**Chapter 9**

**Hypothesis Tests**

**Learning Objectives**

1. Learn how to formulate and test hypotheses about a population mean and/or a population proportion.

2. Understand the types of errors possible when conducting a hypothesis test.

3. Be able to determine the probability of making these errors in hypothesis tests.

4. Know how to compute and interpret *p*-values.

5. Be able to use critical values to draw hypothesis testing conclusions.

6. Be able to determine the size of a simple random sample necessary to keep the probability of hypothesis testing errors within acceptable limits.

7. Know the definition of the following terms:

null hypothesis two-tailed test

alternative hypothesis *p*-value

Type I error level of significance

Type II error critical value

one-tailed test power curve

**Solutions:**

1. a. *H*0: **  600 Manager’s claim.

*H*a: ** > 600

b. We are not able to conclude that the manager’s claim is wrong.

c. The manager’s claim can be rejected. We can conclude that ** > 600.

2. a. *H*0: **  14

*H*a: ** > 14 Research hypothesis

b. There is no statistical evidence that the new bonus plan increases sales volume.

c. The research hypothesis that ** > 14 is supported. We can conclude that the new bonus plan increases the mean sales volume.

3. a. *H*0: ** = 32 Specified filling weight

*H*a: **  32 Overfilling or underfilling exists

b. There is no evidence that the production line is not operating properly. Allow the production process to continue.

c. Conclude **  32 and that overfilling or underfilling exists. Shut down and adjust the production line.

4. a. *H*0: **  220

*H*a: ** < 220 Research hypothesis to see if mean cost is less than $220.

b. We are unable to conclude that the new method reduces costs.

c. Conclude ** < 220. Consider implementing the new method based on the conclusion that it lowers the mean cost per hour.

5. a. Conclude that the population mean monthly cost of electricity in the Chicago neighborhood is greater than $104 and hence higher than in the comparable neighborhood in Cincinnati.

b. The Type I error is rejecting *H*0 when it is true. This error occurs if the researcher concludes that the population mean monthly cost of electricity is greater than $104 in the Chicago neighborhood when the population mean cost is actually less than or equal to $104.

c. The Type II error is accepting *H*0 when it is false. This error occurs if the researcher concludes that the population mean monthly cost for the Chicago neighborhood is less than or equal to $104 when it is not.

6. a. *H*0: **  1 The label claim or assumption.

*H*a: ** > 1

b. Claiming ** > 1 when it is not. This is the error of rejecting the product’s claim when the claim is true.

c. Concluding **  1 when it is not. In this case, we miss the fact that the product is not meeting its label specification.

7. a. *H*0: **  8000

*H*a: ** > 8000 Research hypothesis to see if the plan increases average sales.

b. Claiming ** > 8000 when the plan does not increase sales. A mistake could be implementing the plan when it does not help.

c. Concluding **  8000 when the plan really would increase sales. This could lead to not implementing a plan that would increase sales.

8. a. *H*0: **  220

*H*a: ** < 220

b. Claiming ** < 220 when the new method does not lower costs. A mistake could be implementing the method when it does not help.

c. Concluding **  220 when the method really would lower costs. This could lead to not implementing a method that would lower costs.

9. a. 

b. Lower tail *p*-value is the area to the left of the test statistic

Using normal table with *z* = -2.12: *p*-value =.0170

c. *p*-value ≤ .05, reject *H*0

d. Reject *H*0 if *z* ≤ -1.645

-2.12 ≤ -1.645, reject *H*0

10. a. 

b. Upper tail *p*-value is the area to the right of the test statistic

Using normal table with *z* = 1.48: *p*-value = 1.0000 - .9306 = .0694

c. *p*-value > .01, do not reject *H*0

d. Reject *H*0 if *z* ≥ 2.33

1.48 < 2.33, do not reject *H*0

11. a. 

b. Because *z* < 0, *p*-value is two times the lower tail area

Using normal table with *z* = -2.00: *p*-value = 2(.0228) = .0456

c. *p*-value ≤ .05, reject *H*0

d. Reject *H*0 if *z* ≤ -1.96 or z ≥ 1.96

-2.00 ≤ -1.96, reject *H*0

12. a. 

Lower tail *p*-value is the area to the left of the test statistic

Using normal table with *z* = -1.25: *p*-value =.1056

*p*-value > .01, do not reject *H*0

b. 

Lower tail *p*-value is the area to the left of the test statistic

Using normal table with *z* = -2.50: *p*-value =.0062

*p*-value ≤ .01, reject *H*0

c. 

Lower tail *p*-value is the area to the left of the test statistic

Using normal table with *z* = -3.75: *p*-value ≈ 0

*p*-value ≤ .01, reject *H*0

d. 

Lower tail *p*-value is the area to the left of the test statistic

Using normal table with *z* = .83: *p*-value =.7967

*p*-value > .01, do not reject *H*0

13. Reject *H*0 if *z* ≥ 1.645

a. 

2.42 ≥ 1.645, reject *H*0

b. 

.97 < 1.645, do not reject *H*0

c. 

1.74 ≥ 1.645, reject *H*0

14. a. 

Because *z* > 0, *p*-value is two times the upper tail area

Using normal table with *z* = .87: *p*-value = 2(1 - .8078) = .3844

*p*-value > .01, do not reject *H*0

b. 

Because *z* > 0, *p*-value is two times the upper tail area

Using normal table with *z* = 2.68: *p*-value = 2(1 - .9963) = .0074

*p*-value ≤ .01, reject *H*0

c. 

Because *z* < 0, *p*-value is two times the lower tail area

Using normal table with *z* = -1.73: *p*-value = 2(.0418) = .0836

*p*-value > .01, do not reject *H*0

15. a. *H*0: ** ≥

*H*a: ** < 1056

b. 

Lower tail *p*-value is the area to the left of the test statistic

Using normal table with *z* = -1.83: *p*-value =.0336

c. *p*-value ≤ .05, reject *H*0. Conclude the mean refund of “last minute” filers is less than $1056.

d. Reject *H*0 if *z* ≤ -1.645

-1.83 ≤ -1.645, reject *H*0

16. a. *H*0: ** ≤ 3173

*H*a: ** > 3173

b. 

*p*-value = 1.0000 - .9793 = .0207

c. *p*-value < .05. Reject *H*0. The current population mean credit card balance for undergraduate students has increased compared to the previous all-time high of $3173 reported in April 2009.

17. a. *H*0: **  24.57

*H*a: ** ≠ 24.57

b. 

Because *z* < 0, *p*-value is two times the lower tail area

Using normal table with *z* = -1.55: *p*-value = 2(.0606) = .1212

c. *p*-value > .05, do not reject *H*0. We cannot conclude that the population mean hourly wage for manufacturing workers differs significantly from the population mean of $24.57 for the goods-producing industries.

d. Reject *H*0 if *z* ≤ -1.96 or *z* ≥ 1.96

*z* = -1.55; cannot reject *H*0. The conclusion is the same as in part (c).

18. a. *H*0: **  4.1

*H*a: ** ≠ 4.1

b. 

Because *z* < 0, *p*-value is two times the lower tail area

Using normal table with *z* = -2.21: *p*-value = 2(.0136) = .0272

c. *p*-value = .0272 < .05

Reject *H*0 and conclude that the return for Mid-Cap Growth Funds differs significantly from that for U.S. Diversified funds.

19. *H*0: ** ≥ 12

*H*a: ** < 12



*p*-value is the area in the lower tail

Using normal table with *z* = -1.77: *p*-value = .0384

*p*-value ≤ .05, reject *H*0. Conclude that the actual mean waiting time is significantly less than the claim of 12 minutes made by the taxpayer advocate.

20. a. *H*0: **  32.79

*H*a: ** < 32.79

b. 

c. Lower tail *p*-value is area to left of the test statistic.

Using normal table with *z* = -2.73: *p*-value = .0032.

d. *p*-value  .01; reject . Conclude that the mean monthly internet bill is less in the southern state.

21. a. *H*0: **  15

*H*a: ** > 15

b. 

c. Upper tail *p*-value is the area to the right of the test statistic

Using normal table with *z* = 2.96: *p*-value = 1.0000 - .9985 = .0015

d. *p*-value ≤ .01; reject *H*0; the premium rate should be charged.

22. a. *H*0: **  8

*H*a: ** ≠ 8

b. 

Because *z* > 0, *p*-value is two times the upper tail area

Using normal table with *z* = 1.37: *p*-value = 2(1 - .9147) = .1706

1. *p*-value > .05; do not reject *H*0. Cannot conclude that the population mean waiting time differs from 8 minutes.

d. 

8.4 ± 1.96

8.4 ± .57 (7.83 to 8.97)

Yes; **  8 is in the interval. Do not reject *H*0.

23. a. 

b. Degrees of freedom = *n* – 1 = 24

Upper tail *p*-value is the area to the right of the test statistic

Using *t* table: *p*-value is between .01 and .025

Exact *p*-value corresponding to *t* = 2.31 is .0149

c. *p*-value ≤ .05, reject *H*0.

1. With *df* = 24, *t*.05 = 1.711

Reject *H*0 if *t* ≥ 1.711

2.31 > 1.711, reject *H*0.

24. a.

b. Degrees of freedom = *n* – 1 = 47

Because *t* < 0, *p*-value is two times the lower tail area

Using *t* table: area in lower tail is between .05 and .10; therefore, *p*-value is between .10 and .20.

Exact *p*-value corresponding to *t* = -1.54 is .1303

1. *p*-value > .05, do not reject *H*0.

d. With *df* = 47, *t*.025 = 2.012

Reject *H*0 if *t* ≤ -2.012 or *t* ≥ 2.012

*t* = -1.54; do not reject *H*0

25. a.

Degrees of freedom = *n* – 1 = 35

Lower tail *p*-value is the area to the left of the test statistic

Using *t* table: *p*-value is between .10 and .20

Exact *p*-value corresponding to *t* = -1.15 is .1290

*p*-value > .01, do not reject *H*0

b. 

Lower tail *p*-value is the area to the left of the test statistic

Using *t* table: *p*-value is between .005 and .01

Exact *p*-value corresponding to *t* = -2.61 is .0066

*p*-value ≤ .01, reject *H*0

c. 

Lower tail *p*-value is the area to the left of the test statistic

Using *t* table: *p*-value is between .80 and .90

Exact *p*-value corresponding to *t* = 1.20 is .8809

*p*-value > .01, do not reject *H*0

26. a. 

Degrees of freedom = *n* – 1 = 64

Because *t* > 0, *p*-value is two times the upper tail area

Using *t* table; area in upper tail is between .01 and .025; therefore, *p*-value is between .02 and .05.

Exact *p*-value corresponding to *t* = 2.10 is .0397

*p*-value ≤ .05, reject *H*0

b. 

Because *t* < 0, *p*-value is two times the lower tail area

Using *t* table: area in lower tail is between .005 and .01; therefore, *p*-value is between .01 and .02.

Exact *p*-value corresponding to *t* = -2.57 is .0125

*p*-value ≤ .05, reject *H*0

c. 

Because *t* > 0, *p*-value is two times the upper tail area

Using *t* table: area in upper tail is between .05 and .10; therefore, *p*-value is between .10 and .20.

Exact *p*-value corresponding to *t* = 1.54 is .1285

*p*-value > .05, do not reject *H*0

27. a. *H*0: ** ≥ 238

*H*a: ** < 238

b. 

Degrees of freedom = *n* – 1 = 99

Lower tail *p*-value is the area to the left of the test statistic

Using *t* table: *p*-value is between .10 and .20

Exact *p*-value corresponding to *t* = -.88 is .1905

c. *p*-value > .05; do not reject *H*0. Cannot conclude mean weekly benefit in Virginia is less than the national mean.

d. *df* = 99 *t*.05 = -1.66

Reject *H*0 if *t* ≤ -1.66

-.88 > -1.66; do not reject *H*0

28. a. *H*0: ** ≥ 9

*H*a: ** < 9

b. 

Degrees of freedom = *n* – 1 = 84

Lower tail *p*-value is *P*(*t* ≤ -2.50)

Using *t* table: *p*-value is between .005 and .01

Exact *p*-value corresponding to *t* = -2.50 is .0072

c. *p*-value ≤ .01; reject *H*0. The mean tenure of a CEO is significantly lower than 9 years. The claim of the shareholders group is not valid.

29. a. *H*0: ** = 90,000

*H*a: ** ≠ 90,000

b. 

Degrees of freedom = *n* – 1 = 24

Because *t* < 0, *p*-value is two times the lower tail area

Using *t* table: area in lower tail is between .01 and .025; therefore, *p*-value is between .02 and .05.

Exact *p*-value corresponding to *t* = -2.14 is .0427

c. *p*-value ≤ .05; reject *H*0. The mean annual administrator salary in Ohio differs significantly from the national mean annual salary.

d. *df* = 24 *t*.025 = 2.064

Reject *H*0 if *t* < -2.064 or *t* > 2.064

-2.14 < -2.064; reject *H*0. The conclusion is the same as in part (c).

30. a. *H*0: ** = 6.4

*H*a: ** ≠ 6.4

b. Using Excel or Minitab, we find and *s* = 2.4276



*df* = *n* - 1 = 39

Because *t* > 0, *p*-value is two times the upper tail area at *t* = 1.56

Using *t* table: area in upper tail is between .05 and .10; therefore, *p*-value is between .10 and .20.

Exact *p*-value corresponding to *t* = 1.56 is .1268

c. Most researchers would choose or less. If you chose = .10 or less, you cannot reject *H*0. You are unable to conclude that the population mean number of hours married men with children in your area spend in child care differs from the mean reported by *Time*.

31. *H*0: ** ≤ 423

*H*a: ** > 423



Degrees of freedom = *n* - 1 = 35

Upper tail *p*-value is the area to the right of the test statistic

Using *t* table: *p*-value is between .01 and .025.

Exact *p*-value corresponding to *t* = 2.02 is .0173

Because *p*-value = .0173 < *α*, reject *H*0; Atlanta customers have a higher annual rate of consumption of Coca Cola beverages.

32. a. *H*0: ** = 10,192

*H*a: ** ≠ 10,192

b. 

Degrees of freedom = *n* – 1 = 49

Because *t* < 0, *p*-value is two times the lower tail area

Using *t* table: area in lower tail is between .01 and .025; therefore, *p*-value is between .02 and .05.

Exact *p*-value corresponding to *t* = -2.23 is .0304

c. *p*-value ≤ .05; reject *H*0. The population mean price at this dealership differs from the national mean price $10,192.

33. a. *H*0: ** ≤ 21.6

*H*a: ** > 21.6

b. 24.1 – 21.6 = 2.5 gallons

c. 

Degrees of freedom = *n* – 1 = 15

Upper tail *p*-value is the area to the right of the test statistic

Using *t* table: *p*-value is between .025 and .05

Exact *p*-value corresponding to *t* = 2.08 is .0275

d. *p*-value ≤ .05; reject *H*0. The population mean consumption of milk in Webster City is greater than the National mean.

34. a. *H*0: ** = 2

*H*a: ** ≠ 2

b. 

c. 

d. 

Degrees of freedom = *n* - 1 = 9

Because *t* > 0, *p*-value is two times the upper tail area

Using *t* table: area in upper tail is between .10 and .20; therefore, *p*-value is between .20 and .40.

Exact *p*-value corresponding to *t* = 1.22 is .2535

e. *p*-value > .05; do not reject *H*0. No reason to change from the 2 hours for cost estimating purposes.

35. a. 

b. Because *z* < 0, *p*-value is two times the lower tail area

Using normal table with *z* = -1.25: *p*-value = 2(.1056) = .2112

c. *p*-value > .05; do not reject *H*0

d. z.025 = 1.96

Reject *H*0 if *z* ≤ -1.96 or *z* ≥ 1.96

*z* = 1.25; do not reject *H*0

36. a. 

Lower tail *p*-value is the area to the left of the test statistic

Using normal table with *z* = -2.80: *p*-value =.0026

*p*-value ≤ .05; Reject *H*0

b. 

Lower tail *p*-value is the area to the left of the test statistic

Using normal table with *z* = -1.20: *p*-value =.1151

*p*-value > .05; Do not reject *H*0

c. 

Lower tail *p*-value is the area to the left of the test statistic

Using normal table with *z* = -2.00: *p*-value =.0228

*p*-value ≤ .05; Reject *H*0

d. 

Lower tail *p*-value is the area to the left of the test statistic

Using normal table with *z* = .80: *p*-value =.7881

*p*-value > .05; Do not reject *H*0

37. a. *H*0: *p* ≤ .125

*H*a: *p* > .125

b. 



Upper tail *p*-value is the area to the right of the test statistic

Using normal table with *z* = .30: *p*-value = 1.0000 - .6179 = .3821

1. *p*-value > .05; do not reject *H*0. We cannot conclude that there has been an increase in union membership.

38. a. *H*0: *p*  .64

*H*a: *p* ≠ .64

b. 



Because *z* < 0, *p*-value is two times the lower tail area

Using normal table with *z* = -2.50: *p*-value = 2(.0062) = .0124

c. *p*-value ≤ .05; reject *H*0. Proportion differs from the reported .64.

d. Yes. Since = .52, it indicates that fewer than 64% of the shoppers believe the supermarket brand is as good as the name brand.

39. a. *H*0: *p*  .75

*H*a: *p* ≠ .75

b. 30 – 49 Age Group 



Because *z* > 0, *p*-value is two times the upper tail area

Using normal table with *z* = 2.31: *p*-value = 2(.0104) = .0208

Reject *H0*. Conclude that the proportion of users in the 30 – 49 age group is higher than the overall proportion of .75.

c. 50 – 64 Age Group 



Because *z* < 0, *p*-value is two times the lower tail area

Using the normal table with *z* = -.98: *p*-value = 2(.1635) = .3270

Do not reject *H*0. The proportion for the 50 – 64 age group does not differ significantly from the overall proportion.

d. The proportion of internet users increases from .72 to .85 as we go from the 50 – 64 age group to the younger 30 – 49 age group. So we might expect the proportion to increase further for the even younger 18 – 29 age group. Indeed, the Pew project found the proportion of users in the 18 – 29 age group to be .92.

40. a. Sample proportion:

Number planning to provide holiday gifts: 

b. *H*0: *p* ≥ .46

*H*a: *p* < .46



*p*-value is area in lower tail

Using normal table with *z* = -1.71: *p*-value = .0436

c. Using a .05 level of significance, we can conclude that the proportion of business owners providing gifts has decreased from 2008 to 2009. The smallest level of significance for which we could draw this conclusion is .0436; this corresponds to the *p*-value = .0436. This is why the *p*-value is often called the observed level of significance.

41. a. *H*0: *p* ≥ .70

*H*a: *p* < .70

b. 

Lower tail *p*-value is the area to the left of the test statistic

Using normal table with *z* = -1.13: *p*-value =.1292

c. *p*-value > .05; do not reject *H*0. The executive's claim cannot be rejected.

42. a.  = 12/80 = .15

b. 



.15  1.96 (.0399)

.15  .0782 or .0718 to .2282

c. *H*0: *p*  .06

*H*a: *p* ≠ .06

 = .15



*p*-value ≈ 0

We conclude that the return rate for the Houston store is different than the U.S. national return rate.

43. a. *H*0: *p* ≤ .10

*H*a: *p* > .10

b. There are 13 “Yes” responses in the Eagle data set.



c. 

Upper tail *p*-value is the area to the right of the test statistic

Using normal table with *z* = 1.00: *p*-value = 1 - .8413 = .1587

*p*-value > .05; do not reject *H*0.

On the basis of the test results, Eagle should not go national. But, since> .13, it may be worth expanding the sample size for a larger test.

44. a. *H*0: *p* ≤ .51

*H*a: *p* > .51

b. 



*p*-value is the area in the upper tail at *z* = 2.80

Using normal table with *z* = 2.80: *p*-value = 1 – .9974 = .0026

c. Since *p*-value = .0026 ≤ .01, we reject *H*0 and conclude that people working the night shift get drowsy while driving more often than the average for the entire population.

45. a. *H*0: *p* = .30

*H*a: *p* ≠ .30

b. 

c. 

Because *z* > 0, *p*-value is two times the upper tail area

Using normal table with *z* = 2.78: *p*-value = 2(.0027) = .0054

*p*-value  .01; reject *H*0.

We would conclude that the proportion of stocks going up on the NYSE is not 30%. This would suggest not using the proportion of DJIA stocks going up on a daily basis as a predictor of the proportion of NYSE stocks going up on that day.

46. 



c = 10 - 1.645 (5 /) = 9.25

Reject *H*0 if  9.25

a. When ** = 9,



*P*(Reject *H*0) = (1.0000 - .7088) = .2912

b. Type II error

c. When ** = 8,



** = (1.0000 - .9969) = .0031

47. Reject *H*0 if *z*  -1.96 or if *z*  1.96





c1 = 20 - 1.96 (10 /) = 18.61

c2 = 20 + 1.96 (10 /) = 21.39

a. ** = 18



** = 1.0000 - .8051 = .1949

b. ** = 22.5



** = 1.0000 - .9418 = .0582

c. ** = 21



** = .7088

48. a. *H*0: **  15

*H*a: ** > 15

Concluding **  15 when this is not true. Fowle would not charge the premium rate even though the rate should be charged.

b. Reject *H*0 if *z*  2.33



Solve for = 16.58

Decision Rule:

Accept *H*0 if < 16.58

Reject *H*0 if  16.58

For ** = 17,



** = .2676

c. For ** = 18,



** = .0179

49. a. *H*0: **  25

*H*a: ** < 25

Reject *H*0 if *z*  -2.05



Solve for  = 23.88

Decision Rule:

Accept *H*0 if > 23.88

Reject *H*0 if  23.88

b. For ** = 23,



** = 1.0000 -.9463 = .0537

c. For ** = 24,



** = 1.0000 - .4129 = .5871

d. The Type II error cannot be made in this case. Note that when ** = 25.5, *H*0 is true. The Type II error can only be made when *H*0 is false.

50. a. Accepting *H*0 and concluding the mean average age was 28 years when it was not.

b. Reject *H*0 if *z*  -1.96 or if *z*  1.96



Solving for, we find

at *z* = -1.96, = 26.82

at *z* = +1.96, = 29.18

Decision Rule:

Accept *H*0 if 26.82 < < 29.18

Reject *H*0 if  26.82 or if  29.18

At ** = 26,



** = 1.0000 - .9147 = .0853

At ** = 27,



** = 1.0000 - .3821 = .6179

At ** = 29,



** = .6179

At ** = 30,



** = .0853

c. Power = 1 - **

at ** = 26, Power = 1 - .0853 = .9147

When ** = 26, there is a .9147 probability that the test will correctly reject the null hypothesis that ** = 28.

51. a. Accepting *H*0 and letting the process continue to run when actually over - filling or under - filling exists.

b. Decision Rule: Reject *H*0 if *z*  -1.96 or if *z * 1.96 indicates

Accept *H*0 if 15.71 < < 16.29

Reject *H*0 if  15.71 or if 16.29

For ** = 16.5



** = .0749



c. Power = 1 - .0749 = .9251

d. The power curve shows the probability of rejecting *H*0 for various possible values of **. In particular, it shows the probability of stopping and adjusting the machine under a variety of underfilling and overfilling situations. The general shape of the power curve for this case is



52. 

At **

** = .1151

At **

**= .0015

Increasing the sample size reduces the probability of making a Type II error.

53. a. Accept **  100 when it is false.

b. Critical value for test:



At ** = 120 

**= .4840

c. At **= 130 

** .1894

d. Critical value for test:



At **

**= .2296

At **

**= .0268

Increasing the sample size from 40 to 80 reduces the probability of making a Type II error.

54. 

55. 

56. At **0 = 3, ** = .01. *z*.01 = 2.33

At **a = 2.9375, ** = .10. *z*.10 = 1.28

*σ* = .18

 Use 109

57. At **0 = 400, ** = .02. *z*.02 = 2.05

At **a = 385, ** = .10. *z*.10 = 1.28

*σ*  = 30

 Use 45

58. At **0 = 28, ** = .05. Note however for this two - tailed test, *z* / 2 = *z*.025 = 1.96

At **a = 29, ** = .15. *z*.15 = 1.04

*σ* = 6



59. At **0 = 25, ** = .02. *z*.02 = 2.05

At **a = 24, ** = .20. *z*.20 = .84

*σ* = 3

 Use 76

60. a. *H*0: ** = 16

*H*a: ** ≠ 16

b. 

Because *z* > 0, *p*-value is two times the upper tail area

Using normal table with *z* = 2.19: *p*-value = 2(.0143) = .0286

*p*-value ≤ .05; reject *H*0. Readjust production line.

c. 

Because *z* < 0, *p*-value is two times the lower tail area

Using normal table with *z* = -1.23: *p*-value = 2(.1093) = .2186

*p*-value > .05; do not reject *H*0. Continue the production line.

d. Reject *H*0 if *z* ≤ -1.96 or *z* ≥ 1.96

For = 16.32, *z* = 2.19; reject *H*0

For = 15.82, *z* = -1.23; do not reject *H*0

Yes, same conclusion.

61. a. *H*0: ** = 900

*H*a: **  900

b. 



935 ± 25 (910 to 960)

c. Reject *H*0 because *μ* = 900 is not in the interval.

d. 

Because *z* > 0, *p*-value is two times the upper tail area

Using normal table with *z* = 2.75: *p*-value = 2(.0030) = .0060

62. a. *H*0: **  119,155

*H*a: ** > 119,155

b. 

Upper tail *p*-value is the area to the right of the test statistic

Using normal table with *z* = 2.60: *p*-value = 1.0000 - .9953 = .0047

c. *p*-value  .01, reject *H*0. We can conclude that the mean annual household income for theater goers in the San Francisco Bay area is higher than the mean for all *Playbill* readers.

63. The hypothesis test that will allow us to conclude that the consensus estimate has increased is given below.

*H*0: **  250,000

*H*a: ** > 250,000



Degrees of freedom = *n* – 1 = 19

Upper tail *p*-value is the area to the right of the test statistic

Using *t* table: *p*-value is less than .005

Exact *p*-value corresponding to *t* = 2.981 is .0038

*p*-value ≤ .01; reject *H*0. The consensus estimate has increased.

64. *H*0: ** = 25

*H*a: **  25



Degrees of freedom = *n* – 1 = 41

Because *t* < 0, *p*-value is two times the lower tail area

Using *t* table: area in lower tail is between .10 and .20; therefore, *p*-value is between

.20 and .40.

Exact *p*-value corresponding to *t* = -1.05 is .2999

Because *p*-value > *α* = .05, do not reject *H*0. There is no evidence to conclude that the mean age at which women had their first child has changed.

65. a. *H*0: **≤ 520

*H*a: **> 520

b. Sample mean: 637.94

Sample standard deviation: 148.4694



Degrees of freedom = *n* – 1 = 49

*p*-value is the area in the upper tail

Using *t* table: *p*-value is < .005

Exact *p*-value corresponding to *t* = 5.620

c. We can conclude that the mean weekly pay for all women is higher than that for women with only a high school degree.

d. Using the critical value approach we would:

Reject *H*0 if *t* = 1.677

Since *t* = 5.62 > 1.677, we reject *H*0.

66. *H*0: ** ≤ 125,000

*H*a: ** > 125,000



Degrees of freedom = 32 – 1 = 31

Upper tail *p*-value is the area to the right of the test statistic

Using *t* table: *p*-value is between .01 and .025

Exact *p*-value corresponding to *t* = 2.26 is .0155

*p*-value ≤ .05; reject *H*0. Conclude that the mean cost is greater than $125,000 per lot.

67. *H*0: ** = 86

*H*a: ** ≠ 86







Degrees of freedom = 40 - 1 = 39

Because *t* < 0, *p*-value is two times the lower tail area

Using *t* table: area in lower tail is between .025 and .05; therefore, *p*-value is between .05 and .10.

Exact *p*-value corresponding to *t* = -1.90 is .0648

*p*-value > .05; do not reject *H*0.

There is not a statistically significant difference between the population mean for the nearby county and the population mean of 86 days for Hamilton county.

68. a. *H*0: *p* ≤ .80

*H*a: *p*  .80





*p*-value is the area in the upper tail

Using normal table with *z* = 2.33: *p*-value = 1.0000 - .9901 = .0099

*p*-value ≤ .05; reject *H*0. We conclude that over 80% of airline travelers feel that use of the full body scanners will improve airline security.

b. *H*0: *p* ≤ .75

*H*a: *p*  .75





*p*-value is the area in the upper tail

Using normal table with *z* = 1.61: *p*-value = 1.0000 - .9463 = .0537

*p*-value > .01; we cannot reject *H*0. Thus, we cannot conclude that over 75% of airline travelers approve of using full body scanners. Mandatory use of full body scanners is not recommended.

Author’s note: The TSA is also considering making the use of full body scanners optional. Travelers would be given a choice of a full body scan or a pat down search.

69. a. *H*0: *p* = .6667

*H*a: *p* ≠ .6667

b. 

c. 

Because *z* < 0, *p*-value is two times the lower tail area

Using normal table with *z* = -.82: *p*-value = 2(.2061) = .4122

*p*-value > .05; do not reject *H*0; Cannot conclude that the population proportion differs from 2/3.

70. a. *H*0: *p* ≤ .80

*H*a: *p* > .80

b.  (84%)

c. 

Upper tail *p*-value is the area to the right of the test statistic

Using normal table with *z* = 1.73: *p*-value = 1.0000 - .9582 = .0418

d*. p*-value ≤ .05; reject *H*0. Conclude that more than 80% of the customers are satisfied with the service provided by the home agents. Regional Airways should consider implementing the home agent system.

71. a. 

b. *H*0: *p* ≤ .50

*H*a: *p* > .50

c. 

Upper tail *p*-value is the area to the right of the test statistic

Using normal table with *z* = 3.19: *p*-value ≈ 0

You can tell the manager that the observed level of significance is very close to zero and that this means the results are highly significant. Any reasonable person would reject the null hypotheses and conclude that the proportion of adults who are optimistic about the national outlook is greater than .50

72. *H*0: *p* ≥ .90

*H*a: *p* < .90





Lower tail *p*-value is the area to the left of the test statistic

Using normal table with *z* = -1.40: *p*-value =.0808

*p*-value > .05; do not reject *H*0. Claim of at least 90% cannot be rejected.

73. a. *H*0: *p* ≥ .24

*H*a: *p* < .24

b. 

c. 

Lower tail *p*-value is the area to the left of the test statistic

Using normal table with *z* = -1.76: *p*-value =.0392

*p*-value ≤ .05; reject *H*0.

The proportion of workers not required to contribute to their company sponsored health care plan has declined. There seems to be a trend toward companies requiring employees to share the cost of health care benefits.

74. a. *H*0: **  72

*H*a: ** > 72

Reject *H*0 if *z*  1.645



Solve for = 78

Decision Rule:

Accept *H*0 if < 78

Reject *H*0 if  78

b. For ** = 80



** = .2912

c. For ** = 75,



** = .7939

d. For ** = 70, *H*0 is true. In this case the Type II error cannot be made.

e. Power = 1 - **



75. *H*0: **  15,000

*H*a: ** < 15,000

At **0 = 15,000, ** = .02. *z*.02 = 2.05

At **a = 14,000, ** = .05. *z*.10 = 1.645

 Use 219

76. *H*0: ** = 120

*H*a: **  120

At **0 = 120, ** = .05. With a two - tailed test, *z* / 2 = *z*.025 = 1.96

At **a = 117, ** = .02. *z*.02 = 2.05

 Use 45

b. Example calculation for ** = 118.

Reject *H*0 if *z*  -1.96 or if *z*  1.96



Solve for. At *z* = -1.96, = 118.54

At *z* = +1.96, = 121.46

Decision Rule:

Accept *H*0 if 118.54 << 121.46

Reject *H*0 if  118.54 or if  121.46

For ** = 118,



** = .2358

Other Results:

|  |  |  |
| --- | --- | --- |
| If ** is | *z* | ** |
| 117 | 2.07 | .0192 |
| 118 | .72 | .2358 |
| 119 | -.62 | .7291 |
| 121 | +.62 | .7291 |
| 122 | +.72 | .2358 |
| 123 | -2.07 | .0192 |