A. Accessing Data Files

(a) $\chi^2 = 135.592$

(b) P-value = 0.000

(c) Reject $H_0$ since $P$-value = 0 < .05 = $\alpha$

B. Chi-Square Tests

• 9.36

(a) $df = 2$

(b) Reject $H_0$ if $\chi^2 > 5.99$

(c) 1. $H_A$: Model dress is related to magazine readership
   $H_0$: Model dress is not related to magazine readership

2. Using hand calculations and 3 tables (observed counts, expected counts, $\chi^2$ contributions), $\chi^2 = 80.874$

3. Reject $H_0$ since $\chi^2 = 80.874 > 5.99$

4. There is enough evidence to show that model dress is related to magazine readership.

(d) From MINITAB, $\chi^2 = 80.874$, $P$-value = 0.000

(e) Reject $H_0$ since $P$-value = 0 < .05 = $\alpha$

(f) $p_1$ = proportion of general interest ads which are not sexual
   $p_2$ = proportion of men's ads which are not sexual

   $\hat{p}_1 = \frac{248}{314} = .7898$  $\hat{p}_2 = \frac{514}{619} = .8304$

   From MINITAB: (-0.0944616, 0.0133363)

   Interpret: With 95% confidence, Between 9.45% fewer and 1.33% more general interest ads than men's ads are not sexual.

(g) The comparison in (f) does not reinforce the $\chi^2$ test. The $\chi^2$ test shows that model dress is related to readership generally but the CI doesn't affirm any specific difference between general interest ads and men's ads.

(continued)
(h) \( p_1 = \) proportion of women’s ads which are sexual
\( p_2 = \) proportion of men’s ads which are sexual

\[ \hat{p}_1 = \frac{225}{576} = 0.3906 \quad \hat{p}_2 = \frac{105}{619} = 0.1696 \]

From MINITAB: (0.171382, 0.270612)

Interpret: With 95% confidence,
Between 17.14% and 27.06% more women’s ads than men’s ads are sexual.

(i) The comparison in (h) does reinforce the \( \chi^2 \) test.
The \( \chi^2 \) test shows that model dress is related to readership generally and the CI identifies a specific difference.

(j) Here is the Table of \( \chi^2 \) Contributions from MINITAB:

<table>
<thead>
<tr>
<th>Model Dress</th>
<th>Women</th>
<th>Men</th>
<th>General Interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not sexual</td>
<td>12.835</td>
<td>7.227</td>
<td>1.162</td>
</tr>
<tr>
<td>Sexual</td>
<td>36.074</td>
<td>20.312</td>
<td>3.265</td>
</tr>
</tbody>
</table>

1. The General Interest/Not Sexual cell contributes the smallest \( \chi^2 \) value 1.162.
   Also Men/Not Sexual contributes a relatively small 7.227.
   So it’s not surprising that there are not significant differences between those two categories.

2. The Women/Sexual cell contributes the largest \( \chi^2 \) value 36.074.
   Also Men/Sexual contributes the second-largest value 20.312.
   So it’s not surprising to find significant differences between those two categories.

• 9.44

(a) Percent of over 40 laid off = 41/806 = .0508 = 5.08%
Percent of under 40 laid off = 7/511 = .0137 = 1.37%

(The \( \chi^2 \) test will show whether 5.08% and 1.37% are significantly different.)

(b) 1. \( H_A \): Age is related to being laid off
\( H_0 \): Age is not related to being laid off

2. Using hand calculations, \( \chi^2 = 12.303 \)

3. Reject \( H_0 \) since \( \chi^2 = 12.303 > 3.84 \)
4. There is enough evidence to show that age is related to being laid off.
9.45

(a)

1. \( H_A \): Age is related to Performance
   \( H_0 \): Age is not related to Performance

2. Using hand calculations, \( \chi^2 = 50.812 \)

3. Reject \( H_0 \) since \( \chi^2 = 50.812 > 5.99 \)

4. There is enough evidence to show that age is related to performance.

(b) Older employees do appear to perform less well: \( 230/758 = 30.3\% \) of them are in the lowest category, compared to \( 82/496 = 16.5\% \) of younger employees.

SE 9.8

(a)

1. \( H_A \): City and Income are related
   \( H_0 \): City and Income are not related

2. From MINITAB, \( \chi^2 = 3.955 \), \( P \)-value = 0.412

3. Fail to Reject \( H_0 \) since \( P \)-value = 0.412 > .05 = \( \alpha \)

4. There is not enough evidence to show that income is related to city.

(b) There are several pairs of proportions which support the \( \chi^2 \) test.
   Here is the pair of categories which have the smallest \( \chi^2 \) contributions (0.007 and 0.008):

   (i) \( p_1 = \) proportion of City 1 customers with income under $10,000
       \( p_2 = \) proportion of City 2 customers with income under $10,000

       \( \hat{p}_1 = \frac{70}{241} = .2905 \)
       \( \hat{p}_2 = \frac{62}{218} = .2844 \)

   (ii) From MINITAB: \[ (-0.0768405, 0.0889461) \]

       Interpret:

       We are 95% confident that between 7.68% fewer and 8.89% more City 1 customers than City 2 customers have incomes less than $10,000.

   (iii) The \( \chi^2 \) test does not show any differences in income distributions between City 1 and City 2 customers. The CI confirms this in particular for the lowest income bracket.
C. Two Means

- 7.60

(a) The two samples are independent.
\[ \mu_1 = \text{mean satisfaction score for employees with new monitors} \]
\[ \mu_2 = \text{mean satisfaction score for employees with standard monitors} \]

From MINITAB, a 95% CI for \((\mu_1 - \mu_2)\) is
\((-0.022, 2.422)\)

Interpret:

We are 95% confident that employees using new monitors average between 0.022 points lower satisfaction and 2.422 points higher satisfaction than employees using standard monitors.

(b) No, since 0 is contained in the confidence interval.

- SE 7.20

\[ \mu_1 - \mu_2 = 0 \implies \mu_1 = \mu_2 \]

\((\text{no difference})\)

1. \(\mu_1 = \text{mean change in score after six months by children who took piano lessons}\)
\[ \mu_2 = \text{mean change in score after six months by children who didn’t take piano lessons}\]
\[ H_A: \mu_1 > \mu_2 \]
\[ H_0: \mu_1 \leq \mu_2 \]

2. \(t = 5.06\) \(P\)-value = \(0.000\)

3. Reject \(H_0\) since
\[ P\text{-value} = 0 < 0.05 = \alpha \]

4. There is conclusive evidence that piano lessons increase children’s scores, on average.

- SE 7.21

95% CI for \((\mu_2 - \mu_1): (-4.508, -1.954)\)

Interpret:

We are 95% confident that piano lessons improve children’s scores by between 1.95 and 4.51 points, on average.

- 7.10

The two drink samples are paired by subject.

1. \(\mu_1 = \text{mean rating of Drink A}\)
\[ \mu_2 = \text{mean rating of Drink B} \]
\[ H_A: \mu_1 \neq \mu_2 \]
\[ H_0: \mu_1 = \mu_2 \]

2. \(t = 0.41\) \(P\)-value = \(0.702\)

3. Fail to Reject \(H_0\) since
\[ P\text{-value} = 0.702 > 0.05 = \alpha \]

4. There isn’t enough evidence to show a difference in mean rating between the two drinks.
• 7.11
95% CI for \((\mu_1 - \mu_2)\) = \((-5.74, 7.74)\)

Interpret:
We are 95% confident that Drink A’s mean rating is between 5.74 less than and 7.74 more than Drink B’s mean rating.

• 7.45

(a) and (b)

1. \(\mu_1\) = mean mpg calculated by car’s computer
   \(\mu_2\) = mean mpg calculated by driver
   
   \(H_A: \mu_1 \neq \mu_2\)
   \(H_0: \mu_1 = \mu_2\)

2. \(t = \fbox{4.36}\) \(P\)-value = \fbox{0.000}\)
3. Reject \(H_0\) since \(P\)-value = 0 < .05 = \(\alpha\)

4. There is conclusive evidence that the mean mpg calculated by the computer and driver differ.

(c) 95% CI’s:

* Computer: (41.104, 45.236)
* Driver: (38.29, 42.59)
* Difference: (1.419, 4.041)

(d) True

• 7.47

The samples are paired by plot of land.

1. \(\mu_1\) = mean yield of Variety A tomatoes, in pounds
   \(\mu_2\) = mean yield of Variety B tomatoes, in pounds
   
   \(H_A: \mu_1 > \mu_2\)
   \(H_0: \mu_1 \leq \mu_2\)

2. \(t = \fbox{1.41}\) \(P\)-value = \fbox{0.096}\)
3. Fail to Reject \(H_0\) since \(P\)-value = 0.096 > 0.05 = \(\alpha\)

4. There is not conclusive evidence that Variety A has a higher mean yield than Variety B.
7.89

(a) 1. $\mu_1 =$ mean ego strength of high-fitness professors
   $\mu_2 =$ mean ego strength of low-fitness professors

   $H_A: \mu_1 \neq \mu_2$
   $H_0: \mu_1 = \mu_2$

2. $t = 8.23$  $P$-value $= 0.000$

3. Reject $H_0$ since $P$-value $= 0 < .01 = \alpha$

4. There is overwhelming evidence to show that high-fitness professors and low-fitness professors differ in mean ego strength.

(b) 99% CI: (1.174, 2.405)

(c) The study shows that ego strength generally depends on the fitness level of college faculty. In fact, the mean ego strength of high-fitness professors exceeds that for low-fitness professors by between 1.17 and 2.41 points.

7.46

(a) and (c)

1. $\mu_1 =$ mean pre-test score on Spanish test for executives
   $\mu_2 =$ mean post-test score on Spanish test for executives

   $H_A: \mu_1 < \mu_2$
   $H_0: \mu_1 \geq \mu_2$

2. $t = -2.02$  $P$-value $= 0.029$

3. For $\alpha = .05$, Reject $H_0$ since $P$-value $= 0.029 < .05 = \alpha$

   • For $\alpha = .01$, Fail to Reject $H_0$ since $P$-value $= 0.029 > .01 = \alpha$

4. There is sufficient evidence to show that intensive training improves average Spanish scores for executives at a 5% significance level but not sufficient evidence at a 1% level.

(c) 90% CI: $(-2.689, -0.211)$

Interpret:

We are 90% confident that intensive training improves Spanish scores for executives by between 0.21 and 2.69 points, on average.
If the loaves of bread are measured as described in this exercise, the samples are independent since each measurement is made on a different loaf.

(a)

1. \( \mu_1 = \text{avg. amount of Vitamin C in loaves of bread immediately after baking, in milligrams/100 grams} \)

   \( \mu_2 = \text{avg. amount of Vitamin C in loaves of bread three days after baking, in milligrams/100 grams} \)

   \[ H_A: \mu_1 > \mu_2 \]
   \[ H_0: \mu_1 \leq \mu_2 \]

2. \( t = 22.16 \) \( P\text{-value} = 0.014 \)

3. Reject \( H_0 \) since \( P\text{-value} = 0.014 < .05 = \alpha \).

4. There is sufficient evidence to show that bread loses Vitamin C in the three days immediately after baking, on average.

(b) A 90% confidence interval for \((\mu_1 - \mu_2)\) is

\[ (19.24, 34.58) \]

Interpret:
We are 90% confident that loaves of bread lose between 19.24 and 34.58 mg/100g of Vitamin C on average in the three days immediately after baking.
If the loaves of bread are measured as described in this exercise, the samples are paired by the loaves of bread, each of which is measured twice.

\[ \begin{align*}
\text{Loaf 1} & \quad \begin{cases} 
\kappa_1 = \text{Vitamin C measured immediately} \\
\kappa_2 = \text{Vitamin C measured after 3 days}\end{cases} \{ \text{Pair 1} \\
\text{Loaf 2} & \quad \begin{cases} 
\kappa_1 \\
\kappa_2 \end{cases} \{ \text{Pair 2}
\end{align*} \]

(a)

1. \( \mu_1 = \text{avg. amount of Vitamin C in loaves of bread immediately after baking, in milligrams/100 grams} \)

\( \mu_2 = \text{avg. amount of Vitamin C in loaves of bread three days after baking, in milligrams/100 grams} \)

\[ H_A: \mu_1 > \mu_2 \]
\[ H_0: \mu_1 \leq \mu_2 \]

2. \( t = 49.83 \quad P\text{-value} = 0.006 \)

3. Reject \( H_0 \) since \( P\text{-value} = 0.006 < .05 = \alpha \).

4. There is sufficient evidence to show that bread loses Vitamin C in the three days immediately after baking, on average.

(b) A 90% confidence interval for \( (\mu_1 - \mu_2) \) is

\( (23.501, 30.319) \)

Interpret:

We are 90% confident that loaves of bread lose between 23.5 and 30.3 mg/100g of Vitamin C on average in the three days immediately after baking.
D. Additional

(1)

(a) The answer is (B)

(b) Reject $H_0$ since $P$-value $= 0.034 < 0.05 = \alpha$

(c) There is enough evidence to show that the average price of diesel exceeds the average price of regular gas at Iowa service stations on Sept. 30, 2015.

(2)

(a) The answer is (B)

(b) The answer is (A)