28 a. H_0: $\pi \le 0.10$, H_1: $\pi \le 0.10$, where π is the population proportion of customers who will use the coupons.

b. $p = 0.13$

c. p-value = 0.20, do not reject H_0. Eagle should not go national on this evidence.

30 a. H_0: $\pi = 0.64$

H_1: $\pi \neq 0.64$

b. $p = \frac{52}{100} = 0.52$

$$z = \frac{p - \pi_0}{\sqrt{\frac{\pi_0(1-\pi_0)}{n}}} = \frac{0.52 - 0.64}{\sqrt{\frac{0.64(1-0.64)}{100}}} = -2.50$$

Cumulative probability for $z = -2.50$ is 0.0062

p-value = 2(0.0062) = 0.0124

c. p-value < 0.05; reject H_0. Proportion differs from the reported 0.64.

d. Yes. Since $p = 0.52$, it indicates that fewer than 64 per cent of the shoppers believe the supermarket brand is as good as the name brand.

32 a. H_0: $\pi = 0.63$

H_1: $\pi \neq 0.63$

b. p-value < 0.002

c. Reject H_0. Conclude that support changed.

34 Reject H_0 if $z \le -1.96$ or if $z \ge 1.96$

$$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}} = \frac{10}{\sqrt{200}} = 0.71$$

The critical values are:

$c_1 = 20 - 1.96\,(10/\sqrt{200}) = 18.61$

$c_2 = 20 + 1.96\,(10/\sqrt{200}) = 21.39$

a. $\mu = 18$

$$z = \frac{18.61 - 18}{10/\sqrt{200}} = 0.86$$

$\beta = P(Z > 0.86) = 1 - 0.8051 = 0.1949$

b. $\mu = 22.5$

$$z = \frac{21.39 - 22.5}{10/\sqrt{200}} = -1.57$$

$\beta = P(Z < -1.57) = 0.0582$

c. $\mu = 21$

$$z = \frac{21.39 - 21}{10/\sqrt{200}} = 0.55$$

$\beta = P(Z < 0.55) = 0.7088$

36 At $\mu = 17$, $\beta = 0.1151$

At $\mu = 18$, $\beta = 0.0015$

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

38 a. A Type II error would be 'accepting' that the mean level of tax-deferred investments is no greater than €100, when in fact it is greater than €100.

b. 0.739 c. 0.421 d. 0.476 e. 0.106

40 The required sample size is given by:

$$n = \frac{(z_\alpha + z_\beta)^2\,\sigma^2}{(\mu_0 - \mu_1)^2} = \frac{(1.96 + 1.645)^2\,(10)^2}{(20 - 22)^2} = 325$$

42 $n = 32$

Chapter 10

Solutions

2 a. $$z = \frac{(\bar{x}_1 - \bar{x}_2) - D_0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}} = \frac{(25.2 - 22.8) - 0}{\sqrt{\frac{5.2^2}{40} + \frac{6^2}{50}}} = 2.03$$

b. p-value = 1 − 0.9788 = 0.0212

c. p-value < 0.05, reject H_0.

4 a. 4.6 years

b. 1.3 years

c. 3.3 to 5.9 years

6 a. \$67.03

b. \$17.08

c. \$49.95 to \$84.11

8 a. $$t = \frac{(\bar{x}_1 - \bar{x}_2) - 0}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} = \frac{(13.6 - 10.1) - 0}{\sqrt{\frac{5.2^2}{35} + \frac{8.5^2}{40}}} = 2.18$$

b. $$df = \frac{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)^2}{\frac{1}{n_1 - 1}\left(\frac{s_1^2}{n_1}\right)^2 + \frac{1}{n_2 - 1}\left(\frac{s_2^2}{n_2}\right)^2}$$

$$= \frac{\left(\frac{5.2^2}{35} + \frac{8.5^2}{40}\right)^2}{\frac{1}{34}\left(\frac{5.2^2}{35}\right)^2 + \frac{1}{39}\left(\frac{8.5^2}{40}\right)^2} = 65.7$$

Use $df = 65$.

c. Using t table, area in tail is between 0.01 and 0.025.

Therefore two-tailed p-value is between 0.02 and 0.05. (Actual p-value = 0.0329.)

d. p-value < 0.05, reject H_0.

10 −0.52 to 1.28

12 a. H_0: $\mu_1 - \mu_2 \le 0$

H_1: $\mu_1 - \mu_2 > 0$

b. 38

c. $t = 1.80$, $df = 25$

Using t table, p-value is between 0.025 and 0.05. Exact p-value = 0.0420.

d. Reject H_0; conclude higher mean score if college grad.

14 H_0: $\mu_1 - \mu_2 = 0$

H_1: $\mu_1 - \mu_2 \neq 0$

$$z = \frac{(\bar{x}_1 - \bar{x}_2) - D_0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}} = \frac{(4.1 - 3.4) - 0}{\sqrt{\frac{(2.2)^2}{120} + \frac{(1.5)^2}{100}}} = 2.79$$

p-value = 2(1 − 0.9974) = 0.0052. p-value < 0.05, reject H_0. A difference exists with system B having the lower mean checkout time.

16 a. H_0: $\mu_1 - \mu_2 \ge 120$

H_1: $\mu_1 - \mu_2 < 120$

b. p-value is between 0.01 and 0.025, reject H_0. The improvement is less than the stated average of 120 points.

c. 32 to 118

d. This is a wide interval. A larger sample should be used to reduce the margin of error.

18 a. 11 − 8 = 3, 7 − 8 = −1, 9 − 6 = 3, 12 − 7 = 5, 13 − 10 = 3, 15 − 15 = 0, 15 − 14 = 1

b. $\bar{d} = \Sigma d_i/n = (3 - 1 + 3 + 5 + 3 + 0 + 1)/7 = 14/7 = 2$

c. $$s_d = \sqrt{\frac{\Sigma(d_i - \bar{d})^2}{n - 1}} = \sqrt{\frac{26}{7 - 1}} = 2.08$$

d. $$\bar{d} = 2\sqrt{\frac{\Sigma(d_i - \bar{d})^2}{n - 1}}$$

e. With 6 degrees of freedom $t_{0.025} = 2.447$. The confidence interval is $2 \pm 2.447\,(2.082/\sqrt{7}) = 2 \pm 1.93$, or 0.07 to 3.93.

20 p-value is between 0.10 and 0.20. Do not reject H_0; we cannot conclude that seeing the commercial improves the mean potential to purchase.

22 p-value is between 0.01 and 0.025. Reject H_0. Conclude that the population of readers spends more time, on average, watching television than reading.

24 a. $$p = \frac{n_1 p_1 + n_2 p_2}{n_1 + n_2} = \frac{200(0.22) + 300(0.16)}{200 + 300} = 0.1840$$

$$z = \frac{p_1 - p_2}{\sqrt{p(1-p)\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} = \frac{0.22 - 0.16}{\sqrt{0.1840(1 - 0.1840)\left(\frac{1}{200} + \frac{1}{300}\right)}} = 1.70$$

p-value = 1 − 0.9554 = 0.0446

b. p-value < 0.05; reject H_0.

26 0.062 to 0.178, higher proportion of Jordanians holding the view.

28 H_0: $\pi_1 - \pi_2 = 0$

H_1: $\pi_1 - \pi_2 \neq 0$

$p_1 = 0.74$, $n_1 = 1103$

$p_2 = 0.66$, $n_2 = 1065$

$$p = \frac{n_1 p_1 + n_2 p_2}{n_1 + n_2} = \frac{1519}{2168} = 0.700$$

$$z = \frac{p_1 - p_2}{\sqrt{p(1-p)\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} = \frac{0.74 - 0.66}{\sqrt{0.70(1 - 0.70)\left(\frac{1}{1103} + \frac{1}{1065}\right)}} = 4.06$$

p-value < 0.002. p-value < 0.05, reject H_0. There is a difference between the proportions of students agreeing with the statement (higher proportion in 2001).

Chapter 11

Solutions

2 a. $15.76 \le \sigma^2 \le 46.95$

b. $14.46 \le \sigma^2 \le 53.33$

c. $3.8 \le \sigma \le 7.3$

4 a. $n = 18$, $s^2 = 0.36$

$\chi^2_{0.05} = 27.587$ and $\chi^2_{0.95} = 8.672$ (17 degrees of freedom)

$$\frac{17(0.36)}{27.587} \le \sigma^2 \le \frac{17(0.36)}{8.672}$$

$0.22 \le \sigma^2 \le 0.71$

b. $0.47 \le \sigma \le 0.84$

6 a. $s^2 = 900$

b. $567 \le \sigma^2 \le 1690$

c. $23.8 \le \sigma \le 41.1$

8 a. $$\bar{x} = \frac{\Sigma x_i}{n} = 260.16$$

b. $$s^2 = \frac{\Sigma(x_i - \bar{x})^2}{n - 1} = 4996.8$$

$s = \sqrt{4996.8} = 70.69$

c. $\chi^2_{0.025} = 32.852$ and $\chi^2_{0.975} = 8.907$ (19 degrees of freedom)

$$\frac{(20 - 1)(4996.8)}{32.852} \le \sigma^2 \le \frac{(20 - 1)(4996.8)}{8.907}$$

$2890 \le \sigma^2 \le 10659$

$53.76 \le \sigma \le 103.24$

10 a. $\chi^2 = 24.39$, Degrees of freedom $= n - 1 = 14$

p-value is between 0.025 and 0.05. p-value ≤ 0.10, reject H_0. Conclude that variance exceeds maximum variance requirement.

b. $\chi^2_{0.05} = 23.685$ and $\chi^2_{0.95} = 6.571$ (14 degrees of freedom)

$0.00257 \le \sigma^2 \le 0.00928$

12 a. Try $n = 15$

$\chi^2_{0.025} = 26.119$ and $\chi^2_{0.975} = 5.629$ (14 degrees of freedom)

$5.86 \le \sigma \le 12.62$, therefore a sample size of 15 was used.

b. $n = 25$; expect the width of the interval to be smaller.

$\chi^2_{0.05} = 39.364$ and $\chi^2_{0.975} = 12.401$ (24 degrees of freedom), $6.25 \le \sigma \le 11.13$