Chapter 12

12.1 a $\bar{x} \pm t_{\alpha/2} s/\sqrt{n}$ = 510 ± 2.064(125/$\sqrt{25}$) = 510 ± 51.60; LCL = 458.40, UCL = 561.60

b $\bar{x} \pm t_{\alpha/2} s/\sqrt{n}$ = 510 ± 2.009(125/$\sqrt{50}$) = 510 ± 35.51; LCL = 474.49, UCL = 545.51

c $\bar{x} \pm t_{\alpha/2} s/\sqrt{n}$ = 510 ± 1.984(125/$\sqrt{100}$) = 510 ± 24.80; LCL = 485.20, UCL = 534.80

d. The interval narrows.

12.2 a $\bar{x} \pm t_{\alpha/2} s/\sqrt{n}$ = 1,500 ± 1.984(300/$\sqrt{100}$) = 1,500 ± 59.52; LCL = 1,440.48, UCL = 1,559.52

b $\bar{x} \pm t_{\alpha/2} s/\sqrt{n}$ = 1,500 ± 1.984(200/$\sqrt{100}$) = 1,500 ± 39.68; LCL = 1,460.32, UCL = 1,539.68

c $\bar{x} \pm t_{\alpha/2} s/\sqrt{n}$ = 1,500 ± 1.984(100/$\sqrt{100}$) = 1,500 ± 19.84; LCL = 1,480.16, UCL = 1,519.84

d. The interval narrows.

12.3 a $\bar{x} \pm t_{\alpha/2} s/\sqrt{n}$ = 700 ± 1.645(100/$\sqrt{400}$) = 700 ± 8.23; LCL = 691.77, UCL = 708.23

b $\bar{x} \pm t_{\alpha/2} s/\sqrt{n}$ = 700 ± 1.96(100/$\sqrt{400}$) = 700 ± 9.80; LCL = 690.20, UCL = 709.80

a $\bar{x} \pm t_{\alpha/2} s/\sqrt{n}$ = 700 ± 2.576(100/$\sqrt{400}$) = 700 ± 12.88; LCL = 687.12, UCL = 712.88

d. The interval widens.

12.4 a $\bar{x} \pm t_{\alpha/2} s/\sqrt{n}$ = 10 ± 1.984(1/$\sqrt{100}$) = 10 ± .20; LCL = 9.80, UCL = 10.20

b $\bar{x} \pm t_{\alpha/2} s/\sqrt{n}$ = 10 ± 1.984(4/$\sqrt{100}$) = 10 ± .79; LCL = 9.21, UCL = 10.79

c $\bar{x} \pm t_{\alpha/2} s/\sqrt{n}$ = 10 ± 1.984(10/$\sqrt{100}$) = 10 ± 1.98; LCL = 8.02, UCL = 11.98

d The interval widens.

12.5 a $\bar{x} \pm t_{\alpha/2} s/\sqrt{n}$ = 120 ± 2.009(15/$\sqrt{51}$) = 120 ± 4.22; LCL = 115.78, UCL = 124.22

b $\bar{x} \pm t_{\alpha/2} s/\sqrt{n}$ = 120 ± 1.676(15/$\sqrt{51}$) = 120 ± 3.52; LCL = 116.48, UCL = 123.52

c $\bar{x} \pm t_{\alpha/2} s/\sqrt{n}$ = 120 ± 1.299(15/$\sqrt{51}$) = 120 ± 2.73; LCL = 117.27, UCL = 122.73

d The interval narrows.

12.6 a $\bar{x} \pm t_{\alpha/2} s/\sqrt{n}$ = 63 ± 1.990(8/$\sqrt{81}$) = 63 ± 1.77; LCL = 61.23, UCL = 64.77

b $\bar{x} \pm t_{\alpha/2} s/\sqrt{n}$ = 63 ± 2.000(8/$\sqrt{64}$) = 63 ± 2.00; LCL = 61.00, UCL = 65.00

c $\bar{x} \pm t_{\alpha/2} s/\sqrt{n}$ = 63 ± 2.030(8/$\sqrt{36}$) = 63 ± 2.71; LCL = 60.29, UCL = 65.71

d The interval widens.

12.7 $H_0 : \mu = 20$

$H_1 : \mu > 20$

a Rejection region: $t > t_{\alpha,n-1} = t_{.05,9} = 1.833$

$t = \frac{\bar{x}-\mu}{s/\sqrt{n}} = \frac{23-20}{9/\sqrt{10}} = 1.05$, p-value = .1597. There is not enough evidence to infer that the population mean is greater than 20.

b Rejection region: $t > t_{\alpha,n-1} = t_{.05,29} = 1.699$

$t = \frac{\bar{x}-\mu}{s/\sqrt{n}} = \frac{23-20}{9/\sqrt{30}} = 1.83$, p-value = .0391. There is enough evidence to infer that the population mean is greater than 20.

c Rejection region: $t > t_{\alpha,n-1} = t_{.05,49} \approx 1.676$

$t = \frac{\bar{x}-\mu}{s/\sqrt{n}} = \frac{23-20}{9/\sqrt{50}} = 2.36$, p-value = .0112. There is enough evidence to infer that the population mean is greater than 20.

d As the sample size increases the test statistic increases [and the p-value decreases].

12.8 $H_0 : \mu = 180$

$H_1 : \mu \neq 180$

Rejection region: $t < -t_{\alpha/2,n-1} = -t_{.025,199} \approx -1.972$ or $t > t_{\alpha/2,n-1} = t_{.025,199} = 1.972$

a $t = \frac{\bar{x}-\mu}{s/\sqrt{n}} = \frac{175-180}{22/\sqrt{200}} = -3.21$, p-value = .0015. There is enough evidence to infer that the population mean is not equal to 180.

b $t = \frac{\bar{x}-\mu}{s/\sqrt{n}} = \frac{175-180}{45/\sqrt{200}} = -1.57$, p-value = .1177. There is not enough evidence to infer that the population mean is not equal to 180.

c $t = \frac{\bar{x}-\mu}{s/\sqrt{n}} = \frac{175-180}{60/\sqrt{200}} = -1.18$, p-value = .2400. There is not enough evidence to infer that the population mean is not equal to 180.

d. As the s increases, the test statistic increases and the p-value increases.

12.9 Rejection region: $t < -t_{\alpha,n-1} = -t_{.05,99} \approx -1.660$

a $t = \frac{\bar{x}-\mu}{s/\sqrt{n}} = \frac{145-150}{50/\sqrt{100}} = -1.00$, p-value = .1599. There is not enough evidence to infer that the population mean is less than 150.

b $t = \frac{\bar{x}-\mu}{s/\sqrt{n}} = \frac{140-150}{50/\sqrt{100}} = -2.00$, p-value = .0241. There is enough evidence to infer that the population mean is less than 150.

c $t = \frac{\bar{x}-\mu}{s/\sqrt{n}} = \frac{135-150}{50/\sqrt{100}} = -3.00$, p-value = .0017. There is enough evidence to infer that the population mean is less than 150

d The test statistics decreases and the p-value decreases.

12.10 $H_0: \mu = 50$

$H_0: \mu \neq 50$

a Rejection region: $t < -t_{\alpha/2,n-1} = -t_{.05,24} = -1.711$ or $t > t_{\alpha/2,n-1} = t_{.05,24} = 1.711$

$t = \frac{\bar{x}-\mu}{s/\sqrt{n}} = \frac{52-50}{15/\sqrt{25}} = .67$, p-value = .5113. There is not enough evidence to infer that the population mean is not equal to 50.

b Rejection region: $t < -t_{\alpha/2,n-1} = -t_{.05,14} = -1.761$ or $t > t_{\alpha/2,n-1} = t_{.05,14} = 1.761$

$t = \frac{\bar{x}-\mu}{s/\sqrt{n}} = \frac{52-50}{15/\sqrt{15}} = .52$, p-value = .6136. There is not enough evidence to infer that the population mean is not equal to 50.

c Rejection region: $t < -t_{\alpha/2,n-1} = -t_{.05,4} = -2.132$ or $t > t_{\alpha/2,n-1} = t_{.05,4} = -2.132$

$t = \frac{\bar{x}-\mu}{s/\sqrt{n}} = \frac{52-50}{15/\sqrt{5}} = .30$, p-value = .7804. There is not enough evidence to infer that the population mean is not equal to 50.

d The test statistic decreases and the p-value increases.

12.11 Rejection region: $t < -t_{\alpha,n-1} = -t_{.10,49} \approx -1.299$

a $t = \frac{\bar{x}-\mu}{s/\sqrt{n}} = \frac{585-600}{45/\sqrt{50}} = -2.36$, p-value = .0112. There is enough evidence to infer that the population mean is less than 600.

b $t = \frac{\bar{x}-\mu}{s/\sqrt{n}} = \frac{590-600}{45/\sqrt{50}} = -1.57$, p-value = .0613. There is enough evidence to infer that the population mean is less than 600.

c $t = \frac{\bar{x}-\mu}{s/\sqrt{n}} = \frac{595-600}{45/\sqrt{50}} = -.79$, p-value = .2179. There is not enough evidence to infer that the population mean is less than 600.

d The test statistic increases and the p-value increases.

12.12 Rejection region: $t > t_{\alpha,n-1} = t_{.01,99} \approx 2.364$

a $t = \frac{\bar{x}-\mu}{s/\sqrt{n}} = \frac{106-100}{35/\sqrt{100}} = 1.71$, p-value = .0448. There is not enough evidence to infer that the population mean is greater than 100.

b $t = \frac{\bar{x}-\mu}{s/\sqrt{n}} = \frac{106-100}{25/\sqrt{100}} = 2.40$, p-value = .0091. There is enough evidence to infer that the population mean is greater than 100.

c $t = \frac{\bar{x}-\mu}{s/\sqrt{n}} = \frac{106-100}{15/\sqrt{100}} = 4.00$, p-value = .0001. There is enough evidence to infer that the population mean is greater than 100

d The test statistic increases and the p-value decreases.

12.13 a $\bar{x} \pm t_{\alpha/2} s/\sqrt{n} = 40 \pm 2.365(10/\sqrt{8}) = 40 \pm 8.36$; LCL = 31.64, UCL = 48.36

b $\bar{x} \pm z_{\alpha/2} \sigma/\sqrt{n} = 40 \pm 1.96(10/\sqrt{8}) = 40 \pm 6.93$; LCL = 33.07, UCL = 46.93

c The student t distribution is more widely dispersed than the standard normal; thus, $z_{\alpha/2}$ is smaller than $t_{\alpha/2}$.

12.14 a $\bar{x} \pm t_{\alpha/2} s/\sqrt{n} = 175 \pm 2.132(30/\sqrt{5}) = 175 \pm 28.60$; LCL = 146.40, UCL = 203.60

b $\bar{x} \pm z_{\alpha/2} \sigma/\sqrt{n} = 175 \pm 1.645(30/\sqrt{5}) = 175 \pm 22.07$; LCL = 152.93, UCL = 197.07

c The student t distribution is more widely dispersed than the standard normal; thus, $z_{\alpha/2}$ is smaller than $t_{\alpha/2}$.

12.15 a $\bar{x} \pm t_{\alpha/2} s/\sqrt{n} = 15{,}500 \pm 1.645(9{,}950/\sqrt{1{,}000}) = 15{,}500 \pm 517.59$; LCL = 14,982.41, UCL = 16,017.59

b $\bar{x} \pm z_{\alpha/2} \sigma/\sqrt{n} = 15{,}500 \pm 1.645(9{,}950/\sqrt{1{,}000}) = 15{,}500 \pm 517.59$; LCL = 14,982.41, UCL = 16,017.59

c With n = 1,000 the student t distribution with 999 degrees of freedom is almost identical to the standard normal distribution.

12.16 a $\bar{x} \pm t_{\alpha/2} s/\sqrt{n} = 350 \pm 2.576(100/\sqrt{500}) = 350 \pm 11.52$; LCL = 338.48, UCL = 361.52

b $\bar{x} \pm z_{\alpha/2} \sigma/\sqrt{n} = 350 \pm 2.575(100/\sqrt{500}) = 350 \pm 11.52$; LCL = 338.48, UCL = 361.52

c With n = 500 the student t distribution with 999 degrees of freedom is almost identical to the standard normal distribution.

12.17 $H_0 : \mu = 70$

$H_0 : \mu > 70$

a Rejection region: $t > t_{\alpha,n-1} = t_{.05,10} = 1.812$

$t = \frac{\bar{x}-\mu}{s/\sqrt{n}} = \frac{74.5-70}{9/\sqrt{11}} = 1.66$, p-value = .0641. There is not enough evidence to infer that the population mean is greater than 70.

b Rejection region: $z > z_{\alpha} = z_{.05} = 1.645$

$z = \frac{\bar{x}-\mu}{\sigma/\sqrt{n}} = \frac{74.5-70}{9/\sqrt{11}} = 1.66$, p-value = P(Z > 1.66) = 1 – P(Z< 1.66) = 1 – .9515 = .0485. There is enough evidence to infer that the population mean is greater than 70.

c The Student t distribution is more dispersed than the standard normal.

12.18 $H_0 : \mu = 110$

$H_0 : \mu < 110$

a Rejection region: $t < -t_{\alpha,n-1} = -t_{.10,9} = -1.383$

$t = \frac{\bar{x}-\mu}{s/\sqrt{n}} = \frac{103-110}{17/\sqrt{10}} = -1.30$, p-value = .1126. There is not enough evidence to infer that the population mean is less than 110.

b Rejection region: $z < -z_{\alpha} = z_{.10} = -1.28$

$z = \frac{\bar{x}-\mu}{\sigma/\sqrt{n}} = \frac{103-110}{17/\sqrt{10}} = -1.30$, p-value = P(Z < –1.30) = .0968. There is enough evidence to infer that the population mean is less than 110.

c The Student t distribution is more dispersed than the standard normal.

12.19 $H_0 : \mu = 15$

$H_0 : \mu < 15$

a Rejection region: $t < -t_{\alpha,n-1} = -t_{.05,1499} = -1.645$

$t = \frac{\bar{x}-\mu}{s/\sqrt{n}} = \frac{14-15}{25/\sqrt{1{,}500}} = -1.55$, p-value = .0608. There is not enough evidence to infer that the population mean is less than 15.

b Rejection region: $z < -z_{\alpha} = -z_{.05} = -1.645$

$z = \frac{\bar{x} - \mu}{\sigma / \sqrt{n}} = \frac{14 - 15}{25 / \sqrt{1{,}500}} = -1.55$, p-value = P(Z < –1.55) = .0606. There is not enough evidence to infer that the population mean is less than 15.

c With n = 1,500 the student t distribution with 1,499 degrees of freedom is almost identical to the standard normal distribution.

12.20 a Rejection region: $t > t_{\alpha, n-1} = t_{.05,999} = 1.645$

$t = \frac{\bar{x} - \mu}{s / \sqrt{n}} = \frac{405 - 400}{100 / \sqrt{1{,}000}} = 1.58$, p-value = .0569. There is not enough evidence to infer that the population mean is less than 15.

b Rejection region: $z > z_{\alpha} = z_{.05} = 1.645$

$t = \frac{\bar{x} - \mu}{s / \sqrt{n}} = \frac{405 - 400}{100 / \sqrt{1{,}000}} = 1.58$, p-value = P(Z > 1.58) = 1 – .9429 = .0571. There is not enough evidence to infer that the population mean is less than 15.

c With n = 1,000 the student t distribution with 999 degrees of freedom is almost identical to the standard normal distribution.

12.21 $H_0 : \mu = 6$

$H_0 : \mu < 6$

a Rejection region: $t < -t_{\alpha, n-1} = -t_{.05,11} = -1.796$

$t = \frac{\bar{x} - \mu}{s / \sqrt{n}} = \frac{5.69 - 6}{1.58 / \sqrt{12}} = -.68$, p-value = .2554. There is not enough evidence to support the courier's advertisement.

12.22 $\bar{x} \pm t_{\alpha/2} s / \sqrt{n}$ = 24,051 ± 2.145(17,386/$\sqrt{15}$) = 24,051 ± 9,628; LCL = 14,422, UCL = 33,680

12.23 $H_0 : \mu = 20$

$H_0 : \mu > 20$

Rejection region: $t > t_{\alpha, n-1} = t_{.05,19} = 1.729$

$t = \frac{\bar{x} - \mu}{s / \sqrt{n}} = \frac{20.85 - 20}{6.76 / \sqrt{20}} = .56$, p-value = .2902. There is not enough evidence to support the doctor's claim.

12.24 $H_0 : \mu = 8$

$H_0 : \mu < 8$

Rejection region: $t < -t_{\alpha,n-1} = -t_{.01,17} = -2.567$

$t = \frac{\bar{x}-\mu}{s/\sqrt{n}} = \frac{7.91-8}{.085/\sqrt{18}} = -4.49$, p-value = .0002. There is enough evidence to conclude that the average container is mislabeled.

12.25 $\bar{x} \pm t_{\alpha/2} s/\sqrt{n}$ = 18.13 $\pm$ 2.145(9.75/$\sqrt{15}$) = 18.13 $\pm$ 5.40; LCL = 12.73, UCL =23.53

12.26 $\bar{x} \pm t_{\alpha/2} s/\sqrt{n}$ = 26.67 $\pm$ 1.796(16.52/$\sqrt{12}$) = 26.67 $\pm$ 8.56; LCL = 18.11, UCL = 35.23

12.27 $\bar{x} \pm t_{\alpha/2} s/\sqrt{n}$ = 17.70 $\pm$ 2.262(9.08/$\sqrt{10}$) = 17.70 $\pm$ 6.49; LCL = 11.21, UCL =24.19

12.28 $H_0 : \mu = 10$

$H_0 : \mu < 10$

Rejection region: $t < -t_{\alpha,n-1} = -t_{.10,9} = -1.383$

$t = \frac{\bar{x}-\mu}{s/\sqrt{n}} = \frac{7.10-10}{3.75/\sqrt{10}} = -2.45$, p-value = .0185. There is enough evidence to infer that the mean proportion of returns is less than 10%.

12.29 $\bar{x} \pm t_{\alpha/2} s/\sqrt{n}$ = 7.15 $\pm$ 1.972(1.65/$\sqrt{200}$) = 7.15 $\pm$ .23; LCL = 6.92, UCL = 7.38

12.30 $\bar{x} \pm t_{\alpha/2} s/\sqrt{n}$ = 4.66 $\pm$ 2.576(2.37/$\sqrt{240}$) = 4.66 $\pm$ .39; LCL = 4.27, UCL = 5.05

Total number: LCL = 100 million (4.27) = 427 million, UCL = 100 million (5.05) = 505 million

12.31 $H_0 : \mu = 60$

$H_0 : \mu \neq 60$

Rejection region: $t > t_{\alpha/2,n-1} = t_{.025,161} \approx 1.975$ or $t < -t_{\alpha/2,n-1} = -1.975$

$t = \frac{\bar{x}-\mu}{s/\sqrt{n}} = \frac{63.70-60}{18.94/\sqrt{162}} = 2.49$, p-value = .0140. There is enough evidence to infer that the mean time differs from 60 minutes.

12.32 $\bar{x} \pm t_{\alpha/2} s/\sqrt{n}$ = 15,137 $\pm$ 1.96(5,263/$\sqrt{306}$ = 15,137 $\pm$ 590; LCL = 14,547, UCL = 15,727

Total credit card debt: LCL = 50 million (14,547) = \$727,350 million, UCL = 50 million (15,727) = \$786,350 million

12.33a. $\bar{x} \pm t_{\alpha/2}s/\sqrt{n}$ = 59.04 ± 1.980(20.62/ $\sqrt{122}$) = 59.04 ± 3.70; LCL = 55.34, UCL = 62.74

Total spent on other products: LCL = 2800(55.34 = $154,952, UCL = 2800(62.74) = $175,672

12.34 $\bar{x} \pm t_{\alpha/2}s/\sqrt{n}$ = 2.67 ± 1.973(2.50/ $\sqrt{188}$) = 2.67 ± .36; LCL = 2.31, UCL = 3.03

12.35 $\bar{x} \pm t_{\alpha/2}s/\sqrt{n}$ = 29.69 ± 1.96(27.53/ $\sqrt{900}$ **)** = 29.69 ± 1.80; LCL = 27.89, UCL = 31.49

12.36 $\bar{x} \pm t_{\alpha/2}s/\sqrt{n}$ = 422.36 ± 1.973(122.77/ $\sqrt{176}$) = 422.36 ± 18.26; LCL = 404.10, UCL = 440.62

Total cost of congestion: LCL = 128 million (404.10) = $51,725 million, UCL = 128 million (440.62) = $56,399 million

12.37 $\bar{x} \pm t_{\alpha/2}s/\sqrt{n}$ = 13.94 ± 1.960(2.16/ $\sqrt{212}$) = 13.94 ± .29; LCL = 13.65, UCL = 14.23

Package of 10: LCL = 13.65(10) = 136.5 days, UCL = 14.23(10) = 142.3 days.

12.38 $H_0: \mu = 15$

$H_0: \mu > 15$

Rejection region: $t > t_{\alpha,n-1} = t_{.05,115} \approx 1.658$

$t = \frac{\bar{x}-\mu}{s/\sqrt{n}} = \frac{15.27-15}{5.72/\sqrt{116}}$ = .51, p-value = .3061. There is not enough evidence to infer that the mean number of commercials is greater than 15.

12.39 $\bar{x} \pm t_{\alpha/2}s/\sqrt{n}$ = 3.44 ± 1.960(3.33/ $\sqrt{471}$) = 3.44 ± .30; LCL = 3.14, UCL = 3.74

Total: LCL = 270,509,000(3.14) = 849,398,260, UCL = 270,509,000(3.74) = 1,011,703,660

12.40 $H_0: \mu = 85$

$H_0: \mu > 85$

Rejection region: $t > t_{\alpha,n-1} = t_{.05,84} \approx 1.663$

$t = \frac{\bar{x}-\mu}{s/\sqrt{n}} = \frac{89.27-85}{17.30/\sqrt{85}}$ = 2.28, p-value = .0127. There is enough evidence to infer that an e-grocery will be successful.

12.41 $\bar{x} \pm t_{\alpha/2}s/\sqrt{n}$ = 15.02 ± 1.990(8.31/ $\sqrt{83}$) = 15.02 ± 1.82; LCL = 13.20, UCL = 16.84

12.42 . $H_0: \mu = 450$

$H_0: \mu > 450$

Rejection region: $t > t_{\alpha,n-1} = t_{.05,49} \approx 1.676$

$t = \frac{\bar{x} - \mu}{s/\sqrt{n}} = \frac{460.38 - 450}{38.83\sqrt{50}} = 1.89$, p-value = .0323. There is enough evidence to infer that the belief is correct

12.43 $H_0: \sigma^2 = 300$

$H_1: \sigma^2 \neq 300$

a Rejection region: $\chi^2 < \chi^2_{1-\alpha/2,n-1} = \chi^2_{.975,99} \approx 74.2$ or $\chi^2 > \chi^2_{\alpha/2,n-1} = \chi^2_{.025,99} \approx 130$

$\chi^2 = \frac{(n-1)s^2}{\sigma^2} = \frac{(100-1)(220)}{300} = 72.60$, p-value = .0427. There is enough evidence to infer that the population variance differs from 300.

b Rejection region: $\chi^2 < \chi^2_{1-\alpha/2,n-1} = \chi^2_{.975,49} \approx 32.4$ or $\chi^2 > \chi^2_{\alpha/2,n-1} = \chi^2_{.025,49} \approx 71.4$

$\chi^2 = \frac{(n-1)s^2}{\sigma^2} = \frac{(50-1)(220)}{300} = 35.93$, p-value = .1643. There is not enough evidence to infer that the population variance differs from 300.

c Decreasing the sample size decreases the test statistic and increases the p-value of the test.

12.44 $H_0: \sigma^2 = 100$

$H_1: \sigma^2 < 100$

a Rejection region: $\chi^2 < \chi^2_{1-\alpha,n-1} = \chi^2_{.99,49} \approx 29.7$

$\chi^2 = \frac{(n-1)s^2}{\sigma^2} = \frac{(50-1)(80)}{100} = 39.20$, p-value = .1596. There is not enough evidence to infer that the population variance is less than 100.

b Rejection region: $\chi^2 < \chi^2_{1-\alpha,n-1} = \chi^2_{.99,99} \approx 70.1$

$\chi^2 = \frac{(n-1)s^2}{\sigma^2} = \frac{(100-1)(80)}{100} = 79.20$, p-value = .0714. There is not enough evidence to infer that the population variance is less than 100.

c Increasing the sample size increases the test statistic and decreases the p-value.

12.45 a LCL = $\frac{(n-1)s^2}{\chi^2_{\alpha/2,n-1}} = \frac{(n-1)s^2}{\chi^2_{.05,14}} = \frac{(15-1)(12)}{23.7} = 7.09$

$$UCL = \frac{(n-1)s^2}{\chi^2_{1-\alpha/2,n-1}} = \frac{(n-1)s^2}{\chi^2_{.95,14}} \ \frac{(15-1)(12)}{6.57} = 25.57$$

b $$LCL = \frac{(n-1)s^2}{\chi^2_{\alpha/2,n-1}} = \frac{(n-1)s^2}{\chi^2_{.05,29}} = \frac{(30-1)(12)}{42.6} = 8.17$$

$$UCL = \frac{(n-1)s^2}{\chi^2_{1-\alpha/2,n-1}} = \frac{(n-1)s^2}{\chi^2_{.95,29}} = \frac{(30-1)(12)}{17.7} = 19.66$$

c Increasing the sample size narrows the interval.

12.46 $$LCL = \frac{(n-1)s^2}{\chi^2_{\alpha/2,n-1}} = \frac{(n-1)s^2}{\chi^2_{.05,7}} = \frac{(8-1)(.00093)}{14.1} = .00046,$$

$$UCL = \frac{(n-1)s^2}{\chi^2_{1-\alpha/2,n-1}} = \frac{(n-1)s^2}{\chi^2_{.95,7}} = \frac{(8-1)(.00093)}{2.17} = .00300$$

12.47 $H_0: \sigma^2 = 250$

$H_1: \sigma^2 < 250$

Rejection region: $\chi^2 < \chi^2_{1-\alpha,n-1} = \chi^2_{.90,9} = 4.17$

$\chi^2 = \frac{(n-1)s^2}{\sigma^2} = \frac{(10-1)(210.22)}{250} = 7.57$, p-value = .4218. There is not enough evidence to infer that the population variance has decreased.

12.48 $H_0: \sigma^2 = 23$

$H_1: \sigma^2 \neq 23$

Rejection region: $\chi^2 < \chi^2_{1-\alpha/2,n-1} = \chi^2_{.95,7} = 2.17$ or $\chi^2 > \chi^2_{\alpha/2,n-1} = \chi^2_{.05,7} = 14.1$

$\chi^2 = \frac{(n-1)s^2}{\sigma^2} = \frac{(8-1)(16.50)}{23} = 5.02$, p-value = .6854. There is not enough evidence to infer that the population variance has changed.

12.49 $$LCL = \frac{(n-1)s^2}{\chi^2_{\alpha/2,n-1}} = \frac{(n-1)s^2}{\chi^2_{.025,9}} = \frac{(10-1)(15.43)}{19.0} = 7.31$$

$$UCL = \frac{(n-1)s^2}{\chi^2_{1-\alpha/2,n-1}} = \frac{(n-1)s^2}{\chi^2_{.975,9}} = \frac{(10-1)(15.43)}{2.70} = 51.43$$

12.50 a $H_0: \sigma^2 = 250$

$H_1: \sigma^2 \neq 250$

Rejection region: $\chi^2 < \chi^2_{1-\alpha/2,n-1} = \chi^2_{.975,24} = 12.4$ or $\chi^2 > \chi^2_{\alpha/2,n-1} = \chi^2_{.025,24} = 39.4$

$\chi^2 = \frac{(n-1)s^2}{\sigma^2} = \frac{(25-1)(270.58)}{250} = 25.98$, p-value = .7088. There is not enough evidence to infer that the population variance is not equal to 250.

b Demand is required to be normally distributed.

c The histogram is approximately bell shaped.

12.51 $H_0: \sigma^2 = 18$

$H_1: \sigma^2 > 18$

Rejection region: $\chi^2 > \chi^2_{\alpha,n-1} = \chi^2_{.10,244} = 272.704$ (from Excel)

$\chi^2 = \frac{(n-1)s^2}{\sigma^2} = \frac{(245-1)(22.56)}{18} = 305.81$; p-value = .0044. There is enough evidence to infer that the population variance is greater than 18.

12.52 LCL = $\frac{(n-1)s^2}{\chi^2_{\alpha/2,n-1}} = \frac{(n-1)s^2}{\chi^2_{.05,89}} = \frac{(90-1)(4.72)}{113} = 3.72$

UCL = $\frac{(n-1)s^2}{\chi^2_{1-\alpha/2,n-1}} = \frac{(n-1)s^2}{\chi^2_{.95,89}} = \frac{(90-1)(4.72)}{69.1} = 6.08$

12.53 $H_0: \sigma^2 = 200$

$H_1: \sigma^2 < 200$

Rejection region: $\chi^2 < \chi^2_{1-\alpha,n-1} = \chi^2_{.95,99} \approx 77.9$

$\chi^2 = \frac{(n-1)s^2}{\sigma^2} = \frac{(100-1)(174.47)}{200} = 86.36$; p-value = .1863. There is not enough evidence to infer that the population variance is less than 200. Replace the bulbs as they burn out.

12.54 LCL = $\frac{(n-1)s^2}{\chi^2_{\alpha/2,n-1}} = \frac{(n-1)s^2}{\chi^2_{.025,24}} = \frac{(25-1)(19.68)}{39.4} = 11.99$

UCL = $\frac{(n-1)s^2}{\chi^2_{1-\alpha/2,n-1}} = \frac{(n-1)s^2}{\chi^2_{.975,24}} = \frac{(25-1)(19.68)}{12.4} = 38.09$

12.55 a $\hat{p} \pm z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})/n} = .48 \pm 1.96\sqrt{.48(1-.48)/500} = .48 \pm .0438$

b $\hat{p} \pm z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})/n} = .48 \pm 1.96\sqrt{.48(1-.48)/200} = .48 \pm .0692$

c $\hat{p} \pm z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})/n} = .48 \pm 1.96\sqrt{.48(1-.48)/1000} = .48 \pm .0310$

d The interval narrows.

12.56 a $\hat{p} \pm z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})/n} = .50 \pm 1.96\sqrt{.50(1-.50)/400} = .50 \pm .0490$

b $\hat{p} \pm z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})/n} = .33 \pm 1.96\sqrt{.33(1-.33)/400} = .33 \pm .0461$

c $\hat{p} \pm z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})/n} = .10 \pm 1.96\sqrt{.10(1-.10)/400} = .10 \pm .0294$

d The interval narrows.

12.57 $H_0: p = .60$

$H_1: p > .60$

a $z = \dfrac{\hat{p}-p}{\sqrt{p(1-p)/n}} = \dfrac{.63-.60}{\sqrt{.60(1-.60)/100}} = .61$, p-value = P(Z > .61) = 1 – .7291 =.2709

b $z = \dfrac{\hat{p}-p}{\sqrt{p(1-p)/n}} = \dfrac{.63-.60}{\sqrt{.60(1-.60)/200}} = .87$, p-value = P(Z > .87) = 1 – .8078 = .1922

c $z = \dfrac{\hat{p}-p}{\sqrt{p(1-p)/n}} = \dfrac{.63-.60}{\sqrt{.60(1-.60)/400}} = 1.22$, p-value = P(Z > 1.22) = 1 – .8888 = .1112

d The p-value decreases.

12.58 a $z = \dfrac{\hat{p}-p}{\sqrt{p(1-p)/n}} = \dfrac{.73-.70}{\sqrt{.70(1-.70)/100}} = .65$, p-value = P(Z > .65) = 1 – .7422 =.2578

b $z = \dfrac{\hat{p}-p}{\sqrt{p(1-p)/n}} = \dfrac{.72-.70}{\sqrt{.70(1-.70)/100}} = .44$, p-value = P(Z > .44) = 1 – .6700 =.3300

c $z = \dfrac{\hat{p}-p}{\sqrt{p(1-p)/n}} = \dfrac{.71-.70}{\sqrt{.70(1-.70)/100}} = .22$, p-value = P(Z > .22) = 1 – .5871 =.4129

d. The z statistic decreases and the p-value increases.

12.59 $n = \left(\dfrac{z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})}}{B}\right)^2 = \left(\dfrac{1.645\sqrt{.5(1-.5)}}{.03}\right)^2 = 752$

12.60a .5 $\pm$ .03

b Yes, because the sample size was chosen to produce this interval.

12.61 a $\hat{p} \pm z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})/n} = .75 \pm 1.645\sqrt{.75(1-.75)/752} = .75 \pm .0260$

b The interval is narrower.

c Yes, because the interval estimate is better than specified.

12.62 $n = \left(\frac{z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})}}{B}\right)^2 = \left(\frac{1.645\sqrt{.75(1-.75)}}{.03}\right)^2 = 564$

12.63a .75 $\pm$ .03

b Yes, because the sample size was chosen to produce this interval.

12.64 a $\hat{p} \pm z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})/n} = .92 \pm 1.645\sqrt{.92(1-.92)/564} = .92 \pm .0188$

b The interval is narrower.

c Yes, because the interval estimate is better than specified.

12.65 a $\hat{p} \pm z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})/n} = .5 \pm 1.645\sqrt{.5(1-.5)/564} = .5 \pm .0346$

b The interval is wider.

c No because the interval estimate is wider (worse) than specified.

12.66 $\hat{p}$ = 259/373 = .69

$\hat{p} \pm z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})/n} = .69 \pm 1.96\sqrt{.69(1-.69)/373} = .69 \pm .0469$; LCL = .6431, UCL = .7369

12.67 $H_0: p = .25$

$H_1: p < .25$

$\hat{p}$ = 41/200 = .205

$z = \frac{\hat{p}-p}{\sqrt{p(1-p)/n}} = \frac{.205-.25}{\sqrt{.25(1-.25)/200}} = -1.47$, p-value = P(Z < –1.47) = .0708. There is enough evidence to support the officer’s belief.

12.68 $\hat{p} = 204/314 = .65$

$\hat{p} \pm z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})/n} = .65 \pm 1.645\sqrt{.65(1-.65)/314} = .65 \pm .0443$; LCL = .6057, UCL = .6943

12.69 $H_0: p = .92$

$H_1: p > .92$

$\hat{p} = 153/165 = .927$

$z = \frac{\hat{p}-p}{\sqrt{p(1-p)/n}} = \frac{.927-.92}{\sqrt{.92(1-.92)/165}} = .33$, p-value = P(Z > .33) = 1 – .6293 =.3707. There is not enough evidence to conclude that the airline's on-time performance has improved.

12.70 $\hat{p} = 97/344 = .28$

$\hat{p} \pm z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})/n} = .28 \pm 1.96\sqrt{.28(1-.28)/344} = .28 \pm .0474$; LCL = .2326, UCL = .3274

12.71 $\hat{p} = 68/400 = .17$

$\hat{p} \pm z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})/n} = .17 \pm 1.96\sqrt{.17(1-.17)/400} = .17 \pm .0368$; LCL = .1332, UCL = .2068

12.72 LCL = .1332(1,000,000)(3.00) = \$399,600, UCL = .2068(1,000,000)(3.00) = \$620,400

12.73 $\tilde{p} = \frac{x+2}{n+4} = \frac{1+2}{200+4} = .0147$

$\tilde{p} \pm z_{\alpha/2}\sqrt{\frac{\tilde{p}(1-\tilde{p})}{n+4}} = .0147 \pm 1.96\sqrt{\frac{.0147(1-.0147)}{200+4}} = .0147 \pm .0165$; LCL = 0 (increased from –.0018), UCL = .0312

12.74 $\tilde{p} = \frac{x+2}{n+4} = \frac{3+2}{374+4} = .0132$

$\tilde{p} \pm z_{\alpha/2}\sqrt{\frac{\tilde{p}(1-\tilde{p})}{n+4}} = .0132 \pm 1.645\sqrt{\frac{.0132(1-.0132)}{374+4}} = .0132 \pm .0097$; LCL = .0035, UCL = .0229

12.75 $\tilde{p} = \frac{x+2}{n+4} = \frac{1+2}{385+4} = .0077$

$\tilde{p} \pm z_{\alpha/2}\sqrt{\frac{\tilde{p}(1-\tilde{p})}{n+4}}$ = $.0077 \pm 2.575\sqrt{\frac{.0077(1-.0077)}{385+4}}$ = .0077 ± .0114; LCL = 0 (increased from –.0037), UCL = .0191

12.76a. $\hat{p} \pm z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})/n}$ = .1056 ± 1.96 $\sqrt{.1056(1-.1056)/521}$ = .1056 ± .0264; LCL = .0792, UCL = .1320

12.77 LCL = 75,000(.0792) =5,940, UCL = 75,000(.1320) = 9,900

12.78 $\hat{p} \pm z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})/n}$ = .7584 ± 1.96 $\sqrt{.7584(1-.7584)/567}$ = .7584 ± .0352; LCL = .7232, UCL = .7936

12.79 $H_0: p = .90$

$H_1: p < .90$

$z = \frac{\hat{p}-p}{\sqrt{p(1-p)/n}} = \frac{.8644-.90}{\sqrt{.90(1-.90)/177}}$ = –1.58, p-value = P(Z < –1.58) = .0571. There is not enough evidence to infer that the satisfaction rate is less than 90%.

12.80 $\hat{p} \pm z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})/n}$ = .2333 ± 1.96 $\sqrt{.2333(1-.2333)/120}$ = .2333 ± .0757; LCL = .1576, UCL = .3090

12.81 $\hat{p} \pm z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})/n}$ = .600 ± 1.96 $\sqrt{.600(1-.600)/1508}$ = .600 ± .025; LCL = .575, UCL = .625

Total number of Canadians who prefer artificial Christmas trees: LCL = 6 million(.575) = 3.45 million, UCL = 6 million (.625) = 3.75 million

12.82a. $\hat{p} \pm z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})/n}$ = .7840 ± 1.96 $\sqrt{.7840(1-.7840)/426}$ = .7840 ± .0391; LCL = .7449, UCL = .8231

12.83 $H_0: p = .50$

$H_1: p > .50$

$z = \frac{\hat{p}-p}{\sqrt{p(1-p)/n}} = \frac{.57-.50}{\sqrt{.50(1-.50)/100}}$ = 1.40, p-value = P(Z > 1.40) = 1 – .9192 =.0808. There is enough evidence to conclude that more than 50% of all business students would rate the book as excellent.

12.84 Codes 1, 2, and 3 have been recoded to 5.

$H_0: p = .90$

$H_1: p > .90$

$z = \frac{\hat{p} - p}{\sqrt{p(1-p)/n}} = \frac{.96 - .90}{\sqrt{.90(1-.90)/100}}$ = 2.00, p-value = P(Z > 2.00) = 1 – .9772 =.0228. There is enough evidence to conclude that more than 90% of all business students would rate the book as at least adequate.

12.85 $\hat{p}$ = 303/5000 = .0606 $\hat{p} \pm z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})/n} = .0606 \pm 1.96\sqrt{.0606(1-.0606)/5000} = .0606 \pm .0066$; LCL = .0540, UCL = .0672

Number of households: LCL = 110 million(.0540) = 5.940 million, UCL = 110 million(.0672) = 7.392 million

12.86 $H_0: p = .12$

$H_1: p > .12$

$z = \frac{\hat{p} - p}{\sqrt{p(1-p)/n}} = \frac{.1625 - .12}{\sqrt{.12(1-.12)/400}}$ = 2.62, p-value = P(Z > 2.62) = 1 – .9956 = .0044. There is enough evidence to infer that the proposed newspaper will be financially viable.

12.87 $\hat{p} \pm z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})/n} = .1914 \pm 1.645\sqrt{.1914(1-.1914)/810} = .1914 \pm .0227$; LCL = .1687, UCL = .2141

Number: LCL = 270 million (.1687) = 45.55 million, UCL = 270 million (.2141) = 57.81 million

12.88a. $\hat{p} \pm z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})/n} = .2031 \pm 1.96\sqrt{.2031(1-.2031)/650} = .2031 \pm .0309$; LCL = .1722, UCL = .2340

Number: LCL = 5 million (.1722) = .861 million, UCL = 5 million (.2340) = 1.17 million

12.89 $\hat{p}$ = 269/2377 = .1132 $\hat{p} \pm z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})/n} = .1132 \pm 1.96\sqrt{.1132(1-.1132)/2377} = .1132 \pm .0127$; LCL = .1005, UCL = .1259

Number of televisions: LCL = 50 million(.1005) = 5.025 million, UCL = 50 million(.1259) = 6.295 million

12.90 Codes 3 and 4 were changed to 5

$\hat{p} \pm z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})/n} = .7305 \pm 1.96\sqrt{.7305(1-.7305)/475} = .7305 \pm .0399$; LCL = .6906, UCL = .7704; Market segment size: LCL = 19,108,000 (.6906) = 13,195,985, UCL = 19,108,000 (.7704) = 14,720,803

12.91 Code 2 was changed to 3.

$\hat{p} \pm z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})/n}$ = .5313 $\pm$ 1.96 $\sqrt{.5313(1-.5313)/320}$ = .5313 $\pm$ .0547; LCL = .4766,

UCL = .5860;

Market segment size: LCL = 15,517,000 (.4766) = 7,395,402 , UCL = 15,517,000 (.5860) = 9,092,962

12.92a. $\hat{p} \pm z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})/n}$ = .2919 $\pm$ 1.96 $\sqrt{.2919(1-.2919)/1836}$ = .2919 $\pm$ .0208; LCL = .2711,

UCL = .3127

b LCL = 107,194,000 (.2711) = 29,060,293, UCL = 107,194,000 (.3127) = 33,519,564

12.93 $\hat{p} \pm z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})/n}$ = .1077 $\pm$ 1.96 $\sqrt{.1077(1-.1077)/325}$ = .1077 $\pm$ .0337; LCL = .0740,

UCL = .1414; Market segment size: LCL = 35.6 million(.0740) = 2.634 million,

UCL = 35.6 million(.1414) = 5.034 million

12.94 $\hat{p} \pm z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})/n}$ = .1748 $\pm$ 1.645 $\sqrt{.1748(1-.1748)/412}$ = .1748 $\pm$ .0308; LCL = .1440,

UCL = .2056; Number: LCL = 187 million(.1440) = 26.928 million, UCL = 187 million(.2056) = 38.447 million

12.95 $\hat{p} \pm z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})/n}$ = .1500 $\pm$ 1.96 $\sqrt{.1500(1-.1500)/340}$ = .1500 $\pm$ .0380; LCL = .1120,

UCL = .1880; Number: LCL = 187 million(.1120) = 20.944 million, UCL = 187 million(.1880) = 35.156 million

12.96 $\hat{p}$ = 4/80 = .05; $\hat{p} \pm z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})/n}$ = .05 $\pm$ 1.96 $\sqrt{.05(1-.05)/80}$ = .05 $\pm$ .0478; LCL = .0022, UCL = .0978; Number: LCL = 2,453(.0022) = 5.4 (rounded to 5), UCL = 2,453(.0978) = 239.9
(rounded to 240)

12.97a. $\hat{p}$ = 29/559 = .0519; $\hat{p} \pm z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})/n}$ = .0519 $\pm$ 2.575 $\sqrt{.0519(1-.0519)/559}$ = .0519 $\pm$ .0242; LCL = .0277, UCL = .0761; Number: LCL = 118,653(.0277) = 3,287, UCL = 118,653(.0761) = 9,029

12.98 $\bar{x} \pm t_{\alpha/2}s/\sqrt{n}$ = 229.18 $\pm$ 1.96(67.36/$\sqrt{500}$) = 229.18 $\pm$ 5.92; LCL = 223.26, UCL = 235.10

Total value: LCL = 73,544(223.26) = \$16,419,433, UCL = 73,544(235.10) = \$17,290,194

12.99 $\hat{p}$ = 14/125 = .112; $\hat{p} \pm z_{\alpha/2}\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}\sqrt{\frac{N-n}{N-1}}$ = $.112 \pm 1.645\sqrt{\frac{.112(1-.112)}{125}}\sqrt{\frac{2{,}490-125}{2{,}490-1}}$

= .112 $\pm$ .0452; LCL = .0668, UCL = .1572;

Number of grants: LCL = 2,490(.0668) = 166, UCL = 2,490(.1572) = 391

12.100a. $\hat{p} = 5/85 = .0588$; $\hat{p} \pm z_{\alpha/2}\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}\sqrt{\frac{N-n}{N-1}} = .0588 \pm 1.645\sqrt{\frac{.0588(1-.0588)}{85}}\sqrt{\frac{1,864-85}{1,864-1}}$

$= .0588 \pm .0410$;

LCL = .0178, UCL = .0998; Number: LCL = 1,864(.0178) = 33, UCL = 1,864(.0998) = 186

12.101 $\bar{x} \pm t_{\alpha/2}\frac{s}{\sqrt{n}}\sqrt{\frac{N-n}{N-1}} = 313.47 \pm 1.984\frac{55.53}{\sqrt{100}}\sqrt{\frac{1,431-100}{1,431-1}} = 313.47 \pm 10.63$; LCL = 302.84, UCL = 324.10; Total: LCL = 1,431(302.84) = \$433,364, UCL = 1,431(324.10) = \$463,787

12.102 $\hat{p} = 18/200 = .09$; $\hat{p} \pm z_{\alpha/2}\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}\sqrt{\frac{N-n}{N-1}} = .09 \pm 1.96\sqrt{\frac{.09(1-.09)}{200}}\sqrt{\frac{3,745-200}{3,745-1}} = .09 \pm .0386$; LCL = .0514, UCL = .1286; Number: LCL = 3,745(.0514) = 192, UCL = 3,745(.1286) = 482

12.103 $\bar{x} \pm t_{\alpha/2}\frac{s}{\sqrt{n}}\sqrt{\frac{N-n}{N-1}} = 12,940 \pm 1.653\frac{4,139}{\sqrt{188}}\sqrt{\frac{2,684-188}{2,684-1}} = 12,940 \pm 490$; LCL = 12,450, UCL = 13,430; Total: LCL = 2,684(12,450) = \$33,415,800, UCL = 2,684(13,430 = \$36,046,120

12.104 $\hat{p} = 38/317 = .1199$; $\hat{p} \pm z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})/n} = .1199 \pm 1.96\sqrt{.1199(1-.1199)/317} = .1199 \pm .0358$; LCL = .0841, UCL = .1557; Number: LCL = 102,412(.0841) = 8,613, UCL = 102,412(.1557) = 15,946

12.105 a $H_0: \mu = 30$

$H_1: \mu > 30$

	A	B	C	D
1	**t-Test: Mean**			
2				
3				*Costs*
4	Mean			31.95
5	Standard Deviation			7.19
6	Hypothesized Mean			30
7	df			124
8	t Stat			3.04
9	P(T<=t) one-tail			0.0015
10	t Critical one-tail			1.6572
11	P(T<=t) two-tail			0.0030
12	t Critical two-tail			1.9793

t = 3.04, p-value = .0015; there is enough evidence to infer that the candidate is correct.

	A	B	C	D
1	**t-Estimate: Mean**			
2				
3				*Costs*
4	Mean			31.95
5	Standard Deviation			7.19
6	LCL			30.68
7	UCL			33.23

b LCL = 30.68, UCL = 33.23

c The costs are required to be normally distributed.

12.106 $H_0: \mu = 60$

$H_1: \mu < 60$

	A	B	C	D
1	**t-Test: Mean**			
2				
3				*Times*
4	Mean			57.79
5	Standard Deviation			6.58
6	Hypothesized Mean			60
7	df			23
8	t Stat			-1.64
9	P(T<=t) one-tail			0.0569
10	t Critical one-tail			1.7139
11	P(T<=t) two-tail			0.1138
12	t Critical two-tail			2.0687

t = –1.64, p-value = .0569. There is not enough evidence to conclude that the supplier's assertion is correct.

12.107 $H_0: \sigma^2 = 17$

$H_1: \sigma^2 > 17$

	A	B	C	D
1	**Chi Squared Test: Variance**			
2				
3				*Times*
4	Sample Variance			27.47
5	Hypothesized Variance			17
6	df			19
7	chi-squared Stat			30.71
8	P (CHI<=chi) one-tail			0.0435
9	chi-squared Critical one tail	Left-tail		10.1170
10		Right-tail		30.1435
11	P (CHI<=chi) two-tail			0.0869
12	chi-squared Critical two tail	Left-tail		8.9065
13		Right-tail		32.8523

$\chi^2 = 30.71$, p-value = .0435. There is enough evidence to infer that problems are likely.

12.108

	A	B
1	**z-Estimate: Proportion**	
2		*Resolution*
3	Sample Proportion	0.358
4	Observations	215
5	LCL	0.304
6	UCL	0.412

LCL = .304, UCL = .412

12.109 a

	A	B	C	D
1	**t-Estimate: Mean**			
2				
3				*Marks*
4	Mean			71.88
5	Standard Deviation			10.03
6	LCL			69.03
7	UCL			74.73

LCL = 69.03, UCL = 74.73

b $H_0: \mu = 68$

$H_1: \mu > 68$

	A	B	C	D
1	**t-Test: Mean**			
2				
3				*Marks*
4	Mean			71.88
5	Standard Deviation			10.03
6	Hypothesized Mean			68
7	df			49
8	t Stat			2.74
9	P(T<=t) one-tail			0.0043
10	t Critical one-tail			1.6766
11	P(T<=t) two-tail			0.0086
12	t Critical two-tail			2.0096

t = 2.74, p-value = .0043; there is enough evidence to infer that students with a calculus background would perform better in statistics than students with no calculus.

12.110

	A	B	C	D
1	**t-Estimate: Mean**			
2				
3				*Points*
4	Mean			117.54
5	Standard Deviation			50.24
6	LCL			108.19
7	UCL			126.89

LCL = 108.19, UCL = 126.89

12.111

	A	B
1	**z-Estimate: Proportion**	
2		*Insurance*
3	Sample Proportion	0.632
4	Observations	250
5	LCL	0.582
6	UCL	0.682

LCL = .582, UCL = .682

12.112 a

	A	B	C	D
1	**t-Estimate: Mean**			
2				
3				*Times*
4	Mean			6.91
5	Standard Deviation			0.23
6	LCL			6.84
7	UCL			6.98

LCL = 6.84, UCL = 6.98

b The histogram is bell shaped.

c $H_0 : \mu = 7$

$H_1 : \mu < 7$

	A	B	C	D
1	**t-Test: Mean**			
2				
3				*Times*
4	Mean			6.91
5	Standard Deviation			0.23
6	Hypothesized Mean			7
7	df			74
8	t Stat			-3.48
9	P(T<=t) one-tail			0.0004
10	t Critical one-tail			1.2931
11	P(T<=t) two-tail			0.0008
12	t Critical two-tail			1.6657

t = –3.48, p-value = .0004; there is enough evidence to infer that postal workers are spending less than seven hours doing their jobs.

12.113

	A	B	C	D
1	**t-Estimate: Mean**			
2				
3				*Time*
4	Mean			6.35
5	Standard Deviation			2.16
6	LCL			6.05
7	UCL			6.65

LCL = 6.05, UCL = 6.65

12.114

	A	B	C	D
1	**t-Estimate: Mean**			
2				
3				*Times*
4	Mean			5.79
5	Standard Deviation			2.86
6	LCL			5.11
7	UCL			6.47

LCL = 5.11, UCL = 6.47

12.115

	A	B
1	**z-Estimate: Proportion**	
2		*Tourist*
3	Sample Proportion	0.667
4	Observations	72
5	LCL	0.558
6	UCL	0.776

LCL = .558, UCL = .776

12.116 $H_0: \sigma^2 = 4$

$H_1: \sigma^2 > 4$

	A	B	C	D
1	**Chi Squared Test: Variance**			
2				
3				*Lengths*
4	Sample Variance			6.52
5	Hypothesized Variance			4
6	df			99
7	chi-squared Stat			161.25
8	P (CHI<=chi) one-tail			0.0001
9	chi-squared Critical one tail	Left-tail		77.0463
10		Right-tail		123.2252
11	P (CHI<=chi) two-tail			0.0002
12	chi-squared Critical two tail	Left-tail		73.3611
13		Right-tail		128.4220

χ^2 = 161.25, p-value = .0001; there is enough evidence to conclude that the number of springs requiring reworking is unacceptably large.

12.117 $H_0: p = .90$

$H_1: p < .90$

	A	B	C	D
1	**z-Test: Proportion**			
2				
3				*Springs*
4	Sample Proportion			0.86
5	Observations			100
6	Hypothesized Proportion			0.9
7	z Stat			-1.33
8	P(Z<=z) one-tail			0.0912
9	z Critical one-tail			1.2816
10	P(Z<=z) two-tail			0.1824
11	z Critical two-tail			1.6449

z = –1.33, p-value = .0912; there is enough evidence to infer that less than 90% of the springs are the correct length.

12.118

	A	B	C	D
1	**t-Estimate: Mean**			
2				
3				*Service*
4	Mean			1.10
5	Standard Deviation			0.98
6	LCL			0.94
7	UCL			1.26

LCL = .94, UCL = 1.26

12.119 a $H_0: \mu = 9.8$

$H_1: \mu < 9.8$

	A	B	C	D
1	**t-Test: Mean**			
2				
3				*Time*
4	Mean			9.16
5	Standard Deviation			2.64
6	Hypothesized Mean			9.8
7	df			149
8	t Stat			-2.97
9	P(T<=t) one-tail			0.0018
10	t Critical one-tail			1.2873
11	P(T<=t) two-tail			0.0036
12	t Critical two-tail			1.6551

t = –2.97, p-value = .0018; there is enough evidence to infer that enclosure of preaddressed envelopes improves the average speed of payments.

b $H_0: \sigma^2 = 10.24\ (3.2^2)$

$H_1: \sigma^2 < 10.24$

	A	B	C	D
1	**Chi Squared Test: Variance**			
2				
3				*Time*
4	Sample Variance			6.98
5	Hypothesized Variance			10.24
6	df			149
7	chi-squared Stat			101.58
8	P (CHI<=chi) one-tail			0.0011
9	chi-squared Critical one tail	Left-tail		127.3493
10		Right-tail		171.5069
11	P (CHI<=chi) two-tail			0.0021
12	chi-squared Critical two tail	Left-tail		121.7870
13		Right-tail		178.4854

χ^2 = 101.58, p-value = .0011; there is enough evidence to infer that the variability in payment speeds decreases when a preaddressed envelope is sent.

12.120 $n = \left(\frac{z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})}}{B}\right)^2 = \left(\frac{2.575\sqrt{.5(1-.5)}}{.02}\right)^2 = 4144$

12.121

	A	B
1	**z-Estimate: Proportion**	
2		*Concert*
3	Sample Proportion	0.1533
4	Observations	600
5	LCL	0.1245
6	UCL	0.1822

Proportion: LCL = .1245, UCL = .1822

Total: LCL = 400,000(.1245) = 49,800 UCL = 400,000(.1822) = 72,880

12.122 Number of cars:

$H_0: \mu = 125$

$H_1: \mu > 125$

	A	B	C	D
1	**t-Test: Mean**			
2				
3				*Cars*
4	Mean			125.80
5	Standard Deviation			3.90
6	Hypothesized Mean			125
7	df			4
8	t Stat			0.46
9	P(T<=t) one-tail			0.3351
10	t Critical one-tail			3.7469
11	P(T<=t) two-tail			0.6702
12	t Critical two-tail			4.6041

t = .46, p-value = .3351; there is not enough evidence to infer that the employee is stealing by lying about the number of cars.

Amount of time

$H_0: \mu = 3.5$

$H_1: \mu > 3.5$

	A	B	C	D
1	**t-Test: Mean**			
2				
3				*Time*
4	Mean			3.61
5	Standard Deviation			0.40
6	Hypothesized Mean			3.5
7	df			628
8	t Stat			7.00
9	P(T<=t) one-tail			0
10	t Critical one-tail			2.3323
11	P(T<=t) two-tail			0
12	t Critical two-tail			2.5837

t = 7.00, p-value = 0; there is enough evidence to infer that the employee is stealing by lying about the amount of time.

12.123 a

	A	B	C	D
1	**t-Estimate: Mean**			
2				
3				*Percent Gain/Loss*
4	Mean			12.03
5	Standard Deviation			37.55
6	LCL			-5.54
7	UCL			29.61

LCL = -5.54%, UCL = 29.61%

b. $H_0: \mu = 16$

$H_1: \mu < 16$

	A	B	C	D
1	**t-Test: Mean**			
2				
3				*Percent Gain/Loss*
4	Mean			12.03
5	Standard Deviation			37.55
6	Hypothesized Mean			16
7	df			19
8	t Stat			-0.47
9	P(T<=t) one-tail			0.3210
10	t Critical one-tail			1.7291
11	P(T<=t) two-tail			0.6420
12	t Critical two-tail			2.0930

t = -.47, p-value = .3210; there is not enough evidence to infer that Mr. Cramer does less well than the S&P 500 index.

Case 12.1

95% confidence interval estimate of mean weekly consumption per student:

	A	B	C	D
1	**t-Estimate: Mean**			
2				
3				*Cans*
4	Mean			1.316
5	Standard Deviation			1.115
6	LCL			1.218
7	UCL			1.414

	A	B	C
1	**Case 12.1**		
2			
3	**Mean number of cans/ student / week**		1.218
4	**Number of cans sold annually**		**2,436,000**
5	**Gross revenue**		**$1,827,000**
6	**Less 35% university take**		**$1,187,550**
7	**Cost to produce cans**		**$487,200**
8	**Net profit**		**$500,350**
9			
10	**Current profit**		**$484,000**

	A	B	C
1	**Case 12.1**		
2			
3	**Mean number of cans/ student / week**		1.414
4	**Number of cans sold annually**		**2,828,000**
5	**Gross revenue**		**$2,121,000**
6	**Less 35% university take**		**$1,378,650**
7	**Cost to produce cans**		**$565,600**
8	**Net profit**		**$613,050**
9			
10	**Current profit**		**$484,000**

Estimated Mean Number of Cans per Student	Revenue	Cost	Profit	Current Profit	Net
LCL = 1.218	$1,187,550	$487,200	$500,350	$484,000	$ 16,350
UCL = 1.414	1,378,650	565,600	613,050	484,000	129,050

Pepsi should sign the exclusivity agreement.

Case 12.2

Estimated Mean Number of Cans per Student	Revenue	Cost	Profit	Current Profit	Net
LCL = 1.218	$1,187,550	$487,200	$500,350	$855,910	$–355,560
UCL = 1.414	1,378,650	565,600	613,050	1,071,290	–458,240

Coke would not sign the exclusivity agreement. Coke is expected to lose from the exclusivity agreement because they currently have a much larger share of the market and would not gain by paying for exclusivity.

Case 12.3

a 95% confidence interval estimate of the mean medical costs for each of the four age categories:

	A	B	C	D
1	**t-Estimate: Mean**			
2				
3				*Age:45-64*
4	Mean			1830
5	Standard Deviation			749
6	LCL			1784
7	UCL			1877

	A	B	C	D
1	**t-Estimate: Mean**			
2				
3				*Age:65-74*
4	Mean			4494
5	Standard Deviation			1820
6	LCL			4381
7	UCL			4607

	A	B	C	D
1	**t-Estimate: Mean**			
2				
3				*Age:75-84*
4	Mean			8074
5	Standard Deviation			3186
6	LCL			7876
7	UCL			8272

	A	B	C	D
1	**t-Estimate: Mean**			
2				
3				*Age:85+*
4	Mean			15957
5	Standard Deviation			6207
6	LCL			15572
7	UCL			16342

b Estimated annual costs for 20011

		Estimate of mean		Estimate of total (1,000s)	
Age category	Number (1,000s)	LCL	UCL	LCL	UCL
45 to 64	9,718	1,784	1,877	17,336,912	18,240,686
65 to 74	2,644	4,381	4,607	11,583,364	12,180,908
75 to 84	1,600	7,876	8,272	12,601,600	13,235,200
85 and over	639	15,572	16,342	9,950,508	10,442,538
Total	14,601			51,472,384	54,099,332

Estimated annual costs for 2016

		Estimate of mean		Estimate of total (1,000s)	
Age category	Number (1,000s)	LCL	UCL	LCL	UCL
45 to 64	10,013	1,784	1,877	17,863,192	18,794,401
65 to 74	3,344	4,381	4,607	14,650,064	15,405,808
75 to 84	1,718	7,876	8,272	13,530,968	14,211,296
85 and over	738	15,572	16,342	11,492,136	12,060,396
Total	15,813			57,536,360	60,471,901

Estimated annual costs for 2021

		Estimate of mean		Estimate of total (1,000s)	
Age category	Number (1,000s)	LCL	UCL	LCL	UCL
45 to 64	10,065	1,784	1,877	17,955,960	18,892,005
65 to 74	3,992	4,381	4,607	17,488,952	18,391,144
75 to 84	2,045	7,876	8,272	16,106,420	16,916,240
85 and over	810	15,572	16,342	12,613,320	13,237,020
Total	16,912			64,164,652	67,436,409

Estimated annual costs for 2026

		Estimate of mean		Estimate of total (1,000s)	
Age category	Number (1,000s)	LCL	UCL	LCL	UCL
45 to 64	9,996	1,784	1,877	17,832,864	18,762,492
65 to 74	4,511	4,381	4,607	19,762,691	20,782,177
75 to 84	2,627	7,876	8,272	20,690,252	21,730,544
85 and over	909	15,572	16,342	14,154,948	14,854,878
Total	18,043			72,440,755	76,130,091

Estimated annual costs for 2031

		Estimate of mean		Estimate of total (1,000s)	
Age category	Number (1,000s)	LCL	UCL	LCL	UCL
45 to 64	10,016	1,784	1,877	17,868,544	18,800,032
65 to 74	4,846	4,381	4,607	21,230,326	22,325,522
75 to 84	3,169	7,876	8,272	24,959,044	26,213,968
85 and over	1,121	15,572	16,342	17,456,212	18,319,382
Total	18,043			81,514,126	85,658,904