CHAPTER 20

1. a) $H_0: p = 0.30; H_A: p < 0.30$
   b) $H_0: p = 0.50; H_A: p \neq 0.50$
   c) $H_0: p = 0.20; H_A: p > 0.20$
2. a) $H_0: p = 0.40; H_A: p \neq 0.40$
   b) $H_0: p = 0.20; H_A: p < 0.20$
   c) $H_0: p = 0.60; H_A: p > 0.60$
3. Statement d is correct.
4. Statement d is correct.
5. No, we can say only that there is a 27% chance of seeing the observed effectiveness just from natural sampling variation. There is no *evidence* that the new formula is more effective, but we can't conclude that they are equally effective.
6. Yes. If there is no difference, there's only a 1.7% chance of seeing such a high sample proportion just from sampling variation.
7. a) No. There's a 25% chance of losing twice in a row. That's not unusual.
   b) 0.125 c) No, we expect that to happen 1 time in 8.
   d) Maybe 5? The chance of 5 losses in a row is only 1 in 32, which seems unusual.
8. a) 0.091
   b) Perhaps. If so, we'd get 3 vanillas in a row about 9% of the time.
   c) No. The probability of getting 4 vanillas in a row is only about 3%; that's unlikely to have happened by chance.
9. 1) Use p, not $\hat{p}$, in hypotheses.
   2) The question was about failing to meet the goal, so H_A should be $p < 0.96$.
   3) Did not check $0.04(200) = 8$. Since $nq < 10$, the Success/Failure Condition is violated. Didn't check 10% Condition.
   4) $188/200 = 0.94; SD(\hat{p}) = \sqrt{\frac{(0.96)(0.04)}{200}} = 0.014$
   5) z is incorrect; should be $z = \frac{0.94 - 0.96}{0.014} = -1.43$
   6) $P = P(z < -1.43) = 0.076$
   7) There is only weak evidence that the new instructions do not work.
10. 1) Use p in hypotheses, not $\hat{p}$.
    2) The question asks *"not accurate,"* so H_A should be two sided: $p \neq 0.9$.
    3) The correct conditions are SRS, $750 < 10\%$ of county population; $(0.9)(750) \geq 10$, and $(0.10)(750) \geq 10$.
    4) $\hat{p} = 657/750 = 0.876; SD(\hat{p}) = \sqrt{\frac{(0.9)(0.1)}{750}} = 0.011$
    5) z is incorrect; should be $z = \frac{0.876 - 0.9}{0.011} = -2.18$
    6) $P = 2P(z < -2.18) = 0.029$
    7) There is only a 2.9% chance of observing a $\hat{p}$ as far from 0.90 by sampling variation, so we believe that the proportion of adults who drink milk here is different from the claimed 90%.
11. a) $H_0: p = 0.30; H_A: p > 0.30$
    b) Possibly an SRS; we don't know if the sample is less than 10% of his customers, but it could be viewed as less than 10% of all possible customers; $(0.3)(80) \geq 10$ and $(0.7)(80) \geq 10$. Wells are independent only if customers don't have farms on the same underground springs.
    c) $z = .0.73$; P-value $= 0.232$
    d) If his dowsing is no different from standard methods, there is more than a 23% chance of seeing results as good as those of the dowser's, or better, by natural sampling variation.
    e) These data provide no evidence that the dowser's chance of finding water is any better than normal drilling.
12. a) $H_0: p = 0.05; H_A: p > 0.05$
    b) SRS (not clear from information provided), $< 10\%$ of all children, $(0.05)(384) \geq 10$, and $(0.95)(384) \geq 10$.
    c) $z = 6.28, P = 2 \times 10^{-10}$.
    d) If the abnormality rate has not increased, the chance of observing at least 46 children with abnormalities in a sample of 384 is 2×10^{-10} (almost 0).
    e) Reject H_0. These data show that the rate of abnormalities is now more than 5%.
    f) We do not know that chemicals cause abnormalities, only that the rate is higher now than in the past.
13. a) $H_0: p_{2000} = 0.34; H_A: p_{2000} \neq 0.34$
    b) Students were randomly sampled and should be independent. 34% and 66% of 8302 are greater than 10. 8302 students is less than 10% of the entire student population of the United States.
    c) $P = 0.058$
    d) With such a small P-value, I reject H_0. There has been a statistically significant change in the proportion of students who have no absences.
    e) No. A difference this small, although statistically significant, is not meaningful. We might look at new data in a few years.
14. a) $H_0: p_{2000} = 0.31; H_A: p_{2000} \neq 0.31$
    b) Students are randomly sampled and should be independent; 31% and 69% of 8368 are both at least 10. 8368 students is less than 10% of the entire student population of the U.S.
    c) $P = 0.048$
    d) With a P-value so low, I reject H_0. There is a statistically significant difference in the proportion of college-educated mothers.
    e) A difference this small, although statistically significant, may not be meaningful.
15. a) $H_0: p = 0.05$ vs. $H_A: p < 0.05$
    b) We assume the whole mailing list has over 1,000,000 names. This is a random sample, and we expect 5000 successes and 95,000 failures.
    c) $z = -3.178$; P-value $= 0.00074$, so we reject H_0; there is strong evidence that the donation rate would be below 5%.
16. a) $H_0: p = 0.02$ vs. $H_A: p \neq 0.02$
    b) We assume the company has over 500,000 cardholders. This is a random sample, and we expect 1000 successes and 49,000 failures.
    c) $z = 5.878$; the P-value is less than 0.0001, so we reject H_0, concluding that there is strong evidence that the success rate will be more than 2%.
17. a) $H_0: p = 0.63, H_A: p > 0.63$
    b) The sample is representative. $240 < 10\%$ of all law school applicants. We expect $240(0.63) = 151.2$ to be admitted and $240(0.37) = 88.8$ not to be, both at least 10. $z = 1.58$; P-value = 0.057
    c) Although the evidence is weak, there is some indication that the program may be successful. Candidates should decide whether they can afford the time and expense.
18. a) $H_0: p = 0.46; H_A: p < 0.46$
    b) Assume the sample is representative of all applicants from the college. $180 < 10\%$ of all medical school applicants. We expect $180(0.46) = 82.8$ to be admitted and $180(0.54) = 97.2$ not to be, both at least 10. $z = -0.87$; P-value $= 0.19$
    c) The high P-value says this isn't an unusual result; it may be just year-to-year variation, as the president says.
19. $H_0: p = 0.20; H_A: p > 0.20$. SRS (not clear from information provided); 22 is more than 10% of the population of 150; $(0.20)(22) < 10$. Do not proceed with a test.
20. $H_0: p = 0.02; H_A: p > 0.02$. SRS; less than 10% of all washers and dryers made by the company; $(0.02)(60) < 10$. Do not proceed with a test.
21. $H_0: p = 0.03; p \neq 0.03$. $\hat{p} = 0.015$. One mother having twins will not affect another, so observations are independent; not an SRS; sample is less than 10% of all births. However, the mothers at a hospital may not be representative of all teenagers; $(0.03)(469) = 14.07 \geq 10$; $(0.97)(469) \geq 10$. $z = -1.91$; P-value $= 0.0556$. With a P-value this low, reject H_0. These

show some evidence that the rate of twins born to teenage girls at this hospital is less than the national rate of 3%. It is not clear whether this can be generalized to all teenagers.

22. $H_0: p = 0.50; H_A: p > 0.50$. Results of one game should not affect another, so games are independent; data are all results for one season, which should be representative of all seasons; sample is less than 10% of all games; $(0.50)(240) \geq 10$; $(0.50)(240) \geq 10$. $z = 2.07$; P-value $= 0.02$. With a P-value this low, reject H_0. These data show strong evidence that the home team does have an advantage; they win more than 50% of games at home.
23. $H_0: p = 0.25; H_A: p > 0.25$. SRS; sample is less than 10% of all potential subscribers; $(0.25)(500) \geq 10$; $(0.75)(500) \geq 10$. $z = 1.24$; P-value $= 0.1076$. The P-value is high, so do not reject H_0. These data do not show that more than 25% of current readers would subscribe; the company should not go ahead with the WebZine on the basis of these data.
24. $H_0: p = 0.92; H_A: p < 0.92$. Seeds in a single packet may not be independent of each other. This is a cluster sample of all seeds in the packet. We may view this cluster as representative of all year-old seeds, in which case the sample is less than 10% of all seeds; $(0.92)(200) \geq 10$; $(0.08)(200) \geq 10$. $z = -3.39$; P-value $= 0.0004$ Because the P-value is very low, we reject H_0. There is strong evidence that these seeds have lost viability; their germination rate is less than 92%.
25. $H_0: p = 0.40; H_A: p < 0.40$. Data are for all executives in this company and may not be able to be generalized to all companies; $(0.40)(43) \geq 10$; $(0.60)(43) \geq 10$. $z = -1.31$; P-value $= 0.0955$. Because the P-value is high, we fail to reject H_0. These data do not show that the proportion of women executives is less than the 40% of women in the company in general.
26. $H_0: p = 0.19; H_A: p < 0.19$. $\hat{p} = 0.125$. $z = -1.41$; P-value $= 0.0793$. Because the P-value is high, we fail to reject H_0. These data do not show convincing evidence that Hispanics are represented in the jury pool at less than their 19% proportion in the population in general, but the data do indicate that the percentage is below what was expected.
27. $H_0: p = 0.103; H_A: p > 0.103$. $\hat{p} = 0.118$; $z = 2.06$; P-value $= 0.02$. Because the P-value is low, we reject H_0. These data provide evidence that the dropout rate has increased.
28. $H_0: p = 0.15; H_A: p > 0.15$. $\hat{p} = 0.25$; $z = 2.80$; P-value $= 0.0026$. The 95% confidence interval is $(0.165, 0.335)$. We must assume that the trees sampled are an SRS of the trees in the area and are less than 10% of all trees in the forest. The results are generalizable only to the Hopkins forest (or nearby if the forest is viewed as representative). Because the P-value is so low, we reject H_0. There is strong evidence that the proportion of trees damaged by acid rain in the Hopkins forest is higher than the 15% average for the Northeast.
29. $H_0: p = 0.90; H_A: p < 0.90$. $\hat{p} = 0.844$; $z = -2.05$; P-value $= 0.0201$. Because the P-value is so low, we reject H_0. There is strong evidence that the actual rate at which passengers with lost luggage are reunited with it within 24 hours is less than the 90% claimed by the airline.
30. $H_0: p = 0.40; H_A: p > 0.40$. $\hat{p} = 0.431$; $z = 1.29$; P-value $= 0.0977$ Because the P-value is high, we fail to reject H_0. These data do not show that at least 40% of the public recognizes the brand; I would not recommend they continue to advertise during Super Bowls on the basis of these data.
31. a) Yes; assuming this sample to be a typical group of people, $P = 0.0008$. This cancer rate is very unusual.
    b) No, this group of people may be atypical for reasons that have nothing to do with the radiation.
32. No; the P-value of 0.47 indicates that her school's results could be explained by random variation (sampling error).

CHAPTER 21

1. a) Two sided. Let p be the percentage of students who prefer Diet Pepsi. $H_0: p = 0.5$ vs. $H_A: p \neq 0.5$
   b) One sided. Let p be the percentage of teenagers who prefer the new formulation. $H_0: p = 0.5$ vs. $H_A: p > 0.5$
   c) One sided. Let p be the percentage of people who intend to vote for the override. $H_0: p = 2/3$ vs. $H_A: p > 2/3$.
   d) Two sided. Let p be the percentage of days that the market goes up. $H_0: p = 0.5$ vs. $H_A: p \neq 0.5$
2. a) Two sided. Let p be the percentage of students who prefer plastic. $H_0: p = 0.5$ vs. $H_A: p \neq 0.5$
   b) Two sided. Let p be the percentage of juniors applying for study abroad. $H_0: p = 0.1$ vs. $H_A: p \neq 0.1$
   c) One sided. Let p be the percentage of people who experience relief. $H_0: p = 0.22$ vs. $H_A: p > 0.22$
   d) One sided. Let p be the percentage of hard drives that pass the test the first time. $H_0: p = 0.6$ vs. $H_A: p > 0.6$
3. If there is no difference in effectiveness, the chance of seeing an observed difference this large or larger is 4.7% by natural sampling variation.
4. If harsher penalties and ad campaigns have made no difference in seat-belt use, there is a 17% chance of seeing an observed difference this large or larger by natural sampling variation.
5. $\alpha = 0.10$: Yes. The P-value is less than 0.05, so it's less than 0.10. But to reject H_0 at $\alpha = 0.01$, the P-value must be below 0.01, which isn't necessarily the case.
6. At $\alpha = 0.10$, they reach the same decision only if the P-value is > 0.10. We know only that it's > 0.05. But we know that it's > 0.01, so at $\alpha = 0.01$, they reach the same decision.
7. a) There is only a 1.1% chance of seeing a sample proportion as low as 89.4% vaccinated by natural sampling variation if 90% have really been vaccinated.
   b) We conclude that p is below 0.9, but a 95% confidence interval would suggest that the true proportion is between (0.889, 0.899). Most likely, a decrease from 90% to 89.9% would not be considered important. On the other hand, with 1,000,000 children a year vaccinated, even 0.1% represents about 1000 kids—so this may very well be important.
8. a) There is only a 2.3% chance of seeing a sample proportion of 15.1% (or less) of students not attaining grade level by natural sampling variation if 15.9% is the true population value.
   b) Under old methods, 1352 students would not be expected to read at grade level. With the new program, 1284 did not. This is only a decrease of 68 students. It would depend on the costs of switching to the new program.
9. a) (1.9%, 4.1%)
   b) Because 5% is not in the interval, there is strong evidence that fewer than 5% of all men use work as their primary measure of success.
   c) $\alpha = 0.01$; it's a lower-tail test based on a 98% confidence interval.
10. a) (0.498, 0.622); we are 95% confident that the true proportion of heads is between 49.8% and 62.2%.
    b) No; 0.50 is within the confidence interval, so it's a plausible value for the proportion of heads.
    c) $\alpha = 0.05$; it's a two-tailed test based on a 95% confidence interval.
11. a) (0.274, 0.327)
    b) Since 0.27 is not in the confidence interval, we reject the hypothesis that $p = 0.27$
12. a) (19.0%, 25.1%)
    b) Since the confidence interval extends well below 25%, we can't be sure that over 25% of men are stay-at-home dads. The company should not buy the ads.
    c) Yes, 25% is in the interval. It's a plausible value, but we can never prove that the null hypothesis is true.