tended to be worse after training. Those who were below average initially tended to improve.

40. a) We'd like to know if there is a linear association between *Price* and *Fuel Efficiency* in cars. We have data on 2004 model-year cars giving their highway mpg and retail price. H_0: $\beta_1 = 0$ (no linear relationship); H_A: $\beta_1 \neq 0$.
    b) The scatterplot fails the Straight Enough Condition. It shows a bend and it has an outlier. There is also some spreading from right to left, which would violate the Plot Thickens Condition. We cannot continue the analysis.
    c) The conditions are not met; the regression equation should not be interpreted.
41. a) Data plot looks linear; no overt pattern in residuals; histogram of residuals roughly symmetric and unimodal.
    b) H_0: No linear relationship between *Education* and *Mortality*, $\beta_1 = 0$. H_A: $\beta_1 \neq 0$. $t = -6.24$; P-value < 0.001. There is evidence that cities in which the mean education level is higher also tend to have a lower mortality rate.
    c) No. Data are on cities, not individuals. Also, these are observational data. We cannot predict causal consequences from them.
    d) (−65.95, −33.89) deaths per 100,000 people.
    e) *Mortality* decreases, on average, between 33.89 and 65.95 deaths per 100,000 for each extra year of average *Education*.
    f) Based on the regression, the average *Mortality* for cities with an average of 12 years of *Education* will be between 874.239 and 914.196 deaths per 100,000 people.
42. a) Data plot looks linear; no obvious pattern in residuals; Normal plot of residuals is roughly linear.
    b) H_0: No linear relationship between *Square Footage* and *Assessed Value*, $\beta_1 = 0$. H_A: Larger houses have higher assessed values, $\beta_1 > 0$. $t = 2.77$; P-value = 0.0068. With the very low P-value, we reject H_0. There is evidence that larger houses do have higher assessed values.
    c) 32.5%
    d) I am 90% confident that average *Assessed Value* increases between $4.58 and $19.22 for each square foot.
    e) No. These are observational data, not an experiment. We cannot conclude anything about the consequences of changes. Also, the data are for one city and may not apply to others.
    f) No. A 95% confidence interval for the assessed value of his 2100-square-foot house is from $45,619 to $78,572.

PART VII REVIEW

1. H_0: The proportions are as specified by the ratio 1:3:3:9; H_A: The proportions are not as stated. $\chi^2 = 5.01$; df = 3; P-value = 0.1711. Since $P > 0.05$, we fail to reject H_0. These data do not provide evidence to indicate that the proportions are other than 1:3:3:9.
2. a) 59 products b) 84.5% c) (2.21, 2.78) dollars per minute
    d) Average price increases between $2.21 and $2.78 for each extra minute of polishing time, with 95% confidence.
3. a) H_0: *Mortality* and *calcium concentration* in water are not linearly related, $\beta_1 = 0$; H_A: They are linearly related, $\beta_1 \neq 0$.
    b) $t = -6.73$; P-value < 0.0001. There is a significant negative relationship between calcium in drinking water and mortality.
    c) (−4.19, −2.27) deaths per 100,000 for each ppm calcium.
    d) Based on the regression, we are 95% confident that mortality (deaths per 100,000) decreases, on average, between 2.27 and 4.19 for each part per million of calcium in drinking water.
4. a) Based on these data, with 95% confidence 5-year yields are between 3.15 and 5.93% higher than 3-year yields, on average (paired data).
    b) Yes (at least for this data set). The regression line is $\widehat{5\text{-}year} = 6.93 + 0.719\ \widehat{3\text{-}year}$. H_0: $\beta_1 = 0$ against H_A: $\beta_1 \neq 0$ has $t = 4.27$; P-value = 0.0009. Since P is so small, we reject H_0. There is evidence of an association. (But we don't know that this was an SRS or even a representative sample of large cap funds.)
5. 404 checks
6. a) (36.21, 60.51) feet. b) Yes, 40 is in the interval.
    c) Wider; we'd need to have a wider interval to be more confident.
    d) Roughly 4 times as big—44 flights.
7. H_0: *Income* and *Party* are independent. H_A: *Income* and *Party* are not independent. $\chi^2 = 17.19$; P-value = 0.0018. With such a small P-value, we reject H_0. These data show evidence that income level and party are not independent. Examination of components suggests Democrats are most likely to have low incomes; Independents are most likely to have middle incomes, and Republicans are most likely to have high incomes.
8. a) 38
    b) Yes. Data plot looks linear; residuals plot shows random scatter; histogram of residuals approximately Normal.
    c) (0.131, 0.177) foals per adult.
    d) Based on this regression, we have 95% confidence that for every adult horse, an average of between 0.131 and 0.177 foals will be born.
    e) A herd with 80 adult horses will have between 2.27 and 19.21 foals, with 90% confidence.
9. H_0: $p_L - p_R = 0$; H_A: $p_L - p_R \neq 0$. $z = 1.38$; P-value = 0.1683. Since $P > 0.05$, we do not reject H_0. These data do not provide evidence of a difference in musical abilities between right- and left-handed people.
10. a) Combining boys and girls, df = 4, $\chi^2 = 42.80$; P-value < 0.0001. Reject H_0. These data show evidence that the distribution of scores at this school is significantly different from national results.
    b) Pooling scores of 2 or 1, df = 3, $\chi^2 = 5.59$, P-value = 0.1336. There is no significant difference in the distribution of scores for boys and girls.
11. a) H_0: $\mu_D = 0$; H_A: $\mu_D \neq 0$.
    Boxplot of the differences indicates a strong outlier (1958). With the outlier kept in, the *t*-stat is 0, with a P-value of 1.00 (two sided). There is no evidence of a difference (on averag of actual and that predicted by Gallup. With the outlier taken out, the *t*-stat is still only −0.8525 with a P-value of 0.4106, so the conclusion is the same.
    b) H_0: There is no (linear) relationship between predicted and actual number of Democratic seats won ($\beta_1 = 0$). H_A: There is a relationship ($\beta_1 \neq 0$). The relationship is very strong, with an R^2 of 97.7%. The *t*-stat is 22.56. Even with only 12 df, this is clearly significant (P-value < 0.0001). There is an outlying residual (1958), but without it, the regression is even stronger.
12. Conditions are met; df = 4; $\chi^2 = 6.14$; P-value = 0.1887. Since $P > 0.05$, we do not reject H_0. We do not have evidence of an association between duration of pregnancy and level of care.
13. Conditions are met; df = 4; $\chi^2 = 0.69$; P-value = 0.9526. Since $P > 0.05$, we do not reject H_0. We do not have evidence that the way the hospital deals with twin pregnancies has changed.
14. Conditions are met. H_0: $p_P - p_N = 0$; H_A: $p_P - p_N > 0$. $z = 1.96$; P-value = 0.0249. With such a small P-value, we reject H_0. These data provide moderately strong evidence to suggest that premies are more likely than babies of normal weight to be of "subnormal height" as adults.
15. a) Based on these data, the average annual rainfall in LA is between 11.65 and 17.39 inches, with 90% confidence.
    b) About 46 years
    c) No. The regression equation is $\widehat{Rain} = -51.684 + 0.033 \times Year$. $R^2 = 0.1\%$. For the slope, $t = 0.12$ with P-value = 0.9029.
16. a) Independence—individuals classified on two variables.
    b) H_0: No relationship between *Age* and *Party*; H_A: There is a relationship. df = 6, $\chi^2 = 16.66$; P-value = 0.0106. With such a small P-value, we reject H_0. These data indicate a relationship between *Age* and *Party*.
    c) There seems to be a relationship between age and party: The "largest" standardized residual is for Republicans 18 to 29 (−2.07). The next-largest is for Independents in the same age

group (1.79). These data indicate that young people are much more likely to be Independents than Republicans. We also see that the oldest group is more likely to be Democrat (1.57).

17. a) Linear regression is meaningless—the data are categorical.
    b) This is a two-way table that is appropriate. H_0: *Eye* and *Hair* color are independent. H_A: *Eye* and *Hair* color are not independent. However, four cells have expected counts less than 5, so the χ^2 analysis is not valid unless cells are merged. However, with a χ^2 value of 223.6 with 16 df and a P-value < 0.0001, the results are not likely to change if we merge appropriate eye colors.
18. a) H_0: There is no (linear) relationship between *Depression* and *Internet usage*. $\beta_1 = 0$. H_A: There is a linear relationship. $\beta_1 \neq 0$. $t = 2.76$; P-value $= 0.0064$. With such a small P-value, we reject H_0. These data provide strong evidence of a relationship between Internet use and depression.
    b) The study says nothing about causality. Many other factors may be involved.
    c) H_0: $\mu_D = 0$; H_A: $\mu_D \neq 0$. $t = -2.73$; P-value $= 0.014$. With such a small P-value, we reject H_0. These data suggest that mean depression level actually got better (decreased) during the study.
19. a) H_0: $p_Y - p_O = 0$; H_A: $p_Y - p_O \neq 0$. $z = 3.56$; P-value $= 0.0004$. With such a small P-value, we reject H_0. We conclude there is evidence of a difference in effectiveness; it appears the methods are not as good for older women.
    b) $\chi^2 = 12.70$; P-value $= 0.0004$. Same conclusion.
    c) The P-values are the same; $z^2 = (3.563944)^2 = 12.70 = \chi^2$.
20. a) Answers will vary. Stacked bar charts or pie charts would work well.
    b) Chi-square test of independence. One person's response should not influence another's. We have counts, an SRS of less than 10% of the population, and all expected cell frequencies are much larger than 5. With 8 df, $\chi^2 = 190.96$. Because the P-value < 0.001, reject the null. There is strong evidence to suggest that responses are not independent of age.
21. a) Positive direction, generally linear trend; moderate scatter.
    b) H_0: There is no linear relationship between *Interval* and *Duration*. $\beta_1 = 0$. H_A: There is a linear relationship, $\beta_1 \neq 0$.
    c) Yes; histogram is unimodal and roughly symmetric; residuals plot shows random scatter.
    d) $t = 27.1$; P-value ≤ 0.001. With such a small P-value, we reject H_0. There is evidence of a positive linear relationship between duration and time to next eruption of Old Faithful.
    e) The average time to next eruption after a 2-minute eruption is between 53.24 and 56.12 minutes, with 95% confidence.
    f) Based on this regression, we will have to wait between 63.23 and 87.57 minutes after a 4-minute eruption, with 95% confidence.
22. a) H_0: $\beta_1 = 0$; H_A: $\beta_1 \neq 0$. $t = 4.16$, P-value < 0.0001. These data show evidence of a positive relationship between number of meals eaten together and grades.
    b) No. R^2 is small and $s = 0.66$ points. So we could predict only to within 1.32 grade points at best.
    c) No. The slope is clearly not 0, but that doesn't mean the relationship is strong or the predictions are useful.
23. a) $t = 1.42$, df $= 459.3$, P-value $= 0.1574$. Since P > 0.05, we do not reject H_0. There's no evidence the two groups differed in ability at the start of the study.
    b) $t = 15.11$; P-value < 0.0001. The group taught using the accelerated Math program showed a significant improvement.
    c) $t = 9.24$; P-value < 0.0001. The control group showed a significant improvement in test scores.
    d) $t = 5.78$; P-value < 0.0001. The Accelerated Math group had significantly higher gains than the control group.
24. H_0: $p = 0.512$; H_A: $p < 0.512$. $z = -3.35$; P-value $= 0.0004$. With such a small P-value, we reject H_0. These data provide evidence that exposure to dioxin reduces the rate of male births.
25. a) The regression—he wanted to know about association.
    b) There is a moderate relationship between cottage cheese and ice cream sales; for every million pounds of cottage cheese, 1.19 million pounds of ice cream are sold, on average.
    c) Testing if the mean difference is 0 (matched *t*-test). Regression won't answer this question.
    d) The company sells more cottage cheese than ice cream, on average.
    e) part (a)—linear relationship; residuals have a Normal distribution; residuals are independent with equal variation about the line. (c)—Observations are independent; differences are approximately Normal; less than 10% of all possible months' data.
    f) About 71.32 million pounds. g) (0.09, 2.29)
    h) From this regression, every million pounds of cottage cheese sold is associated with an increase in ice cream sales of between 0.09 and 2.29 million pounds.
26. $\chi^2 = 14.96$; P-value $= 0.0006$. With such a small P-value, we reject H_0. These data provide evidence that continued treatment with inflixamab is of value.
27. Based on these data, the average weight loss for the clinic is between 8.24 and 10.06 pounds, with 95% confidence. The clinic's claim is plausible.
28. a) Yes. Data plot is linear; residuals plot shows random scatter; histogram of residuals is roughly normal.
    b) Yes; $t = 5.19$; P-value ≤ 0.0001.
    c) Weaker. Individuals are more variable than averages.
    d) Based on this regression, every extra year of median education in a city is associated with an increase of between \$1500.48 and \$3389.10 in median income.
    e) Based on the regression, median income for cities where residents spent an average of 11 years in school is between \$32,198.81 and \$33,526.67, with 90% confidence.
29. $\chi^2 = 8.23$; P-value $= 0.0414$. There is evidence of an association between *cracker type* and *bloating*. Standardized residuals for the gum cracker are −1.32 and 1.58. Prospects for marketing this cracker are not good.
30. a) H_0: $\mu_1 - \mu_2 = 0$; H_A: $\mu_1 - \mu_2 > 0$. $t = 0.98$; P-value $= 0.1864$. Since P > 0.05, we do not reject H_0. Weeklong study scores were not significantly higher.
    b) H_0: $p_1 - p_2 = 0$; H_A: $p_1 - p_2 \neq 0$. $z = -3.10$, P-value $= 0.0019$. With such a small P-value, we reject H_0. There is evidence of a difference in proportion for passing on Friday; it appears that cramming may be more effective.
    c) H_0: $\mu_D = 0$; H_A: $\mu_D > 0$. $t = 5.17$, P-value < 0.0001. These data show evidence that learning does not last for 3 days because mean score declined.
    d) Based on these data, the average number of words forgotten by crammers is between 3.03 and 7.05, with 95% confidence.
    e) Yes. Regression equation is $\widehat{Monday} = 14.6 + 0.536 \times Friday$. $t = 2.57$; P-value $= 0.0170$