within specifications, and $H_a$: tissue strength is below specifications. A Type I error is committed when a true null hypothesis is mistakenly rejected.

8. **(D)**

$$P(\text{water}|\text{hurricane}) = \frac{P(\text{water} \cap \text{hurricane})}{P(\text{hurricane})} = \frac{.22}{.25} = .88$$

9. (E) The wording of questions can lead to response bias. The neutral way of asking this question would simply have been, "Do you support the proposed school budget increase?"

10. (E) While it is important to look for basic patterns, it is also important to look for deviations from these patterns. In this case, there is an overall positive correlation; however, those faculty with under ten years of service show little relationship between years of service and salary. While (A) is a true statement, it does not give an overall interpretation of the scatterplot.

11. (D) The second set has a greater range, $3.8 - 1.8 = 2.0$ as compared to $4.1 - 2.3 = 1.8$, and with its skewness it also has a greater standard deviation.

12. (B) With $n = 10$, increasing $\Sigma x$ by 40 increases $\frac{\Sigma x}{n}$ by 4.

13. (B) The means and the variances can be added. Thus the new variance is $5^2 + 12^2 = 169$, and the new standard deviation is 13.

14. (E) Dice have no memory, so the probability that the next toss will be an even number is .5 and the probability that it will be an odd number is .5. The law of large numbers says that as the number of tosses becomes larger, the proportion of even numbers tends to become closer to .5.

15. (B) The critical $t$-scores for 90% confidence with $df = 7$ are $\pm 1.895$.

16. (A) Either directly or anonymously, you should be able to obtain the test results for *every* student.

17. (C) Percentile ranking is a measure of relative position. Adding five points to everyone's score will not change the relative positions.

18. (A) The control group should have experiences identical to those of the experimental groups except for the treatment under examination. They should not be given a new treatment.

19. (B) If $H_a$ is true, the probability of failing to reject $H_0$ and thus committing a Type II error is 1 minus the power, that is, $1 - .8 = .2$.

20. (C) Five does not split the area in half, so 5 is not the median. Histograms such as these show relative frequencies, not actual frequencies. The area from 1.5 to 4.5 is the same as that between 7.5 and 10.5, each being about 25% of the total. Given the spread, 1 is too small an estimate of the standard deviation. The area above 3 looks to be the same as the area above 9 and 10, so the median won't change.

21. (D) There must be a fixed number of trials, which rules out (A); only two possible outcomes, which rules out (B); and a constant probability of success on any trial, which rules out (C).

22. (C) In both cases 1 hour is one standard deviation from the mean with a right tail probability of .1587.

23. (C) Control, randomization, and replication are all important aspects of well-designed experiments. We try to control lurking variables, not to use them to control something else.

24. (D) The data are strongly skewed to the left, indicating that the mean is less than the median. The median appears to be roughly 215, indicating that the interval [200, 240] probably has more than 50% of the values. While in a standard boxplot each whisker contains 25% of the values, this is a modified boxplot showing four outliers, and so the left whisker has four fewer values than the right whisker.

25. (C) For the regression line, the sum and thus the mean of the residuals are always zero. An influential score may have a small residual but still have a great effect on the regression line. If the correlation is 1, all the residuals would be 0, resulting in a very distinct pattern.

26. (C) $\bar{x} = \frac{32 + 24 + 29 + 27}{4} = 28$. Since $(\bar{x}, \bar{y})$ is a point on the regression line, $\bar{y} = 3(28) + 4 = 88$.

27. (C) $P(\text{at least 1}) = 1 - P(\text{none}) = 1 - (.88)^6 = .536$

28. (B) Different samples give different sample statistics, all of which are estimates for the same population parameter, and so error, called *sampling error*, is naturally present.

29. (A) While the associate does use chance, each customer would have the same chance of being selected only if the same number of customers had names starting with each letter of the alphabet. This selection does not result in a simple random sample because each possible set of 104 customers does not have the same chance of being picked as part of the sample. For example, a group of customers whose names all start with *A* will not be chosen. Sampling error, the natural variation inherent in a survey, is always present and is not a source of bias. Letting the surveyor have free choice in selecting the sample, rather than incorporating chance in the selection process, is a recipe for disaster!

30. (A) Corresponding to cumulative proportions of 0.25 and 0.75 are $Q_1 = 2.25$ and $Q_3 = 3.1$, respectively, and so the interquartile range is $3.1 - 2.25 = 0.85$.

31. (E) The standard deviation of the test statistic is $\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}} \approx \frac{s}{\sqrt{n}}$.

32. (D) From a table or a calculator (for example `invNorm` on the TI-84), the 40th percentile corresponds to a $z$-score of $-0.2533$, and $-0.2533(.28) = -0.0709$.

33. (D) Increasing the sample size by a multiple of $d$ divides the interval estimate by $\sqrt{d}$.

34. (D) The $t$-distributions are symmetric; however, they are lower at the mean and higher at the tails and so are more spread out than the normal distribution. The greater the *df*, the closer the $t$-distributions are to the normal distribution. The 68–95–99.7 Rule applies to the $z$-distribution and will work for $t$-models with very large *df*. All probability density curves have an area of 1 below them.

35. (E) The given bar chart shows percentages, not actual numbers.

36. (C) This follows from the central limit theorem.

37. (E) There is a different Type II error for each possible correct value for the population parameter.

38. (C) $X$ is close to the mean and so will have a $z$-score close to 0. Modified boxplots show only outliers that are far from the mean. $X$ and the two clusters are clearly visible in a stemplot of these data. In symmetric distributions the mean and median are equal. The IQR here is close to the range.

39. (E) Using a measurement from a sample, we are never able to say *exactly* what a population proportion is; rather we always say we have a certain *confidence* that the population proportion lies in a particular *interval*. In this case that interval is 82% ± 3% or between 79% and 85%.

40. (A) Whether or not students are taking AP Statistics seems to have no relationship to which type of school they are planning to go to. Chi-square is close to 0.

## SECTION II

1. (a) Number the volunteers 1 through 10. Use a random number generator to pick numbers between 1 and 10, throwing out repeats. The volunteers corresponding to the first two numbers chosen will receive aloe, the next two will receive camphor, the next two eucalyptus oil, the next two benzocaine, and the remaining two a placebo.
   (b) Each volunteer (the volunteers are "blocks") should receive all five treatments, one a day, with the time-order randomized. For example, label aloe 1, camphor 2, eucalyptus oil 3, benzocaine 4, and the placebo 5. Then for each volunteer use a random number generator to pick numbers between 1 and 5, throwing away repeats. The order picked gives the day on which each volunteer receives each treatment.
   (c) Results cannot be generalized to women.