Answer Key

Section I

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

Answers Explained

Section I

1. **(C)** A complete census can give much information about a population, but it doesn't necessarily establish a cause-and-effect relationship among seemingly related population parameters. While the results of well-designed observational studies might suggest relationships, it is difficult to conclude that there is cause and effect without running a well-designed experiment. If bias is present, increasing the sample size simply magnifies the bias. The control group is selected by the researchers making use of chance procedures.

2. **(A)** In the first class only 40% of the students scored below the given score, while in the second class 80% scored below the same score.

3. **(C)** 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.

4. **(E)** The negative sign comes about because we are dealing with the difference of proportions. The confidence interval estimate means that we have a certain *confidence* that the difference in population proportions lies in a particular *interval.*

5. **(B)** The desire of the workers for the study to be successful led to a placebo effect.

6. **(E)** The proportion of successful calls (problem solved) is $\frac{700}{1000}$, so $\frac{700}{1000}(450)$ is the expected number of calls from location 1 that are successful. Alternatively, the proportion of calls from location 1 is $\frac{450}{1000}$, so $\frac{450}{1000}(700)$ gives the expected number of successful calls from location 1.

7. **(C)** The slope and the correlation always have the same sign. Correlation shows association, not causation. Correlation does not apply to categorical data. Correlation measures linear association, so even with a correlation of 0, there may be very strong nonlinear association.

8. **(B)** If two random variables are independent, the mean of the difference of the two random variables is equal to the difference of the two individual means; however, the variance of the difference of the two random variables is equal to the *sum* of the two individual variances.

9. **(D)** A sample is simply a subset of a population.

10. **(B)** The markings, spaced 15 apart, clearly look like the standard deviation spacings associated with a normal curve.

11. **(B)** With a right tail having probability .01, the critical z-score is 2.326. Thus $\mu + 2.326(.3) = 12$, giving $\mu = 11.3$.

12. **(E)** There is no reason to think that AAA members are representative of the city's drivers. Family members may have similar driving habits and the independence condition would be violated. Random selection is important regardless of the sample size. The larger a random sample, the closer its standard deviation will be to the population standard deviation.

13. **(D)**

$$\begin{aligned} P\begin{pmatrix}\text{child}\\ \text{shows}\end{pmatrix} &= P\begin{pmatrix}\text{father}\\ \text{shows}\end{pmatrix} \cap \begin{pmatrix}\text{child}\\ \text{shows}\end{pmatrix} + P\begin{pmatrix}\text{father}\\ \text{doesn't}\end{pmatrix} \cap \begin{pmatrix}\text{child}\\ \text{shows}\end{pmatrix} \\ &= (.25)(.8) + (.75)(.06) \\ &= .200 + .045 \\ &= .245 \end{aligned}$$

$$P\left(\begin{matrix}\text{father}\\ \text{shows}\end{matrix}\middle|\begin{matrix}\text{child}\\ \text{shows}\end{matrix}\right) = \frac{.200}{.245} = .816$$

14. **(C)** As n increases the probabilities of Type I and Type II errors both decrease.

15. **(A)** The mean equals the common value of all the data elements. The other terms all measure variability, which is zero when all the data elements are equal.

16. **(E)** $\mu_{\bar{x}} \approx \frac{s}{\sqrt{n}} = \frac{0.45}{\sqrt{15}}$ and with $df = 15 - 1 = 14$, the critical t-scores are ± 1.761.

17. **(E)** In a simple random sample, every possible group of the given size has to be equally likely to be selected, and this is not true here. For example, with this procedure it is impossible for the employees in the final sample to all be from a single plant. This method is an example of stratified sampling, but stratified sampling does not result in simple random samples.

18. **(D)** $(.32)(.15) = .048$ so $P(E \cap F) = P(E)P(F)$ and thus E and F are independent. $P(E \cap F) \neq 0$, so E and F are not mutually exclusive.

19. **(A)** The quartiles Q_1 and Q_3 have z-scores of ± 0.67, so $Q_1 = 640{,}000 - (0.67)18{,}000 \approx 628{,}000$, while $Q_3 = 640{,}000 + (0.67)18{,}000 \approx 652{,}000$. The interquartile range is the difference $Q_3 - Q_1$.

20. **(D)** One set is a shift of 20 units from the other, so they have different means and medians, but they have identical shapes and thus the same variability including IQR, standard deviation, and variance.

21. **(B)** A 99% confidence interval estimate means that in about 99% of all samples selected by this method, the population mean will be included in the confidence interval. The wider the confidence interval, the higher the confidence level. The central limit theorem applies to any population, no matter if it is normally distributed or not. The sampling distribution for a mean always has standard deviation $\frac{\sigma}{\sqrt{n}}$; large enough sample size n refers to the closer the distribution will be to a normal distribution. The center of a confidence interval is the sample statistic, not the population parameter.

22. **(E)** In none of these are the trials independent. For example, as each consecutive person is stopped at a roadblock, the probability the next person has a seat belt on will quickly increase; if a student has one A, the probability is increased that he or she has another A.

23. **(E)** Independence implies $P(E \cap F) = P(E)P(F)$, while mutually exclusive implies $P(E \cap F) = 0$.

24. **(E)** In a binomial with $n = 4$ and $p = .9$, P(at least 3 successes) = P(exactly 3 successes) + P(exactly 4 successes) = $4(.9)^3(.1) + (.9)^4$.

25. **(C)** In stratified sampling the population is divided into representative groups, and random samples of persons from each group are chosen. In this case it might well be important to be able to consider separately the responses from each of the three groups—urban, suburban, and rural.

26. **(E)** r^2, the coefficient of determination, indicates the percentage of variation in y that is explained by variation in x.

27. **(C)** It is most likely that the homes at which the interviewer had difficulty finding someone home were homes with fewer children living in them. Replacing these homes with other randomly picked homes will most likely replace homes with fewer children with homes with more children.

28. **(A)** The median corresponds to the 0.5 cumulative proportion.

29. **(A)** Blocking divides the subjects into groups of similar individuals, in this case individuals with similar exercise habits, and runs the experiment on each separate group. This controls the known effect of variation in exercise level on cholesterol level.

30. **(B)** The margin of error varies directly with the critical z-value and directly with the standard deviation of the sample, but inversely with the square root of the sample size.

31. **(E)** $\sigma_{\bar{x}} = \frac{3.2}{\sqrt{400}} = 0.16$. With a true mean increase of 4.2, the z-score for 4.0 is $\frac{4.0-4.2}{0.16} = -1.25$ and the officers fail to reject the claim if the sample mean has z-score greater than this.

32. **(E)** Both have 50 for their means and medians, both have a range of $90 - 10 = 80$, and both have identical boxplots, with first quartile 30 and third quartile 70.

33. **(B)** Since we are not told that the investigator suspects that the average weight is over 300 mg or is under 300 mg, and since a tablet containing too little or too much of a drug clearly should be brought to the manufacturer's attention, this is a two-sided test. Thus the P-value is twice the tail probability obtained (using the t-distribution with $df = n - 1 = 6$.)

34. **(A)** This study was an experiment because a treatment (weekly quizzes) was imposed on the subjects. However, it was a poorly designed experiment with no use of randomization and no control over lurking variables.

35. **(C)** The expected frequencies, as calculated by the rule in (E), may not be whole numbers.

36. **(E)** The probabilities of Type I and Type II error are related; for example, lowering the Type I error increases the probability of a Type II error. A Type I error can be made only if the null hypothesis is true, while a Type II error can be made only if the null hypothesis is false. In medical testing, with the usual null hypothesis that the patient is healthy, a Type I error is that a healthy patient is diagnosed with a disease, that is, a *false positive*. We reject H_0 when the P-value falls below α, and when H_0 is true this rejection will happen precisely with probability α.

37. **(C)** X is probably very close to the least squares regression line and so has a small residual. Removing X will change the regression line very little if at all, and so it is not an influential point. The association between the x and y variables is very strong, just not linear. Correlation measures the strength of a *linear* relationship, which is very weak regardless of whether the point X is present or not.

38. **(B)** The probability of an application being turned down is $1 - .90 = .10$, and the expected value of a binomial with $n = 50$ and $p = .10$ is $np = 50(.10)$.

39. **(E)** A boxplot gives a five-number summary: smallest value, 25th percentile (Q_1), median, 75th percentile (Q_3), and largest value. The interquartile range is given by $Q_3 - Q_1$, or the total length of the two "boxes" minus the "whiskers."

40. **(E)** Using a measurement from a sample, we are never able to say *exactly* what a population mean is; rather we always say we have a certain *confidence* that the population mean lies in a particular *interval*.