Answers

Chapter 1

Sections 1.1–1.2

1.1 **(a)** Descriptive. **(b)** Inferential. **(c)** Inferential. **(d)** Inferential. **(e)** Descriptive. **(f)** Descriptive.

1.2 **(a)** Descriptive. **(b)** Inferential. **(c)** Descriptive. **(d)** Inferential. **(e)** Descriptive.

1.3 **(a)** Open heart patients operated on in the last year. **(b)** 30 patients selected. **(c)** Length of stay.

1.4 **(a)** People who wear T-shirts. **(b)** 50 people selected. **(c)** Whether they cut off the tag or not.

1.5 Population: employees at Citigroup Inc. Sample: 35 employees selected.

1.6 Population: Texas residents. Sample: 500 people from Texas selected.

1.7 Population: 10,000 families affected by the flood. Sample: 75 affected families selected.

1.8 **(a)** Population: All people who purchase a dining room table. Sample: 5 people selected at random. Probability question. **(b)** Population: All people entering the rest area and food court. Sample: 25 people selected. Statistics question. **(c)** Population: All people who use the slide. Sample: 50 people selected at random. Probability question. **(d)** Population: All doors that open automatically. Sample: 100 doors selected. Statistics question. **(e)** Population: All people entering LAX. Sample: 1000 people selected. Statistics question. **(f)** Population: All women. Sample: 34 selected. Probability question. **(g)** Population: Two populations - two types of nursing homes. Sample: Several nursing homes selected. Statistics question.

1.9 **(a)** Population: all cheddar cheeses. Sample: 20 cheddar cheeses selected. **(b)** Probability question: What is the probability at least 10 of the cheddar cheeses selected are aged less than two years? Statistics questions: Suppose 12 of the cheddar cheeses selected are aged less than two years. Does this suggest that the true proportion of all cheddars aged less than two years has decreased?

1.10 **(a)** Population: All television households in the United States. Sample: 500 TV households selected. **(b)** Probability question: What is the probability at most 400 of the TV households selected have at least one DVD player? Statistics question: Estimate the true proportion of TV households that have at least one DVD player.

1.11 **(a)** Population: All Americans. **(b)** Sample: 1000 Americans selected. **(c)** Variable: Whether or not each believes sharks are dangerous.

1.12 **(a)** Population: All American companies. **(b)** Sample: 75 companies selected. **(c)** Variable: Whether each company has overseas IT workers. **(d)** Probability question: What is the probability exactly 30 of the 75 companies selected have overseas IT workers? Statistics question: Use the resulting data to determine if there is evidence the proportion of companies with overseas IT workers has changed.

1.13 Population: All shampoos. Sample: 20 shampoos selected. Variable: Amount of sulfur in each shampoo.

1.14 Population: People diagnosed with hepatitis C. Sample: 50 patients selected. Variable: Liver enzyme levels.

1.15 **(a)** Population: All Bounty paper towel rolls. **(b)** Sample: 35 rolls selected. **(c)** Variable: Amount of absorption.

Section 1.3

1.16 **(a)** Observational study. **(b)** Sample: The students who respond to the questions. **(c)** Not a random sample, only one dorm.

1.17 **(a)** Observational study. **(b)** Sample: 25 volunteer fire companies selected. **(c)** Not a random sample, *largest* companies selected.

1.18 **(a)** Population: All 12-ounce bottles of soda. Sample: The bottles selected. **(b)** Yes, a simple random sample.

1.19 Assign a number to each shipped weather station. Select numbers using a random number generator and examine each weather station corresponding to the numbers selected.

1.20 **(a)** Observational study. **(b)** Population: All Massachusetts State Police. Sample: 12 officers selected. **(c)** Not a random sample, only 1 shift considered.

1.21 **(a)** Population: All men who use a disposable razor. Sample: 100 men selected. **(b)** Not a random sample. Just selected men observed buying a razor.

1.22 Obtain a list of people who have purchased this product, and assign a number to each person. Randomly select numbers from a random number table or random number generator, and ask each corresponding customer how long it took to set up the fence.

1.23 Assign a number to each challenge. Randomly select numbers from a random number table or random number generator.

1.24 **(a)** Assign a number to each mile-long stretch. Randomly select numbers from a random number table or random number generator. **(b)** Observational study.

1.25 **(a)** Experimental study. **(b)** Variable: Lifetime of each blossom. **(c)** Flip a coin: heads is treated, tails is untreated.

1.26 **(a)** Experimental study. **(b)** Variable: Which car is most comfortable. **(c)** Conversation with the driver, peeking, sound of the engine, legroom.

1.27 **(a)** Population: All ceramic tile from this manufacturer. Sample: 25 tiles selected. **(b)** Not a random sample. All tiles from the same box.

1.28 **(a)** Observational study. **(b)** Variables: proportion of white feathers, proportion of down, proportion of other components. **(c)** Randomly select stores from around the country that sell comforters. Visit the selected stores, and randomly purchase comforters on display.

Chapter 2

Section 2.1

2.1 **(a)** Numerical, continuous. **(b)** Numerical, discrete. **(c)** Categorical. **(d)** Numerical, discrete. **(e)** Numerical, continuous. **(f)** Categorical.

2.2 **(a)** Numerical, continuous. **(b)** Numerical, discrete. **(c)** Numerical, continuous. **(d)** Numerical, continuous. **(e)** Categorical. **(f)** Categorical.

2.3 **(a)** Numerical, discrete. **(b)** Numerical, discrete. **(c)** Categorical. **(d)** Numerical, continuous. **(e)** Numerical, continuous. **(f)** Categorical.

2.4 **(a)** Numerical, discrete. **(b)** Numerical, continuous. **(c)** Categorical. **(d)** Categorical. **(e)** Categorical. **(f)** Numerical, discrete.

2.5 **(a)** Continuous. **(b)** Continuous. **(c)** Discrete. **(d)** Continuous. **(e)** Continuous. **(f)** Discrete.

2.6 **(a)** Continuous. **(b)** Continuous. **(c)** Discrete. **(d)** Continuous. **(e)** Continuous. **(f)** Discrete.

2.7 **(a)** Continuous. **(b)** Discrete. **(c)** Discrete. **(d)** Continuous. **(e)** Discrete. **(f)** Discrete.

2.8 **(a)** Continuous. **(b)** Discrete. **(c)** Continuous. **(d)** Discrete. **(e)** Categorical. **(f)** Categorical.

2.9 **(a)** Discrete. **(b)** Categorical. **(c)** Continuous. **(d)** Continuous. **(e)** Categorical. **(f)** Continuous.

Section 2.2

2.10

Category	Frequency	Relative Frequency
Comedy	7	0.1667
Drama	10	0.2381
Educational	3	0.0714
Reality	7	0.1667
Soap	10	0.2381
Sports	5	0.1190
Total	42	1.0000

2.11

Art	Frequency	Relative Frequency
Abstract	15	0.3571
Expressionist	6	0.1429
Realist	12	0.2857
Surrealist	9	0.2143
Total	42	1.0000

2.12

Class	Frequency	Relative Frequency
Bally's	40	0.200
Caesars	25	0.125
Harrah's	32	0.160
Resorts	22	0.110
Sands	25	0.125
Trump Plaza	56	0.280
Total	200	1.000

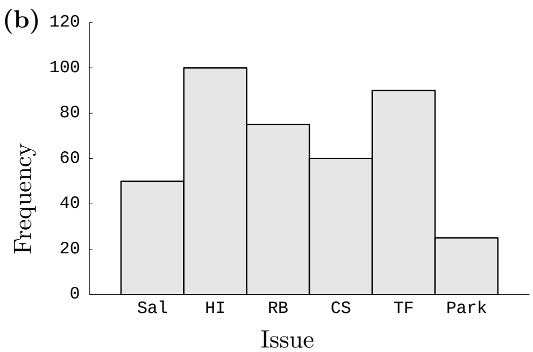
(a) 200 **(b)** Trump Plaza: largest (relative) frequency.

2.13

(a)

Issue	Frequency	Relative Frequency
Salary	50	0.1250
Health Insurance	100	0.2500
Retirement Benefits	75	0.1875
Class Size	60	0.1500
Temporary Faculty	90	0.2250
Parking	25	0.6250
Total	400	1.0000

(b)

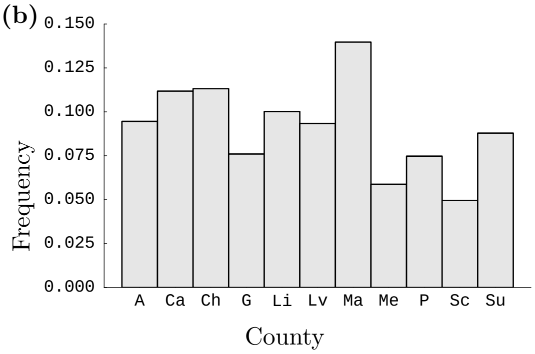


2.14

(a)

County	Frequency	Relative Frequency
Adair	915	0.0946
Carroll	1081	0.1118
Chariton	1095	0.1132
Grundy	735	0.0760
Linn	969	0.1002
Livingston	903	0.0934
Macon	1351	0.1397
Mercer	569	0.0588
Putnam	723	0.0748
Schuyler	480	0.0496
Sullivan	850	0.0879
Total	9671	1.0000

(b)

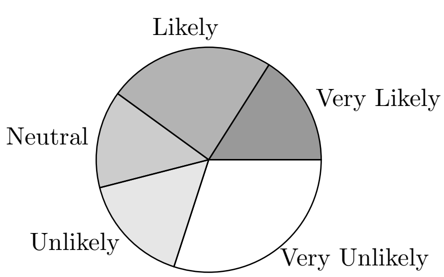


2.15

(a)

Answer	Frequency	Relative Frequency
VL	8	0.16
L	12	0.24
N	7	0.14
U	8	0.16
VU	15	0.30
Total	50	1.00

(b)

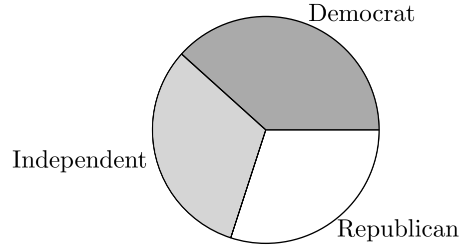


2.16

(a)

Political affiliation	Frequency	Relative Frequency
D	23	0.3833
I	19	0.3167
R	18	0.3000
Total	60	1.0000

(b)

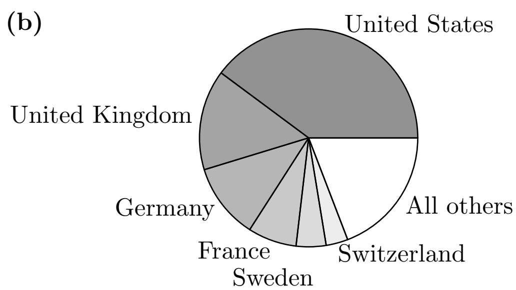


2.17

(a)

Country	Frequency	Relative Frequency
United States	270	0.3982
United Kingdom	101	0.1490
Germany	76	0.1121
France	49	0.0723
Sweden	30	0.0442
Switzerland	22	0.0324
All others	130	0.1917
Total	678	1.0000

(b)

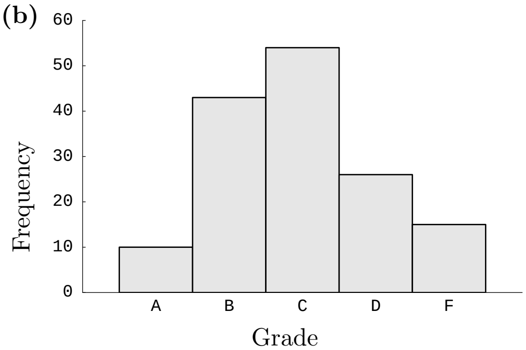


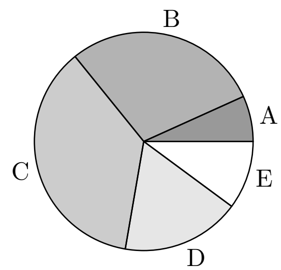
2.18

(a)

Grade	Frequency	Relative frequency
A	10	0.0676
B	43	0.2905
C	54	0.3549
D	26	0.1757
F	15	0.1014
Total	148	1.0000

(b)





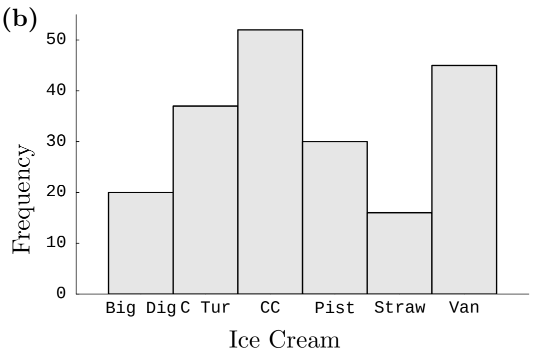
(c) 148; 0.8986

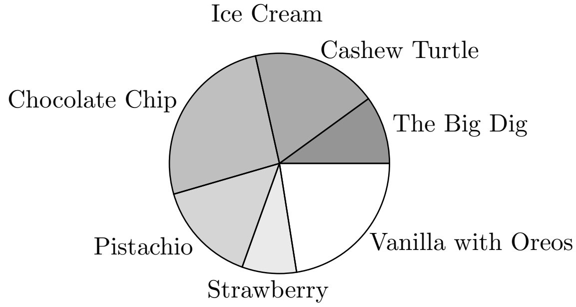
2.19

(a)

Ice Cream	Frequency	Relative frequency
The Big Dig	20	0.100
Cashew Turtle	37	0.185
Chocolate Chip	52	0.260
Pistachio	30	0.150
Strawberry	16	0.080
Vanilla with Oreos	45	0.225
Total	200	1.000

(b)





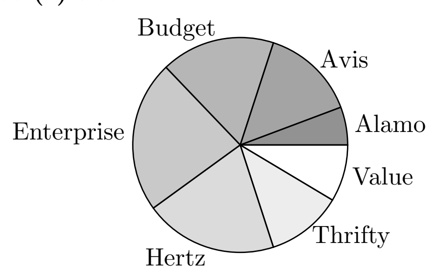
2.20

(a)

Agency	Frequency	Relative frequency
Alamo	10	0.0571
Avis	25	0.1429
Budget	30	0.1714
Enterprise	40	0.2286
Hertz	35	0.2000
Thrifty	20	0.1143
Value	15	0.0857
Total	175	1.0000

(b) 175 **(c)** 0.5714

(d)

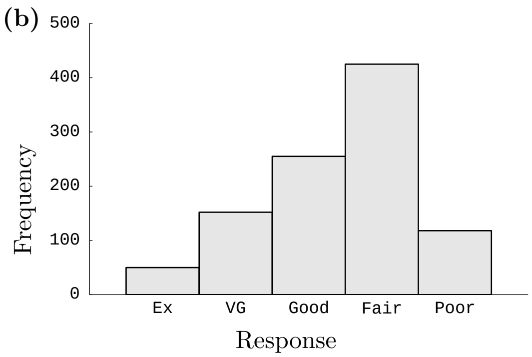


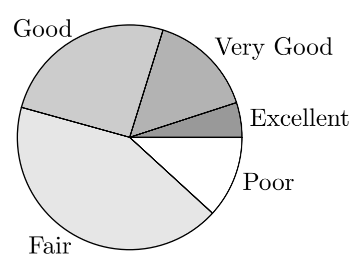
2.21

(a)

Response	Frequency	Relative frequency
Excellent	50	0.0500
Very Good	152	0.1520
Good	255	0.4250
Fair	425	0.4250
Poor	118	0.1180
Total	1000	1.0000

(b)





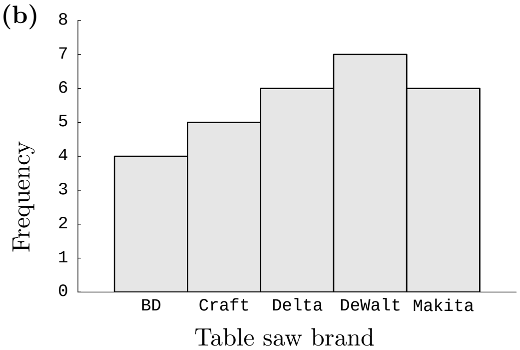
(c) 0.7980

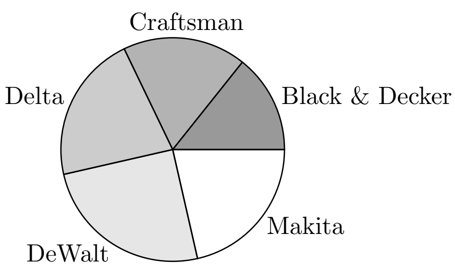
2.22

(a)

Table saw brand	Frequency	Relative frequency
B & D	4	0.1429
Craftsman	5	0.1786
Delta	6	0.2143
DeWalt	7	0.2500
Makita	6	0.2143
Total	28	1.0000

(b)



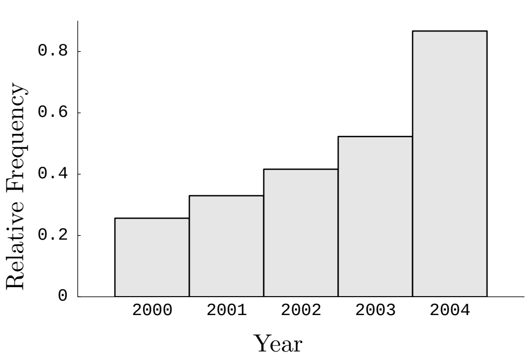


(c) 0.3214 **(d)** 0.7857

2.23

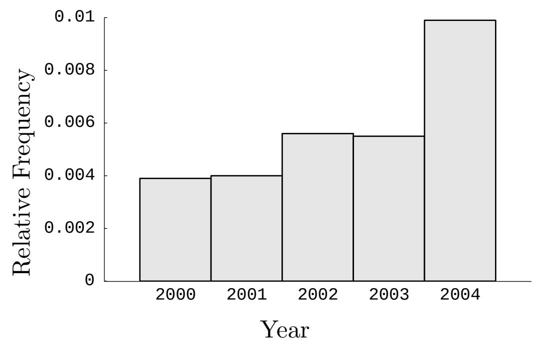
(a)

Year	Relative frequency
2000	0.2564
2001	0.3298
2002	0.4162
2003	0.5229
2004	0.8671



(b)

Year	Relative frequency
2000	0.0039
2001	0.0040
2002	0.0056
2003	0.0055
2004	0.0099



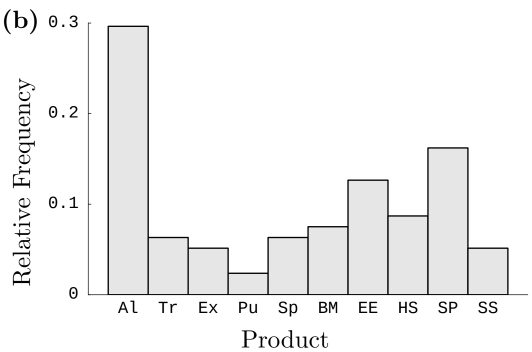
(c) Both graphs show an increase, each with a large jump in 2004.

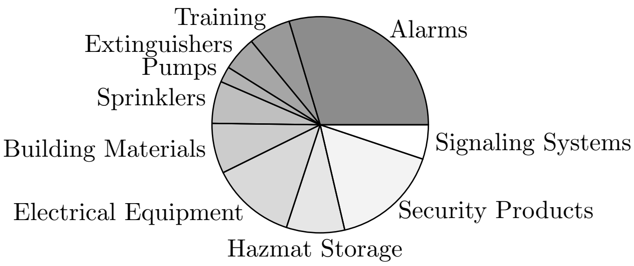
2.24

(a)

Product	Frequency
Alarms	75
Training	16
Extinguishers	13
Pumps	6
Sprinklers	16
Building Materials	19
Electrical Equipment	32
Hazmat Storage	22
Security Products	41
Signaling Systems	13

(b)



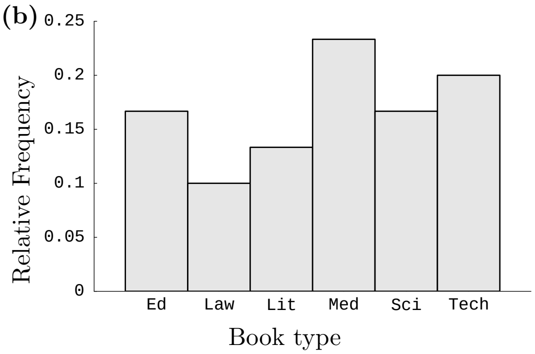


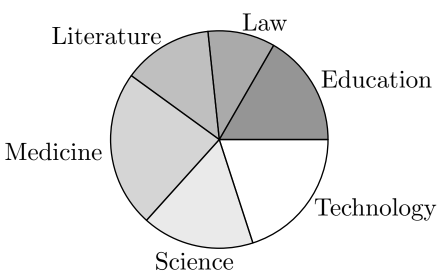
2.25

(a)

Book type	Frequency	Relative frequency
Education	5	0.1667
Law	3	0.1000
Literature	4	0.1333
Medicine	7	0.2333
Science	5	0.1667
Technology	6	0.2000

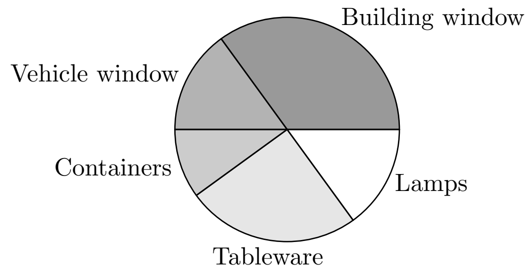
(b)

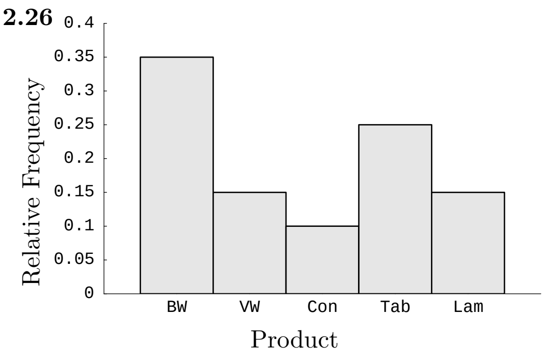




(c) Perhaps medicine. However, no book type is overwhelmingly borrowed.

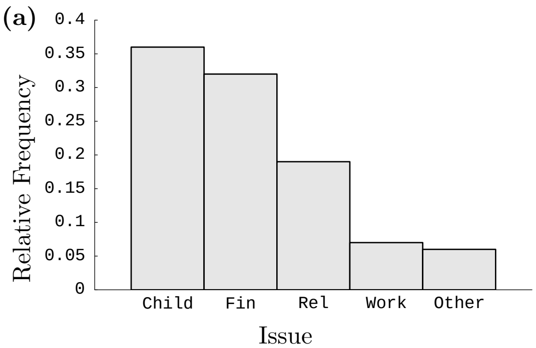
2.26

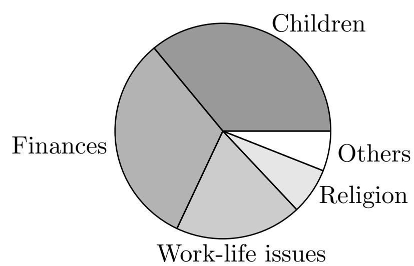




2.27

(a)





(b)

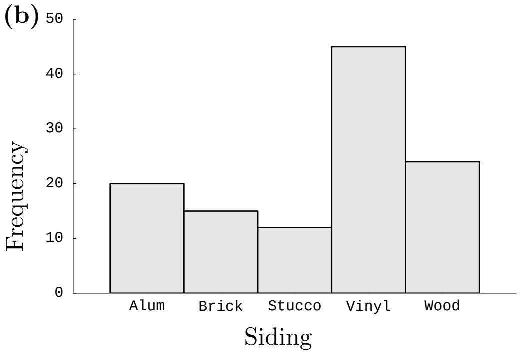
Issue	Frequency
Children	361
Finances	321
Religion	190
Work-life issues	70
Others	60

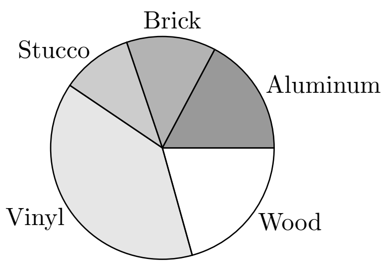
2.28

(a)

Siding	Relative frequency
Aluminum	0.1724
Brick	0.1293
Stucco	0.1034
Vinyl	0.3879
Wood	0.2069

(b)



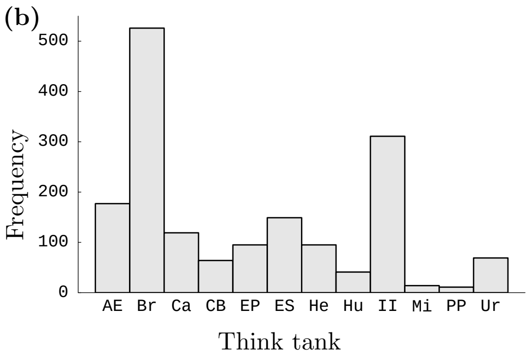


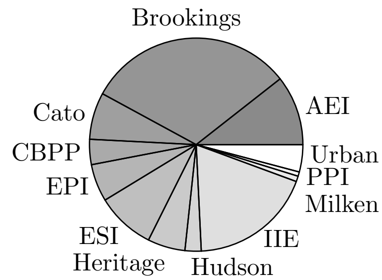
2.29

(a)

Think tank	Relative frequency
AEI	0.1059
Brookings	0.3148
Cato	0.0712
CBPP	0.0383
EPI	0.0569
ESI	0.0892
Heritage	0.0569
Hudson	0.0245
IIE	0.1861
Milken	0.0084
PPI	0.0066
Urban	0.0413

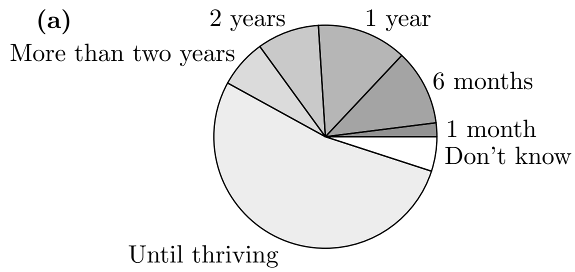
(b)





2.30

(a)



(b)

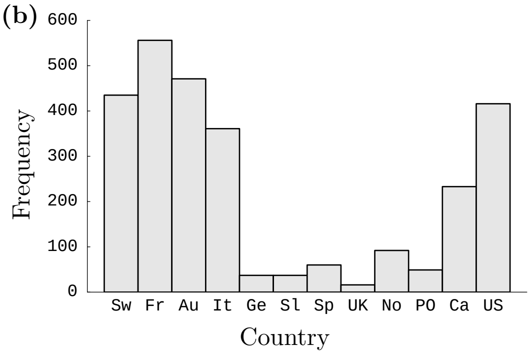
Length of time	Frequency
One month	21
Six months	115
One year	136
Two years	94
More than two years	73
Until thriving	553
Don't know	52

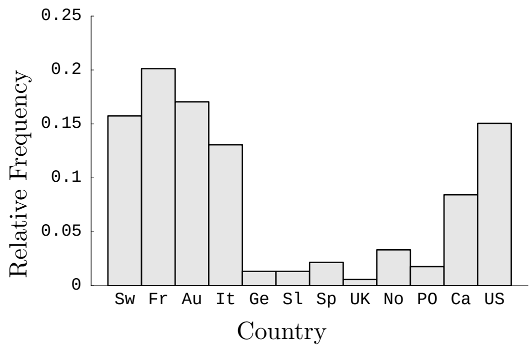
2.31

(a)

Country	Relative frequency
Switzerland	0.1574
France	0.2012
Austria	0.1705
Italy	0.1307
Germany	0.0134
Slovakia	0.0134
Spain	0.0217
United Kingdom	0.0058
Norway	0.0333
Poland	0.0177
Canada	0.0843
United States	0.1506

(b)

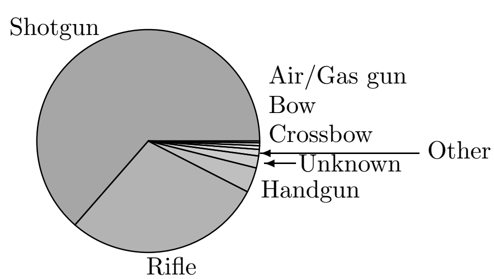




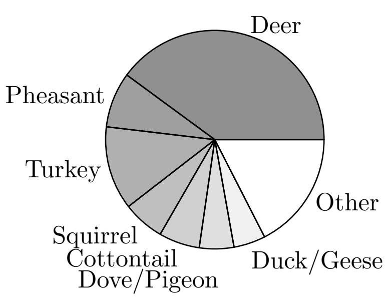
The graphs are the same except for the scale (label) on the vertical axis.

2.32

(a)



(b)



(c) No. These two tables do not show the weapon *and* the game involved with each injury.

2.33

(a)

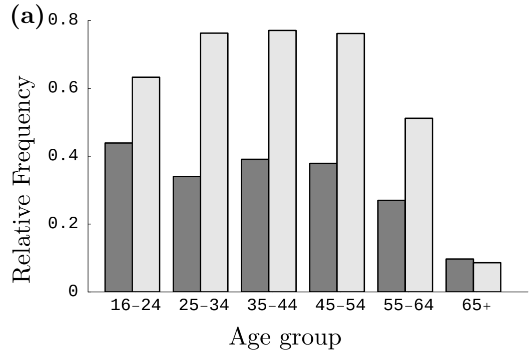
Rating	Men relative frequency	Women relative frequency
Excellent	0.1840	0.2333
Very Good	0.2750	0.2500
Good	0.2130	0.1100
Fair	0.2250	0.2400
Poor	0.1030	0.1667

(b)

(c) The total number of men who responded is different from the total number of women who responded.

2.34

(a)



(b) No. We do not know the frequency in each age group.

Section 2.3

2.35

2	79
3	
3	5666 9
4	112
4	779
5	01124
5	57789
6	1444
6	68
7	1

Stem: ones; Leaf: tenths.

The center of the data is between 5.0 and 5.5. A typical value is 5.2.

2.36

10	58
11	556
12	3477
13	
14	5899
15	168
16	01224449
17	0445689
18	24
19	56699
20	1
21	7

Stem: hundreds and tens; Leaf: ones.

2.37

53	0344
53	799
54	111344
54	566677777889
55	112334
55	67777
56	002
56	9

Stem: hundreds and tens; Leaf: ones.

The center of the data is between 545 and 550. A typical value is 547.

2.38

4	7
5	2
6	
7	048
8	47
9	34567888
10	00345
11	046799
12	17
13	
14	02

Stem: thousands and hundreds; Leaf: tens.

Outliers: 474, 520, 1408, 1424

2.39 **(a)** 543, 543, 549. **(b)** 574 **(c)** The data tails off slowly on the low end. **(d)** There do not appear to be any outliers.

2.40

(a)

1	356677
2	014445577889
3	0011222444678
4	
5	0

Stem: thousands; Leaf: hundreds.

(b)

13	90
14	
15	05
16	45 45
17	17 19
18	
19	
20	67
21	19
22	
23	
24	30 49 97
25	73 84
26	
27	30 67
28	40 44
29	91
30	21 24
31	24 92
32	15 28 92
33	
34	26 66 69
35	
36	64
37	39
38	30
39	
40	
41	
42	
43	
44	
45	
46	
47	
48	
49	
50	86

Stem: thousands and hundreds; Leaf: tens and ones.

(c) Neither plot presents a very good picture of the distribution. The first is too compact, and the second is very spread out. The second plot is slightly better.

2.41

(a)

0	4
1	16
2	12779
3	3449
4	0111125555799
5	699
6	023444
7	0123679
8	258
9	3

Stem: ones; Leaf: tenths.

(b)

0	4
1	16
2	12779
3	3449
4	0111125555799
5	699
6	023444
7	0123679
8	258
9	3

Stem: ones; Leaf: tenths.

(c) These two graphs are identical. Typical value is 4.5.

2.42

(a)

6	899
7	013455667777889
8	000011111122222333333444444566789
9	1

Stem: tens; Leaf: ones.

(b)

6	899
7	0134
7	55667777889
8	000011111122222333333444444
8	566789
9	1

Stem: tens; Leaf: ones.

(c) The second plot is better: two more stems, presents a better picture of the shape of the distribution.

2.43

(a)

Lower floors		Upper floors
	10	14
	10	
4300	11	1
998877777776666665555	11	55578
333332221111111110000000	12	1244
665	12	55556777899
0	13	122234
	13	567888999
	14	02234
	14	5888
	15	244

(b) The lower floors distribution is more compact and has, on average, smaller values. The upper floors distribution has more variability and has, on average, larger values.

2.44

(a)

33	5
34	
35	
36	3
37	022488
38	12345556
39	024555777
40	0122235689
41	02233445
42	2267
43	26
44	2

Stem: hundreds and tens;
Leaf: ones.

(b) Typical value: 400. One outlier: 335.

2.45

(a)

1	00699
2	244557
3	11245678899
4	000011555669
5	2259
6	8
7	1

Stem: tens; Leaf: ones.

(b) Typical value: 32. No outliers.

2.46

(a)

86	35
87	26
88	033699
89	0014566799
90	00012222799
91	002379
92	23345
93	0
94	2
95	8

Stem: ones and tenths;
Leaf: hundredths.

(b) Unimodal, approximately symmetric, no outliers.

2.47

(a)

2	135667
3	13456777788999
4	0001122355
5	002245566
6	
7	
8	0

Stem: tens; Leaf: ones.

(b) Typical value: 40. One outlier: 80.

2.48

(a)

6	57
7	467
8	5679
9	1226
10	27889
11	1114559
12	235889
13	47
14	4
15	6
16	01
17	1
18	
19	4
20	2

Stem: ones and tenths;
Leaf: hundredths.

(b) Unimodal, positively skewed, lots of variability.
(c) Typical lifetime: 11.5. Outliers: 19.4, 20.2.

2.49

(a)

308	0
309	
310	89
311	27
312	3799
313	122
314	16778
315	12222479
316	17
317	7
318	6
319	3

Stem: tens, ones, and tenths; Leaf: hundredths.

(b) Typical time: 31.47. Little chance of winning. Only three winning times 31.70 or greater. **(c)** Split between ones place and the tenths place: no, only two stems. Split between tens place and the ones place: no, only one stem.

2.50

(a)

With		Without
	250	24
	251	
84	252	145
3	253	788
63	254	49
8742221	255	023
9866653110	256	149
873	257	1248
6553	258	23367
4	259	3
	260	26
	261	2
	262	3

Stem: hundreds, tens, and ones;
Leaf: tenths.

(b) With distribution: unimodal, compact, approximately symmetric. Without distribution: unimodal, lots of variability, slightly positively skewed. It appears the humidifier does help a piano stay in tune. The With humidifier distribution is more compact and centered near 256.

2.51

(a)

3	5
3	67
3	88889999
4	000011
4	22223333
4	4444445555555
4	666677777777
4	889
5	001
5	23
5	
5	66

Stem: ones; Leaf: tenths.

(b) Yes. All durations are between 3 and 6 seconds, and a typical duration is near 4.5.

2.52

(a)

0	899
1	0
1	333
1	455
1	67777
1	8
2	001
2	233
2	45
2	
2	
3	
3	3

Stem: tens; Leaf: ones.

(b) Typical weight: 17. One outlier: 33.

Section 2.4

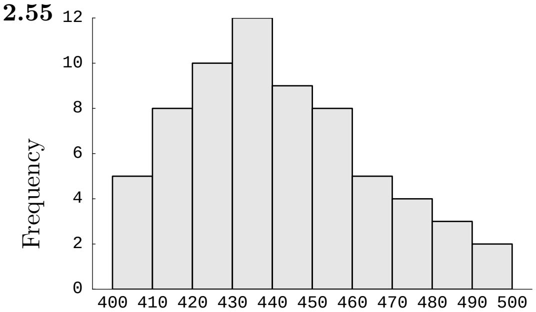
2.53

Class	Frequency	Relative frequency	Cumulative relative frequency
78–80	2	0.050	0.050
80–82	4	0.100	0.150
82–84	4	0.100	0.250
84–86	4	0.100	0.350
86–88	9	0.225	0.575
88–90	6	0.150	0.725
90–92	9	0.225	0.950
92–94	2	0.050	1.000
Total	40	1.000	

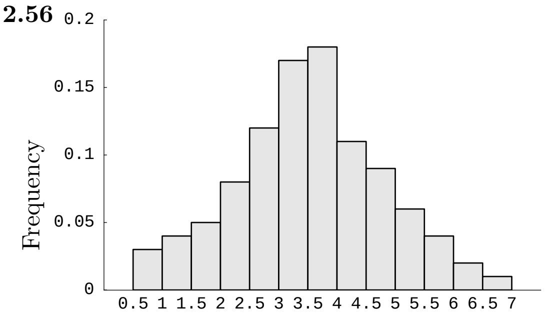
2.54

Class	Frequency	Relative frequency	Cumulative relative frequency
20–22	3	0.06	0.06
22–24	7	0.14	0.20
24–26	22	0.44	0.64
26–28	16	0.32	0.96
28–30	2	0.04	1.00
Total	50	1.00	

2.55



2.56



2.57

Class	Frequency	Relative frequency	Cumulative relative frequency
100–150	155	0.1938	0.1938
150–200	120	0.1500	0.3438
200–250	130	0.1625	0.5063
250–300	145	0.1813	0.6875
300–350	150	0.1875	0.8750
350–400	100	0.1250	1.0000
Total	800	1.0000	

2.58

Class	Frequency	Relative frequency	Cumulative relative frequency
1.0–1.1	15	0.0500	0.0500
1.1–1.2	20	0.0667	0.1167
1.2–1.3	45	0.1500	0.2667
1.3–1.4	65	0.2167	0.4833
1.4–1.5	75	0.2500	0.7333
1.5–1.6	35	0.1167	0.8500
1.6–1.7	25	0.0833	0.9333
1.7–1.8	20	0.0667	1.0000
Total	300	1.0000	

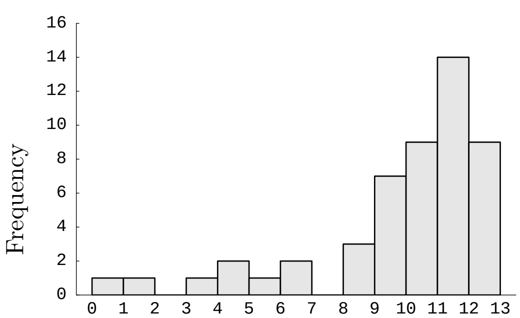
2.59

Class	Frequency	Relative frequency	Cumulative relative frequency
0–25	150	0.150	0.150
25–50	200	0.200	0.350
50–75	175	0.175	0.525
75–100	150	0.150	0.675
100–125	125	0.125	0.800
125–150	100	0.100	0.900
150–175	75	0.075	0.975
175–200	25	0.025	1.000
Total	1000	1.000	

2.60

(a)

Class	Frequency	Relative frequency	Cumulative relative frequency
0–1	1	0.02	0.02
1–2	1	0.02	0.04
2–3	0	0.00	0.04
3–4	1	0.02	0.06
4–5	2	0.04	0.10
5–6	1	0.02	0.12
6–7	2	0.04	0.16
7–8	0	0.00	0.16
8–9	3	0.06	0.22
9–10	7	0.14	0.36
10–11	9	0.18	0.54
11–12	14	0.28	0.82
12–13	9	0.18	1.00
Total	50	1.00	

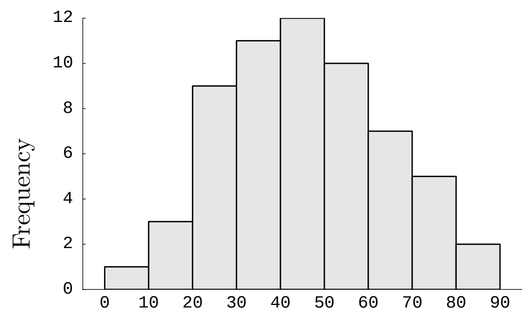


(b) Unimodal, negatively skewed. Two possible outliers: 0.5, 1.9

2.61

(a)

Class	Frequency	Relative frequency	Cumulative relative frequency
0–10	1	0.0167	0.0167
10–20	3	0.0500	0.0667
20–30	9	0.1500	0.2167
30–40	11	0.1833	0.4000
40–50	12	0.2000	0.6000
50–60	10	0.1667	0.7667
60–70	7	0.1167	0.8833
70–80	5	0.0833	0.9667
90–100	2	0.0333	1.0000
Total	60	1.0000	

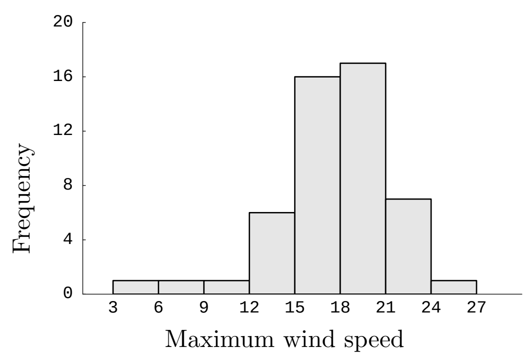


(b) Unimodal, symmetric, bell-shaped. **(c)** $M \approx 45$ **(d)** $Q_1 \approx 31.8$ **(e)** $Q_3 \approx 58.9$

2.62

(a)

Class	Frequency	Relative frequency	Cumulative relative frequency
3–6	1	0.02	0.02
6–9	1	0.02	0.04
9–12	1	0.02	0.06
12–15	6	0.12	0.18
15–18	16	0.32	0.50
18–21	17	0.34	0.84
21–24	7	0.14	0.98
24–27	1	0.02	1.00
Total	50	1.00	

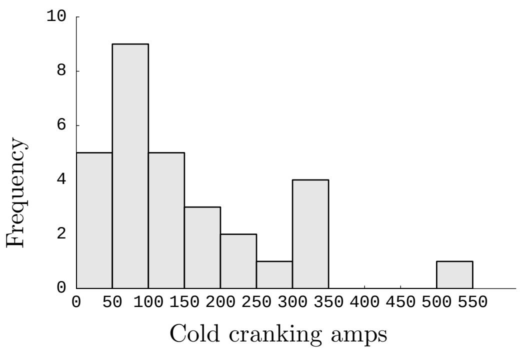


(b) Approximately symmetric. One possible outlier: 3.

2.63

(a)

Class	Frequency	Relative frequency	Cumulative relative frequency
0–50	5	0.1667	0.1667
50–100	9	0.3000	0.4667
100–150	5	0.1667	0.6333
150–200	3	0.1000	0.7333
200–250	2	0.0667	0.8000
250–300	1	0.0333	0.8333
300–350	4	0.1333	0.9667
350–400	0	0.0000	0.9667
400–450	0	0.0000	0.9667
450–500	0	0.0000	0.9667
500–550	1	0.0333	1.0000
Totals	30	1.0000	

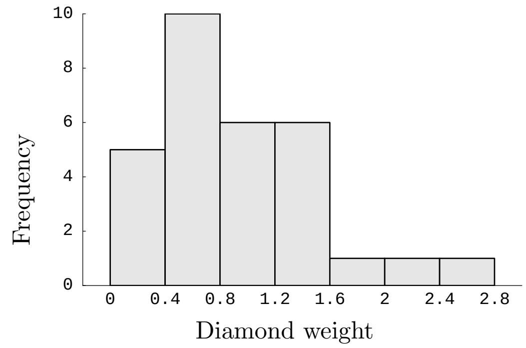


(a) Positively skewed. **(b)** $M \approx 110$

2.64

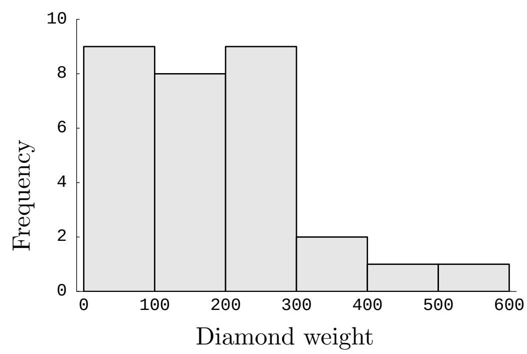
(a)

Class	Frequency	Relative frequency	Cumulative relative frequency
0.0–0.4	5	0.1667	0.1667
0.4–0.8	10	0.3333	0.5000
0.8–1.2	6	0.2000	0.7000
1.2–1.6	6	0.2000	0.9000
1.6–2.0	1	0.0333	0.9333
2.0–2.4	1	0.0333	0.9667
2.4–2.8	1	0.0333	1.0000
Totals	30	1.0000	



(b)

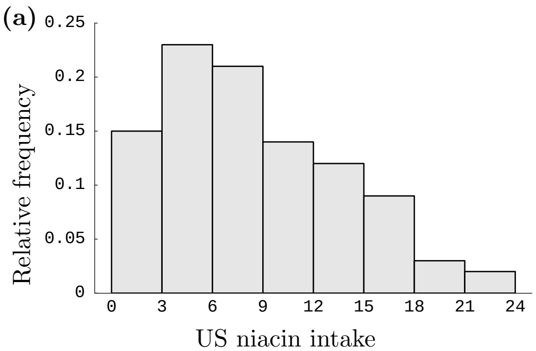
Class	Frequency	Relative frequency	Cumulative relative frequency
0–100	9	0.3000	0.3000
100–200	8	0.2667	0.5667
200–300	9	0.3000	0.8667
300–400	2	0.0667	0.9333
400–500	1	0.0333	0.9667
500–600	1	0.0333	1.0000
Totals	30	1.0000	

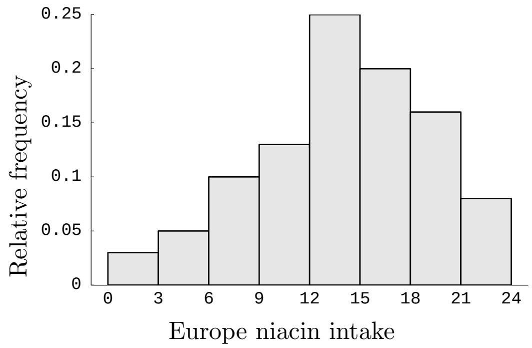


(c) The shapes are similar. The first frequency distribution and histogram has one more class. Both histograms appear to be positively skewed.

2.65

(a)





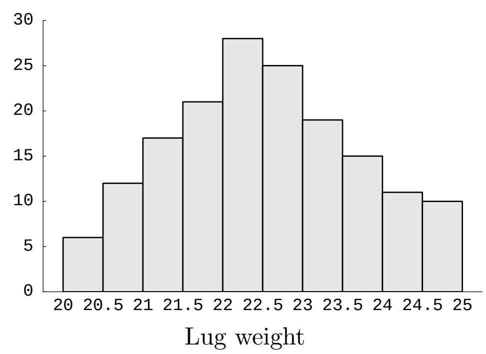
(b) United States: unimodal, positively skewed. Europe: unimodal, negatively skewed. On average, it appears Europeans have a greater daily niacin intake.

2.66

(a)

Class	Frequency	Relative frequency	Cumulative relative frequency
20.0–20.5	6	0.0366	0.0366
20.5–21.0	12	0.0732	0.1098
21.0–21.5	17	0.1037	0.2134
21.5–22.0	21	0.1280	0.3415
22.0–22.5	28	0.1707	0.5122
22.5–23.0	25	0.1524	0.6646
23.0–23.5	19	0.1159	0.7805
23.5–24.0	15	0.0915	0.8720
24.0–24.5	11	0.0671	0.9390
24.5–25.0	10	0.0610	1.0000
Total	164	1.0000	

(b)



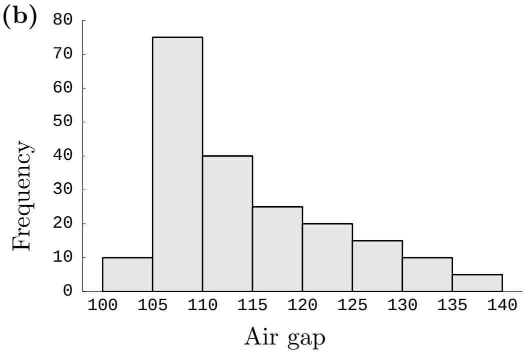
(c) 24.2

2.67

(a)

Class	Frequency	Relative frequency	Cumulative relative frequency
100–105	10	0.050	0.050
105–110	75	0.375	0.425
110–115	40	0.200	0.625
115–120	25	0.125	0.750
120–125	20	0.100	0.850
125–130	15	0.075	0.925
130–135	10	0.050	0.975
135–140	5	0.025	1.000
Total	200	1.000	

(b)



(c) 0.425

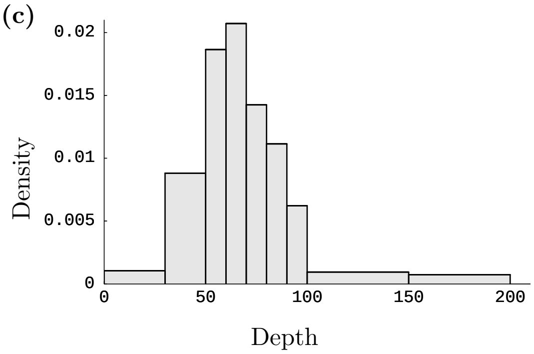
2.68

(a)

Class	Frequency	Relative frequency	Width	Density
0–30	12	0.0311	30	0.0010
30–50	68	0.1762	20	0.0088
50–60	72	0.1865	10	0.0187
60–70	80	0.2073	10	0.0207
70–80	55	0.1425	10	0.0143
80–90	43	0.1114	10	0.0111
90–100	24	0.0622	10	0.0062
100–150	18	0.0466	50	0.0009
150–200	14	0.0363	50	0.0007
Total	386	1.0000		

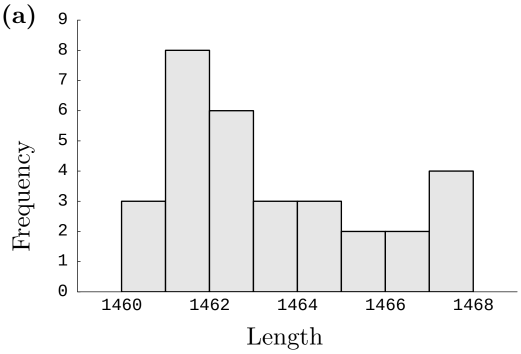
(b) The classes are of unequal width.

(c)



2.69

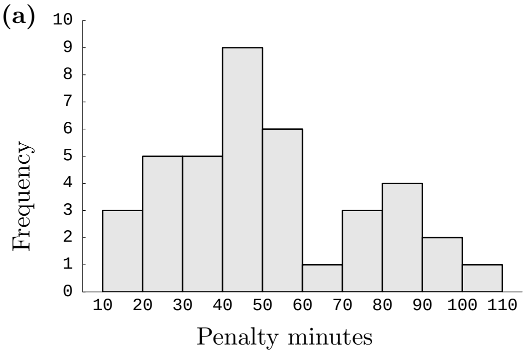
(a)



(b) Center is approximately 1464, little variability, and the shape is not symmetric, and not quite positively skewed.

2.70

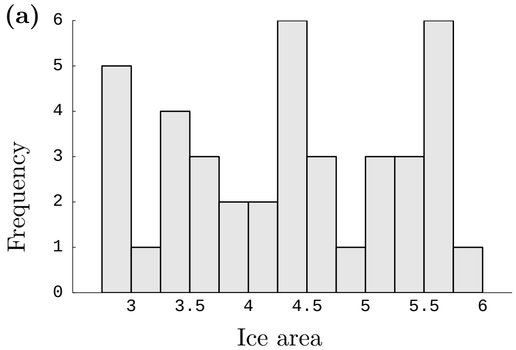
(a)



(b) The distribution appears to be approximately bimodal. Center: approximately 55. Lots of variability. **(c)** $m = 90$.

2.71

(a)



(b) No discernible shape. Center around 4.5. Lots of variability. **(c)** $Q_1 \approx 3.45$, $Q_3 \approx 5.25$ **(d)** Should be $0.5 * 40 = 20$ values between Q_1 and Q_3. There are 20 values between Q_1 and Q_3.

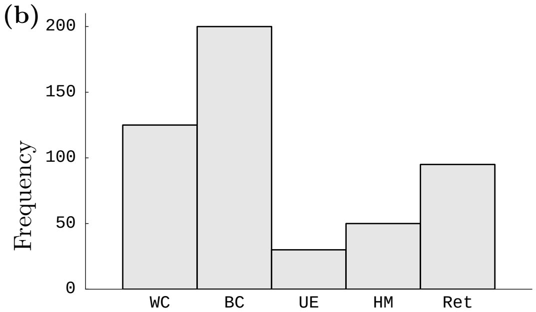
Chapter Exercises

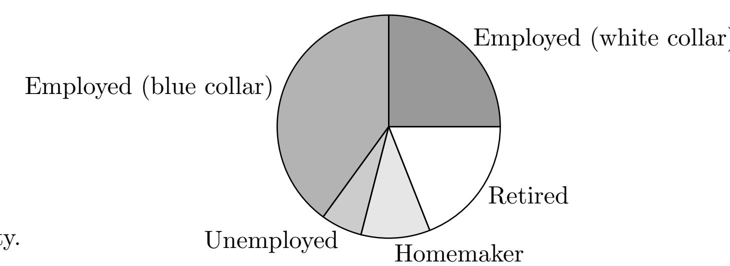
2.72

(a)

Employment status	Frequency	Relative frequency
Employed (white collar)	125	0.25
Employed (blue collar)	200	0.40
Unemployed	30	0.06
Homemaker	50	0.10
Retired	95	0.19
Total	500	1.00

(b)





2.73

(a)

1	5789
2	01134
2	5567889999
3	0011223344
3	55566679
4	01234
4	89
5	2

Stem: tenths; Leaf: hundredths.

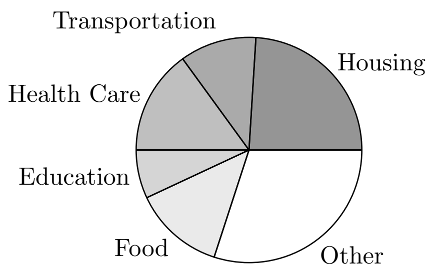
(b) Approximately bell-shaped, center around 32, little variability.

2.74

(a)

Social issue	Frequency	Relative frequency
Housing	245	0.2402
Transportation	112	0.1098
Health Care	153	0.1500
Education	71	0.0696
Food	133	0.1304
Other	306	0.3090
Total	1020	1.0000

(b)



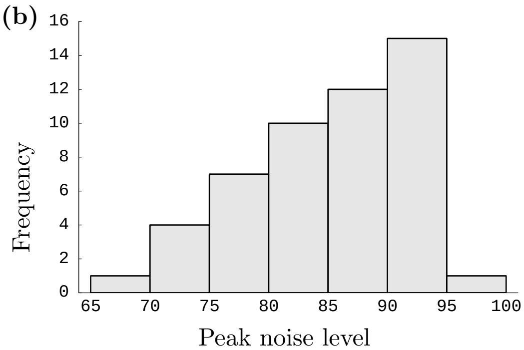
(c) 0.3500 **(d)** 0.9304

2.75

(a)

Class	Frequency	Relative frequency	Cumulative relative frequency
65– 70	1	0.02	0.02
70– 75	4	0.08	0.10
75– 80	7	0.14	0.24
80– 85	10	0.20	0.44
85– 90	12	0.24	0.68
90– 95	15	0.30	0.98
95–100	1	0.02	1.00
Total	50	1.0000	

(b)



(c) 0.24 **(d)** 0.32

2.76 **(a)** Positively skewed.

(b)

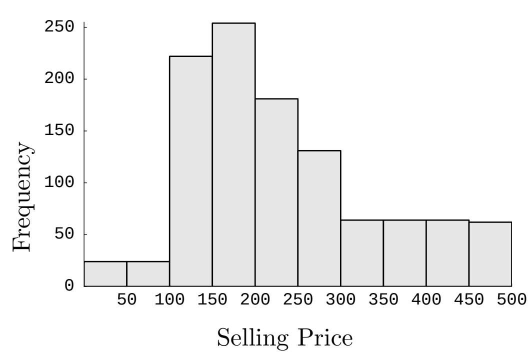
Class	Frequency	Relative frequency	Cumulative relative frequency
0– 5	8	0.1067	0.1067
5–10	15	0.2000	0.3067
10–15	12	0.1600	0.4667
15–20	7	0.0933	0.5600
20–25	6	0.0800	0.6400
25–30	6	0.0800	0.7200
30–35	7	0.0933	0.8133
35–40	2	0.0267	0.8400
40–45	4	0.0533	0.8933
45–50	2	0.0267	0.9200
50–55	2	0.0267	0.9467
55–60	1	0.0133	0.9600
60–65	1	0.0133	0.9733
65–70	1	0.0133	0.9867
70–75	0	0.0000	0.9867
75–80	1	0.0133	1.0000
Totals	75	1.0000	

(c) 0.4667 **(d)** 0.3600

2.77

(a)

Class	Frequency	Relative frequency	Cumulative relative frequency
000–050	24	0.0220	0.0220
050–100	24	0.0220	0.0440
100–150	222	0.2037	0.2477
150–200	254	0.2330	0.4807
200–250	181	0.1661	0.6468
250–300	131	0.1202	0.7670
300–350	64	0.0587	0.8257
350–400	64	0.0587	0.8844
400–450	64	0.0587	0.9431
450–500	62	0.0569	1.0000
Total	1090	1.0000	



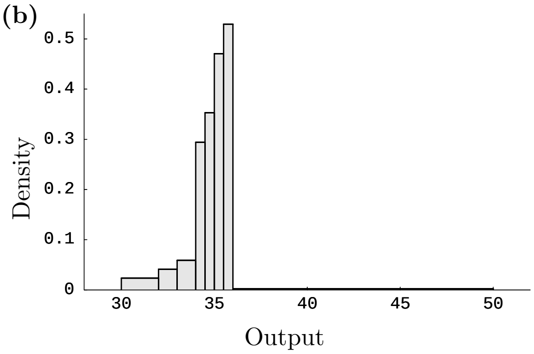
(b) Positively skewed, center around 206, lots of variability. **(c)** Typical selling price around 200. No outliers. **(d)** 0.2330

2.78

(a)

Class	Frequency	Width	Density
30.0–32.0	8	2.0	0.0235
32.0–33.0	7	1.0	0.0412
33.0–34.0	10	1.0	0.0588
34.0–34.5	25	0.5	0.2941
34.5–35.0	30	0.5	0.3529
35.0–35.5	40	0.5	0.4706
35.5–36.0	45	0.5	0.5294
36.0–50.0	5	14.0	0.0021
Total	170		

(b)



2.79

(a)

New		Traditional
	0	89
	1	5
87660	2	6
765443200	3	34
99774444322	4	02568
110	5	579
43	6	122888
	7	33567
	8	033589
	9	178
	10	034
	11	3
	12	033
	13	03
	14	16

Stem: tens and ones, Leaf: tenths.

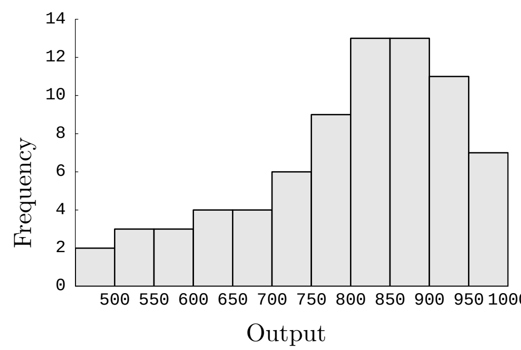
(b) New equipment times tend to be smaller, the distribution is more compact. Traditional equipment times are more spread out, and tend to be larger.

(c) The new equipment times tend to be better, shorter response times. The majority of the times are less than the traditional equipment times.

2.80

(a)

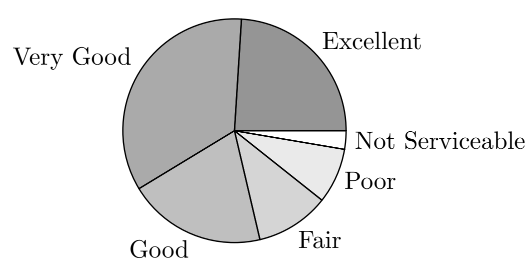
Class	Frequency	Relative frequency	Cumulative relative frequency
450– 500	2	0.0267	0.0267
500– 550	3	0.0400	0.0667
550– 600	3	0.0400	0.1067
600– 650	4	0.0533	0.1600
650– 700	4	0.0533	0.2133
700– 750	6	0.0800	0.2933
750– 800	9	0.1200	0.4133
800– 850	13	0.1733	0.5867
850– 900	13	0.1733	0.7600
900– 950	11	0.1467	0.9067
950–1000	7	0.0933	1.0000
Total	75	1.0000	



(b) 0.1067

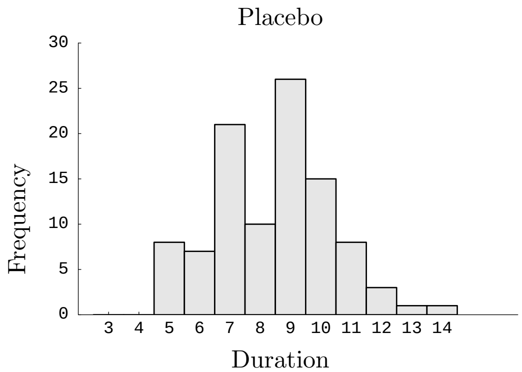
(c)

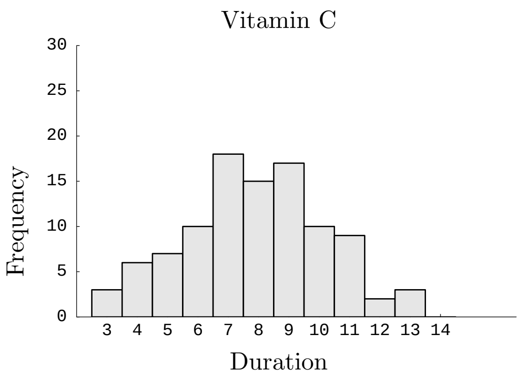
Class	Frequency	Relative frequency
Excellent	18	0.2400
Very Good	26	0.3467
Good	15	0.2000
Fair	8	0.1067
Poor	6	0.0800
Not serviceable	2	0.0267
Total	75	1.0000



2.81

(a)





(b) Both graphs appear to be centered at about the same duration. Both appear to be symmetric and bell-shaped. The Placebo durations are slightly more compact than the Vitamin C durations. **(c)** There is no graphical evidence to suggest Vitamin C reduced the duration.

2.82

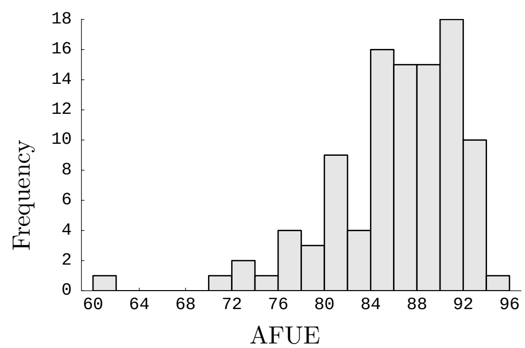
(a)

6	0
6	
6	
6	
6	
7	1
7	23
7	4
7	6777
7	889
8	000000001
8	2223
8	4444444444555555
8	666666667777777
8	888889999999999
9	000000000000011111
9	2222223333
9	5

Stem: tens, Leaf: ones.

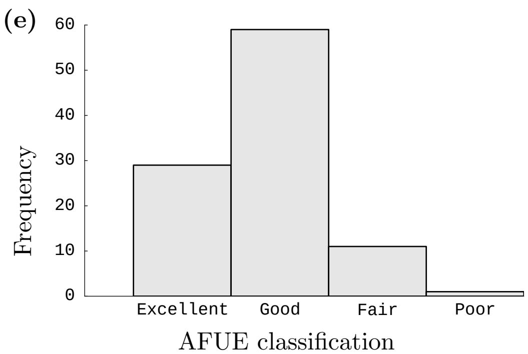
(b)

Class	Frequency	Relative frequency	Cumulative relative frequency
60–62	1	0.01	0.01
62–64	0	0.00	0.01
64–66	0	0.00	0.01
66–68	0	0.00	0.01
68–70	0	0.00	0.01
70–72	1	0.01	0.02
72–74	2	0.02	0.04
74–76	1	0.01	0.05
76–78	4	0.04	0.09
78–80	3	0.03	0.12
80–82	9	0.09	0.21
82–84	4	0.04	0.25
84–86	16	0.16	0.41
86–88	15	0.15	0.56
88–90	15	0.15	0.71
90–92	18	0.18	0.89
92–94	10	0.10	0.99
94–96	1	0.01	1.00
Totals	100	1.00	



(c) Negatively skewed, center around 86, lots of variability. One outlier: 60. **(d)** 0.09

(e)



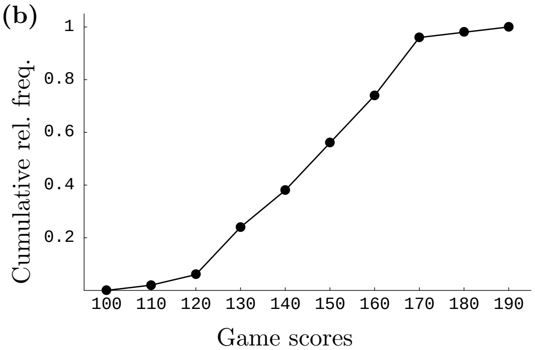
Exercises′

2.83

(a)

Class	Frequency	Relative frequency	Cumulative relative frequency
100–110	1	0.02	0.02
110–120	2	0.04	0.06
120–130	9	0.18	0.24
130–140	7	0.14	0.38
140–150	9	0.18	0.56
150–160	9	0.18	0.74
160–170	11	0.22	0.96
170–180	1	0.02	0.98
180–190	1	0.02	1.00
Total	50	1.00	

(b)

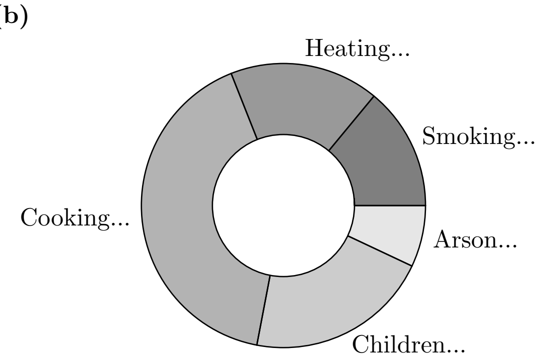


2.84

(a)

Class	Frequency	Relative frequency
Smoking, ...	70	0.14
Heating equipment	85	0.17
Cooking, ...	205	0.41
Children ...	105	0.21
Arson / suspicious	35	0.07
Total	500	1.00

(b)



Chapter 3

Section 3.1

3.1 **(a)** 82 **(b)** 3474 **(c)** 32 **(d)** 2779 **(e)** 164 **(f)** 164

3.2 **(a)** 26727.4 **(b)** 1418420.806 **(c)** 447.4 **(d)** 262963.84 **(e)** 0 **(f)** 73.2571

3.3 **(a)** 105.7 **(b)** 13.1852 **(c)** 6.9583 **(d)** 0.1232 **(e)** −2.4933 **(f)** 17.7432

3.4 **(a)** 11.5 **(b)** 19 **(c)** 59 **(d)** 32.5

3.5 **(a)** 6.6667, 7 **(b)** 6.6364, 9 **(c)** 10.6889, 7.7 **(d)** −107.69, −109.1

3.6 $\widetilde{x} = 5.5$. There is an outlier (27) pulling the mean in its direction.

3.7 **(a)** Skewed left. **(b)** Symmetric. **(c)** Skewed left. **(d)** Skewed left.

3.8 **(a)** 30.75 **(b)** 76.1667 **(c)** 152.9167 **(d)** 6.95

3.9 **(a)** 6 **(b)** 0 **(c)** No mode.

3.10 **(a)** 0.4286 **(b)** 0.7619 **(c)** 0.4

3.11 **(a)** 68.5238 **(b)** 67.0 **(c)** Slightly skewed right.

3.12 **(a)** $\overline{x} = 25661.3333$, $\widetilde{x} = 25514.5$ **(b)** Skewed right.

3.13 **(a)** $\overline{x} = 6.5833$, $\widetilde{x} = 6.4$ **(b)** $\overline{x} = 6.6944$, $\widetilde{x} = 6.4$. The mean is higher, pulled in the direction of the new, higher value. The median stays the same.

3.14 **(a)** $\overline{x} = 0.4730$, $\widetilde{x} = 0.3950$ **(b)** 0.4333

3.15 **(a)** $\overline{x} = 619.5$, $\widetilde{x} = 620.0$ **(b)** 619.1667 **(c)** Approximately symmetric.

3.16 **(a)** $\overline{x} = 6.5357$, $\widetilde{x} = 7.0$ **(b)** mode = 7.5. **(c)** $\overline{x} = 17.6464$, $\widetilde{x} = 18.9$. The new values are 2.7 times the values found in part (a).

3.17 **(a)** $\overline{x} = 80.0$ **(b)** $\overline{x} = 84$. The new mean is 4 more than the original mean.

3.18 **(a)** $\overline{x} = 10.0667$ **(b)** $\overline{x} = 22.5191$. The new mean is the original mean times 2.237.

3.19 **(a)** $\overline{x} = 12.0632$, $\widetilde{x} = 12.0700$ **(b)** Approximately symmetric. **(c)** 0.88

3.20 **(a)** $\overline{x} = 627784.6$, $\widetilde{x} = 121676.5$ **(b)** Median: because of the outlier.

3.21 **(a)** 0.8438 **(b)** 0.8438. The two values are the same. **(c)** No. Need 36 successes to produce $\widehat{p} = 0.9$. Even if all 8 additional panels are successes, the total number of successes will only be 35.

3.22 **(a)** $\overline{x} = 3.8917$, $\widetilde{x} = 3.6550$ **(b)** 3.7821 **(c)** Two modes: 3.37 and 3.88

3.23 **(a)** $\overline{x} = 61.3$, $\widetilde{x} = 61.0$ **(b)** 61.75 **(c)** mode = 61

3.24 **(a)** $\overline{x} = 16.5588$, $\widetilde{x} = 15.1$ **(b)** Skewed right.
(c) There is no value that will make the sample mean equal to the sample median.

3.25 **(a)** 38.325 **(b)** No. We need to know the 7th and 8th observations in the ordered list.

3.26 **(a)** $x_5 = 9414$ **(b)** $x_5 = 6250.75$

3.27 Traditional: $\overline{x} = 23.1429$, $\widetilde{x} = 23.0$
Cooperative: $\overline{x} = 26.4286$, $\widetilde{x} = 25.0$
On average, the Cooperative learning scores are higher than the traditional scores.

3.28 75.8, 67.8

3.29 **(a)** $\overline{x}_{\text{F}} = 57.1667$, $\widetilde{x}_{\text{F}} = 57.5$ **(b)** $\overline{x}_{\text{C}} = 13.9815$
(c) $\overline{x}_{\text{C}} = (\overline{x}_{\text{F}} - 32)/1.8$

3.30 $\overline{x} = 1.7903$, $\widetilde{x} = 1.5$

Section 3.2

3.31 **(a)** $R = 3.9$, $s^2 = 2.1690$, $s = 1.4728$
(b) $R = 20.6$, $s^2 = 27.2812$, $s = 5.2231$
(c) $R = 98.32$, $s^2 = 1096.2665$, $s = 33.1099$
(d) $R = 5.7$, $s^2 = 2.5843$, $s = 1.6076$

3.32 **(a)** $s^2 = 323.7757$, $s = 17.9938$
(b) $s^2 = 479.7322$, $s = 21.9028$
(c) $s^2 = 31.3735$, $s = 5.6012$
(d) $s^2 = 2.4892$, $s = 1.5777$

3.33 **(a)** $15.5, 45.5$ **(b)** $10, 30$ **(c)** $25.5, 75.5$
(d) $12.5, 36.5$

3.34 **(a)** $Q_1 = 20$, $Q_3 = 35$, $IQR = 15$
(b) $Q_1 = 2.3$, $Q_3 = 7.75$, $IQR = 5.45$
(c) $Q_1 = -21$, $Q_3 = -13$, $IQR = 8$
(d) $Q_1 = 44.1$, $Q_3 = 59.2$, $IQR = 15.1$

3.35 **(a)** $s^2 = 430.4$, $s = 20.7461$
(b) $s^2 = 430.4$, $s = 20.7461$ Same.
(c) $s^2 = 172160.0$, $s = 414.9217$ The same variance is multiplied by $20^2 = 400$, and the sample standard deviation is multiplied by 20.

3.36 **(a)** Increases. **(b)** Increases. **(c)** Does not affect.
(d) Does not affect.

3.37 **(a)** $R = 1.3$ **(b)** $s^2 = 0.1380$, $s = 0.3714$
(c) $Q_1 = 28.87$, $Q_3 = 29.35$, $IQR = 0.48$

3.38 **(a)** $s = 279.0969$ **(b)** $IQR = 529$ **(c)** Probably IQR because there are several observations that are very large and some that are very small.

3.39 **(a)** $s^2 = 773.2292$, $s = 27.8070$ **(b)** $Q_1 = 667.5$, $Q_3 = 700$ **(c)** $IQR = 32.5$, $QD = 16.25$

3.40 **(a)** $s^2 = 3177342.1958$, $s = 1782.5101$
(b) $Q_1 = 392.5$, $Q_3 = 2215$, $IQR = 1822.5$ **(c)** Sum is 0.

3.41 **(a)** $s^2_{\text{L}} = 4.2958$, $s_{\text{L}} = 2.0726$, $IQR_{\text{L}} = 2$
(b) $s^2_{\text{M}} = 12.2632$, $s_{\text{M}} = 3.5019$, $IQR_{\text{M}} = 5.5$
(c) The More than two hours data set has more variability.

3.42 **(a)** $Q_1 = 300$, $Q_3 = 401$, $IQR = 101$
(b) $Q_1 = 300$, $Q_3 = 401$, $IQR = 101$
(c) 401 **(d)** 300

3.43 **(a)** 158.1429 **(b)** **(c)** Same.

3.44 **(a)** $Q_1 = 170$, $Q_3 = 1187$, $IQR = 1017$
(b) $s^2 = 483822.7967$, $s = 695.5737$
(c) $IQR = 1162$, $s^2 = 1022065.1714$
(d) The new values are larger. 3687 is much larger than any other number in the data set. This contributes more variability.

3.45 **(a)** $Q_1 = 291$, $Q_3 = 313$, $IQR = 22$
(b) $s^2 = 536.4889$, $s = 23.1622$
(c) $IQR = 22$, $s^2 = 1160.3222$
(d) IQR is the same, s^2 is larger. s^2 is more sensitive to outliers.

3.46 **(a)** $s^2 = 234671415.9556$, $s = 15318.9887$
(a) $s^2 = 190085861.8222$, $s = 13787.1629$
(c) The sample variance and the sample standard deviation are smaller for the number of flights scheduled in August. Note: The new sample variance is approximately $(0.9)^2 = 0.81$ times the original, and the new standard deviation is approximately 0.9 times the original. it is not an exact equality due to rounding the number of scheduled flights to the nearest whole number.

3.47 **(a)** -4.6667, 9.3333, -13.6667, 5.3333, -11.6667, 15.3333 **(b)** Sum is 0.

(c)
$$\begin{aligned}\sum_{i=1}^{n}(x_i - \overline{x}) &= \sum_{i=1}^{n} x_i - \sum_{i=1}^{n} \overline{x} \\ &= \sum_{i=1}^{n} x_i - n\overline{x} \\ &= \sum_{i=1}^{n} x_i - n\,\frac{1}{n}\sum_{i=1}^{n} x_i \\ &= \sum_{i=1}^{n} x_i - \sum_{i=1}^{n} x_i = 0\end{aligned}$$

3.48 **(a)** $s^2_{\text{k}} = 20.0238$, $s_{\text{k}} = 4.4748$
(b) $s^2_{\text{m}} = 7.7761$, $s_{\text{m}} = 2.7886$
(c) $s^2_{\text{m}} = (0.62317)^2 s^2_{\text{k}}$, $s_{\text{m}} = (0.62317)s_{\text{k}}$

3.49
$$\frac{1}{n-1}\sum_{i=1}^{n}(x_i - \overline{x})^2$$
$$= \frac{1}{n-1}\sum_{i=1}^{n}(x_i^2 - 2x_i\overline{x} + \overline{x}^2)$$

$$= \frac{1}{n-1}\left[\sum_{i=1}^{n} x_i^2 - 2\overline{x}\sum_{i=1}^{n} x_i + n\overline{x}^2\right]$$

$$= \frac{1}{n-1}\left[\sum_{i=1}^{n} x_i^2 - 2\overline{x}\,n\,\frac{1}{n}\sum_{i=1}^{n} x_i + n\overline{x}^2\right]$$

$$= \frac{1}{n-1}\left[\sum_{i=1}^{n} x_i^2 - 2n\overline{x}^2 + n\overline{x}^2\right]$$

$$= \frac{1}{n-1}\left[\sum_{i=1}^{n} x_i^2 - n\overline{x}^2\right]$$

$$= \frac{1}{n-1}\left[\sum_{i=1}^{n} x_i^2 - n\left(\frac{1}{n}\sum_{i=1}^{n} x_i\right)^2\right]$$

$$= \frac{1}{n-1}\left[\sum_{i=1}^{n} x_i^2 - \frac{1}{n}\left(\sum_{i=1}^{n} x_i\right)^2\right]$$

3.50 **(a)** East: CV = 3.3932, CQV = 2.6149; West: $CV = 16.5767$, CQV = 13.7452 **(b)** The West-side development data has more variability.

3.51 **(a)** $s^2 = 3175.5667$, $s = 56.3522$ **(b)** $s^2 = 3175.5667$, $s = 56.3522$ **(c)** The answers are the same. **(d)** $s_y^2 = s_x^2$ and $s_y = s_x$.

3.52 **(a)** $s_x^2 = 9.6293$, $s_x = 3.1031$ **(b)** $s_y^2 = 471.8374$, $s_y = 21.7218$ **(c)** $s_y^2 = 7^2 s_x^2$, $s_y = 7s_x$ **(d)** $s_y^2 = a^2 s_x^2$, $s_y = as_x$

3.53 $s_y^2 = a^2 s_x^2$, $s_y = as_x$

3.54 **(a)** $s^2 = 11975.7018$, $s = 109.4335$ **(b)** $Q_1 = 265$, $Q_3 = 352$, $IQR = 87$ **(c)** $s^2 = 3580.9853$, $s = 59.8413$, $Q_1 = 270$, $Q_3 = 352$, $IQR = 82$ Both values are smaller in the modified data set. By eliminating the two smallest values (outliers), the variability in the modified data set is smaller.

3.55 No. The subset with the smallest 7 numbers has a sample mean $\overline{x} = 7.1111$, which is greater than 5. Any other subset will have a sample mean greater than 7.1111.

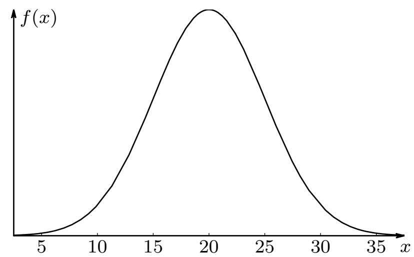
3.56 **(a)** $s_{\mathrm{K}}^2 = 54.5763$, $s_{\mathrm{K}} = 7.3876$, $IQR_{\mathrm{K}} = 10.5$ **(b)** $s_{\mathrm{G}}^2 = 365.2921$, $s_{\mathrm{G}} = 19.1126$, $IQR_{\mathrm{G}} = 26$ **(c)** The General Mills data has more variability.

3.57 **(a)** $Q_1 = 7.1$, $Q_3 = 13.1$, $IQR = 6$ **(b)** 7.1 **(c)** CQV = 29.703

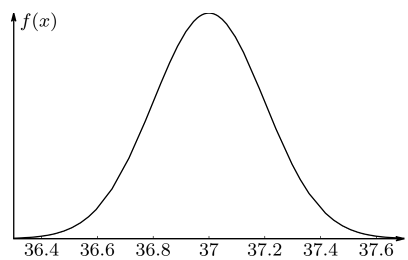
Section 3.3

3.58 **(a)** $(40.0, 60.0)$, 0.75 **(b)** $(320.5, 383.5)$, 0.8889 **(c)** $(11.4, 22.6)$, 0.6094 **(d)** $(18.2125, 54.7875)$, 0.6735 **(e)** $(95.5, 220.5)$, 0.84 **(f)** $(-55.35, -54.65)$, 0.8724 **(g)** $(-56.35, 59.75)$, 0.8025

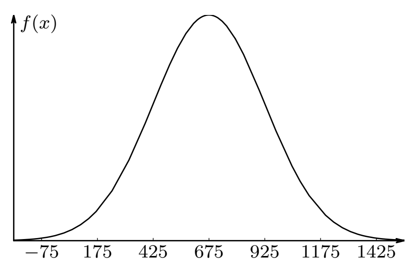
3.59 **(a)** $(15, 25)$, $(10, 30)$, $(5, 35)$



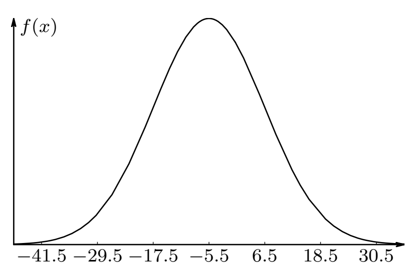
(b) $(36.8, 37.2)$, $(36.6, 37.4)$, $(36.4, 37.6)$



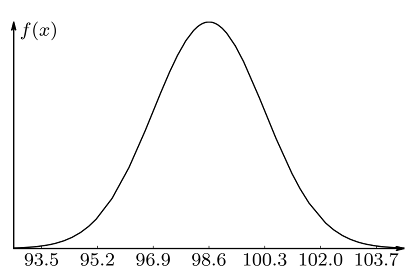
(c) $(425, 925)$, $(175, 1175)$, $(-75, 1425)$



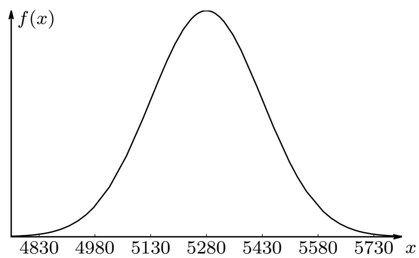
(d) $(-17.5, 6.5)$, $(-29.5, 18.5)$, $(-41.5, 30.5)$



(e) $(96.9, 100.3)$, $(95.2, 102.0)$, $(93.5, 103.7)$



(f) (5130, 5430), (4980, 5580), (4830, 5730)



3.60 **(a)** 3 **(b)** −1.25 **(c)** 0.8333 **(d)** −1.1111 **(e)** −1.1563 **(f)** 0.4545 **(g)** −2.2 **(h)** 4.1143 **(i)** 1.1111 **(j)** 5.8125

3.61 **(a)** 36.5 **(b)** 8.96 **(c)** −409.75 **(d)** 26.036 **(e)** 55.175 **(f)** 3.78 **(g)** 0.0 **(h)** 1.574

3.62 **(a)** 120.5 **(b)** 90 **(c)** 22 **(d)** 30.5 **(e)** 20.5 **(f)** 3525

3.63 **(a)** (22.2, 30.8), (17.9, 35.1) **(b)** At least 0.75

3.64 **(a)** (18.8, 32.4), (15.4, 35.8) **(b)** 0.68

3.65 85% of all fish caught in the tournament weighed less than the one caught by Ruskey, and 15% weighed more.

3.66 **(a)** (138, 162), (126, 174) **(b)** At least 0.75. **(c)** At most 0.1111. **(d)** 0.95, 0.003

3.67 **(a)** At least 0.75. **(b)** At least 0.8889. **(c)** At most 0.1111. **(d)** At least 0.5556

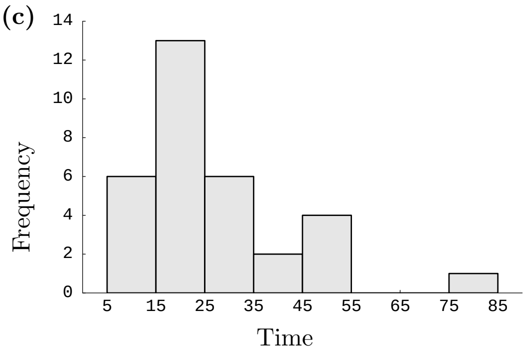
3.68 **(a)** 0.68 **(b)** 0.16 **(c)** 0.8385

3.69 **(a)** 0.95 **(b)** 0.8385 **(c)** 0.975

3.70 **(a)** $\overline{x} = 10168.6$, $s = 2128.2206$ **(b)** Within 1: 0.70, within 2: 0.9667 within 3: 1.00 **(c)** Since these proportions are close to the Empirical Rule proportions, this suggests the shape of the distribution is approximately normal.

3.71 **(a)** Within 1: 0.8125, within 2: 0.9688 within 3: 0.9688 **(b)** Since these proportions are not close to the Empirical Rule proportions, this suggests the shape of the distribution is not normal.

(c)



The shape is positively skewed.

3.72 **(a)** In Reading, third-graders in Washington scored better than 58% of all those who took the exam, and in mathematics, better than 66% of all those who took the exam. **(b)** The median. **(c)** The third-grader did better than 99% of those who took the exam.

3.73 **(a)** $\overline{x} = 120.3$, $s = 9.9672$ **(b)** −0.7324, 0.3712, 2.0768, −0.5318, −0.5318, 0.8729, −0.7324, 0.8729, −0.8327, −0.8327 **(c)** $\overline{z} = 0$, $s_z = 1.0$ **(d)** Predictions: $\overline{z} = 0$, $s_z = 1.0$

Proof:

$$\sum_{i=1}^{n} z_i = \sum_{i=1}^{n} \frac{(x_i - \overline{x})}{s} = \frac{1}{s}\left[\sum_{i=1}^{n} x_i - \sum_{i=1}^{n} \overline{x}\right]$$

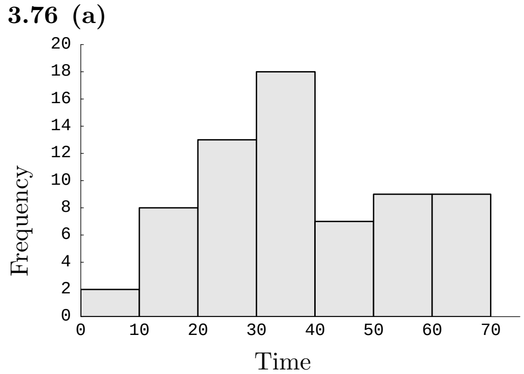
$$= \frac{1}{s}\left[\sum_{i=1}^{n} x_i - n\overline{x}\right]$$

$$= \frac{1}{s}\left[\sum_{i=1}^{n} x_i - n\frac{1}{n}\sum_{i=1}^{n} x_i\right] = \frac{1}{s}\cdot 0 = 0$$

3.74 $z_1 = -0.8$, $z_2 = -1.0$ The second service actually performed *better*. The second service had a time that was farther away from the mean to the left in standard deviations.

3.75 **(a)** Claim: $\mu = 11$ ($\sigma = 2.5$, distribution approximately normal)
Experiment: $x = 13$
Likelihood: $z = (13 - 11)/2.5 = 0.80$
Conclusion: This is a reasonable z-score. There is no evidence to suggest the manager's claim is false.
(b) Claim: $\mu = 11$ ($\sigma = 2.5$, distribution approximately normal)
Experiment: $x = 20$
Likelihood: $z = (20 - 11)/2.5 = 3.6$
Conclusion: This is a very unusual observation. There is evidence to suggest the manager's claim is false.

3.76 **(a)**

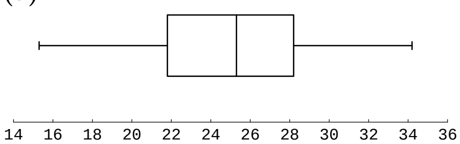


(b) 33, 52, 15 **(c)** $p_{45} = 32$, $p_{80} = 53$, $p_{10} = 14$

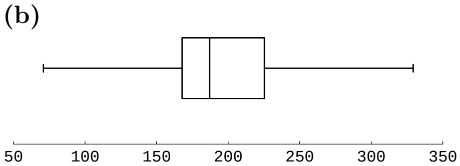
Section 3.3

3.77 **(a)** $x_{\min} = 28.0$, $Q_1 = 32.0$, $\widetilde{x} = 34.5$, $Q_3 = 35.0$, $x_{\max} = 40.0$ **(b)** $x_{\min} = 52.0$, $Q_1 = 57.0$, $\widetilde{x} = 66.5$, $Q_3 = 70.5$, $x_{\max} = 78.0$ **(c)** $x_{\min} = 80.0$, $Q_1 = 83.0$, $\widetilde{x} = 91.5$, $Q_3 = 94.0$, $x_{\max} = 98.0$ **(d)** $x_{\min} = 0.4$, $Q_1 = 1.0$, $\widetilde{x} = 1.95$, $Q_3 = 2.4$, $x_{\max} = 10.9$ **(e)** $x_{\min} = 103.1$, $Q_1 = 119.9$, $\widetilde{x} = 141.9$, $Q_3 = 159.7$, $x_{\max} = 196.9$ **(f)** $x_{\min} = -40.1$, $Q_1 = -33.8$, $\widetilde{x} = -28.0$, $Q_3 = -18.5$, $x_{\max} = -9.8$

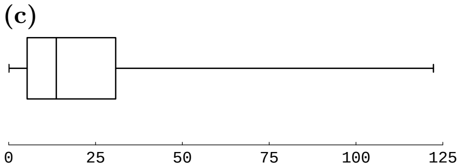
3.78
(a)



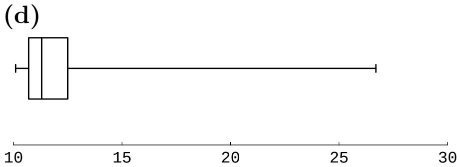
(b)



(c)



(d)



3.79

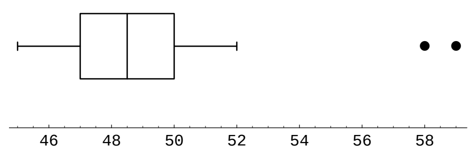
	IQR	IF_L	IF_H	OF_L	OF_H
(a)	24.0	−14.0	82.0	−50.0	118.0
(b)	51.0	1178.5	1382.5	1102.0	1459.0
(c)	9.46	51.56	89.4	37.37	103.59
(d)	225.6	576.5	1478.9	238.1	1817.3
(e)	2.795	−2.9175	8.2625	−7.11	12.455
(f)	2.245	−3.1025	5.8775	−6.47	9.245
(g)	9.77	−48.325	−9.245	−62.98	5.41
(h)	0.38	97.86	99.38	97.29	99.95

3.80 **(a)** Neither. **(b)** Mild outlier. **(c)** Neither. **(d)** Extreme outlier. **(e)** Mild outlier. **(f)** Neither.

3.81

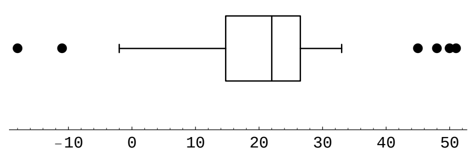
	$x_{\min}$	Q_1	$\widetilde{x}$	Q_3	$x_{\max}$
(a)	20.0	40.0	55.0	60.0	85.0
(b)	−0.5	1.4	1.9	2.8	3.9
(c)	4.5	5.5	6.3	7.2	9.5
(d)	75.0	95.0	103.0	109.0	119.0
(e)	0.0	0.8	1.6	2.9	9.2
(f)	0.0	2.5	5.5	9.0	34
(g)	−80.0	−58.0	−51.0	−45.0	−22.0

3.82



Centered near 48.5, positively skewed, two mild outliers.

3.83



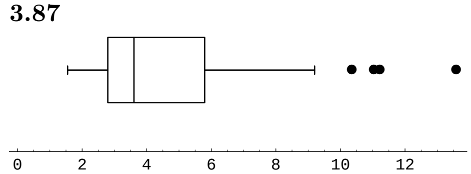
Slightly skewed left, lots of variability, 6 mild outliers.

3.84 Approximately symmetric, centered near 1560, two mild outliers.

3.85 Skewed left, centered near 3.4, little variability.

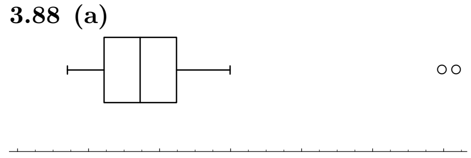
3.86 Males: Slightly skewed right, centered near 29, lots of variability, 1 mild outlier. Females: Slightly skewed right, centered near 29, little variability, 1 mild outlier. Both centered near 29, both slightly skewed right. Female data is more compact.

3.87

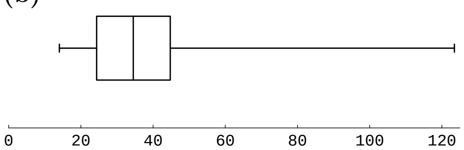


Positively skewed, centered near 3.7, lots of variability, 4 mild outliers.

3.88 **(a)**

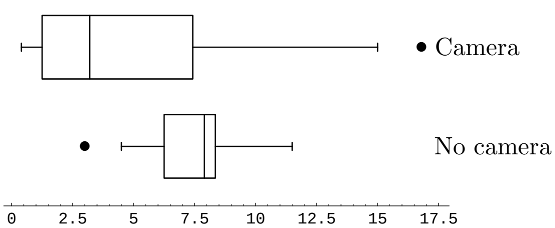


Positively skewed, centered near 34, compact except for the two extreme outliers.
(b)



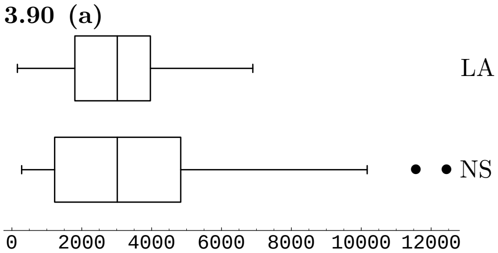
The modified box plot is more descriptive. The standard box plot hides information in the right-tail of the distribution.

3.89



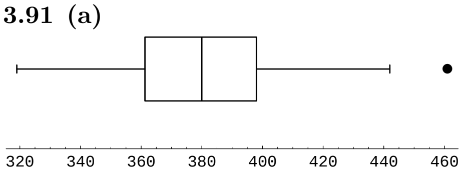
Camera: centered near 3, lots of variability, positively skewed, 1 mild outlier. No camera: centered near 8, compact, slightly skewed left, 1 mild outlier. These graphs suggest the amber light times at intersections with a camera are, on average, shorter.

3.90 (a)



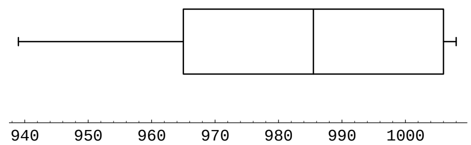
(b) The natural science data is centered slightly higher than the liberal arts data, has more variability, is positively skewed, and has 3 mild outliers. **(c)** The graphs suggest that on average, the natural science faculty use the copier more than the liberal arts faculty.

3.91 (a)



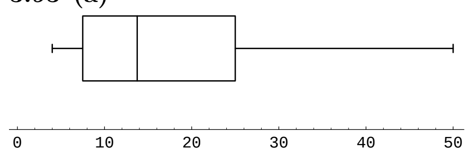
(b) Approximately symmetric, centered near 380, lots of variability, 1 mild outlier. **(c)** The graph suggests, on average, a 400-mg vitamin C tablet contains less than 400 mg.

3.92

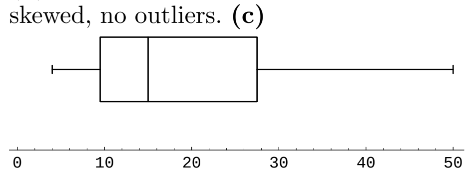


Centered near 985, lots of variability, negatively skewed, no outliers. The graph of a standard box plot would be the same.

3.93 (a)

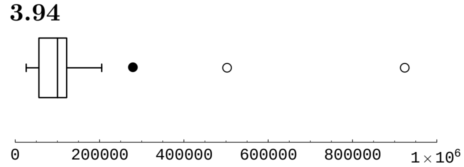


(b) Centered near 14, lots of variability, positively skewed, no outliers. **(c)**



The new box plot looks exactly the same.

3.94

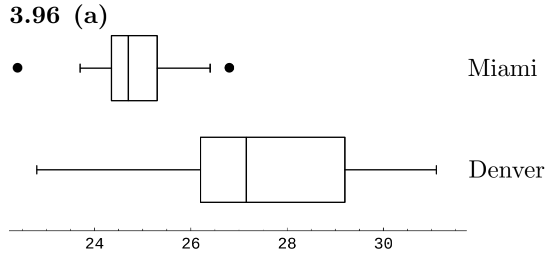


Centered near 100,000, lots of variability, slight positive skew, 1 mild outlier, 2 extreme outliers. $\overline{x} = 129{,}714.20$, Interval: $(79, 714.2, 179714.2)$. This interval captures 18 observations, just over 50%. Note: answers may vary.

Chapter Exercises

3.95 (a) $\overline{x} = 177.5789$, $s^2 = 217.924$, $s = 14.7622$
(b) Within 1: 0.6842, within 2: 1.0, within 3: 1.0
(c) Since these proportions are close to the Empirical Rule proportions, this suggests the distribution is approximately normal.

3.96 (a)

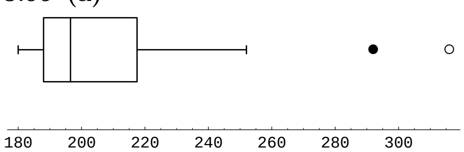


(b) Miami: centered near 24.5, little variability, approximately symmetric, 2 mild outliers. Denver: centered near 27, lots of variability, approximately symmetric, no outliers. **(c)** Both distributions approximately symmetric. Denver has more variability and the values are, on average, larger.

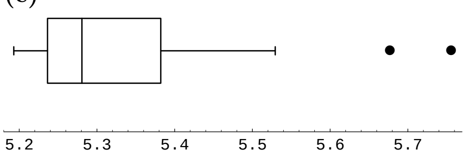
3.97 **(a)** 0.68 **(b)** 0.0015 **(c)** 0.4985 **(d)** No. This observation is within 2 standard deviations of the mean, a reasonable observation.

3.98 **(a)** $\widetilde{x} = 243.5$, $Q_1 = 200.0$, $Q_3 = 361.0$, $IQR = 161.0$ **(b)** $p_{30} = 201$, $p_{95} = 588$ **(c)** $p_{74} = 361$, 356 lies in the 74th percentile.

3.99 **(a)**



(b) Within 1: 0.9167, within 2: 0.9444, within 3: 0.9722 The box plot and the Empirical Rule suggest the distribution is not normal.
(c)



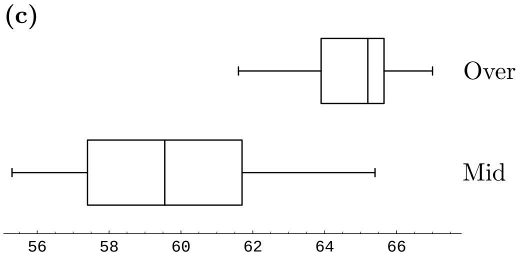
Within 1: 0.8611, within 2: 0.9444, within 3: 0.9722 The transformed data is still not normal.

3.100 **(a)** This is not an unusual generating capacity. The z-score is $z = 1.1429$, which suggests a reasonable observation. **(b)** This is an unusual generating capacity. The z-score is $z = -3.1429$, which indicates the observation is more than 3 standard deviations from the mean.

3.101 **(a)**

	R	s^2	IQR	CV	CQV
Over	5.4000	1.8023	1.7000	2.0707	1.3127
Mid	10.1000	7.9009	4.3000	4.6919	3.6104

(b) The summary statistics in part (a) suggest the mid-over racket tensions have more variability.
(c)

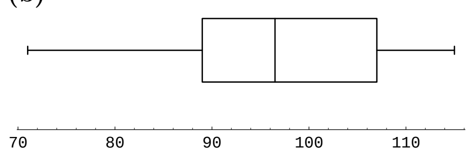


The box plots also suggest the mid-over racket tensions have more variability.

3.102 **(a)** At least 0.75. At most 0.1111. **(b)** There is evidence to suggest the manufacturer's claim is false. This is a very unusual observation.

3.103 **(a)** $\overline{x} = 3.0003$, $\widetilde{x} = 2.995$ **(b)** Since the mean is approximately equal to the median, this suggests the distribution is approximately symmetric.
(c) $\overline{x}_{\text{tr}(0.10)} = 3.0046$. A trimmed mean is not necessary. The distribution is approximately symmetric, and there are no extreme outliers.

3.104 **(a)** $\overline{x} = 97.1111$, $\widetilde{x} = 96.5$, $s^2 = 156.5752$, $s = 12.5130$
(b)



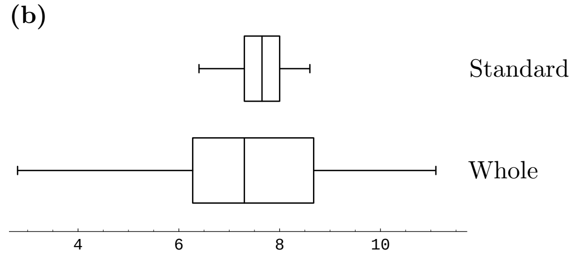
(c) The summary statistics and the box plot suggest the distribution is approximately symmetric. The distribution is centered around 97, lots of variability, and no outliers. **(d)** A person who drinks three cups of coffee has, on average, around 291 mg ($= 3 \times 97$) of caffeine. This is under the moderate amount of 300 mg.

3.105 **(a)** $\overline{x} = 25.3810$, $s^2 = 38.8516$, $s = 6.2331$
(b) Within 1: 0.7143, within 2: 0.9524, within 3: 1.0. These proportions suggest the distribution is approximately normal. **(c)** 17

3.106 **(a)**

	$\overline{x}$	s^2	s
Standard	7.6000	0.3952	0.6287
Whole	7.3760	3.7986	1.9490

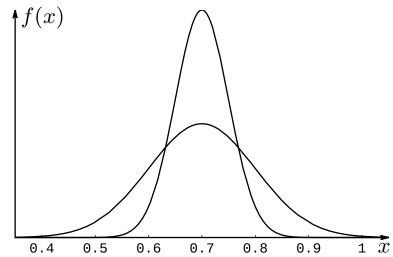
(b)



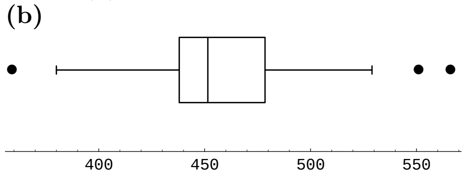
(c) The whole language reading speeds have much more variability and the center of the distribution is slightly smaller.

3.107 **(a)** Almost all (0.997) 2x4's have width between 1.69 and 1.81 inches. **(b)** 1.79 is two standard deviations from the mean. This is a reasonable observation. There is no evidence to suggest the claim is false. **(c)** -1.68 is more than 3 standard deviations from the mean. This is a very unusual observation. There is evidence to suggest the claim is false.

3.108 **(a)** It is unlikely a fisherman will catch a small mouth bass with mercury level greater than 1 because this is 3 standard deviations from the mean. **(b)** It is even more unlikely a fisherman will catch a small mouth bass with mercury level greater than 1 because this is 6 standard deviations from the mean. **(c)**

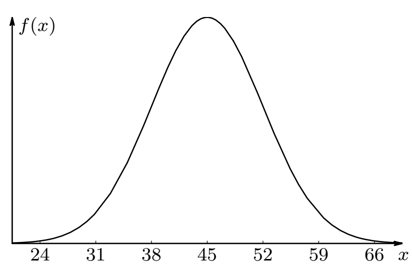


3.109 **(a)** $\overline{x} = 458.2083$, $s^2 = 2231.4764$, $s = 47.2385$ **(b)**



Three mild outliers: 359, 551, 529 **(c)** $p_{10} = 409$. 400 lies in the 10th percentile. **(d)** At least 0.75 of the observations lie in the interval $(363.73, 552.69)$. At least 0.89 of the observations lie in the interval $(316.49, 599.92)$.

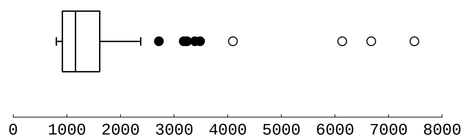
3.110 **(a)**



(b) No. 30 is within 2 standard deviations of the mean. **(c)** 52

3.111 **(a)** $\overline{x} = 3.4826$, $\widetilde{x} = 3.8$, $s^2 = 3.7188$, $s = 1.9284$ **(b)** $p_{40} = 3.6$, $p_{80} = 4.9$ **(c)** Although 5.7 is just over 1 standard deviation from the mean, it is in the 90th percentile. The distribution is slightly skewed left.

3.112 **(a)** $\overline{x} = 1554.5938$, $\widetilde{x} = 1161.0$ These values suggest the distribution is positively skewed. **(b)** $s^2 = 1350154.1174$, $s = 1161.9613$. Within 1: 0.8958, within 2: 0.9583, within 3: 0.9688. These proportions suggest the distribution is not normal. **(c)** $Q_1 = 916.5$, $Q_3 = 1613.0$, $IQR = 696.5$



The distribution is centered near 1200, lots of variability, positively skewed, with several mild and extreme outliers. This description agrees with the answers in parts (a) and (b). **(d)** *Phantom of the Opera*: 7685 performances as of July 2, 2006. This value should increase the values of the sample mean, median, variance, and standard deviation. $\overline{x} = 1617.7938$, $\widetilde{x} = 1165.0$, $s^2 = 1723532.0820$, $s = 1312.8336$

Exercises′

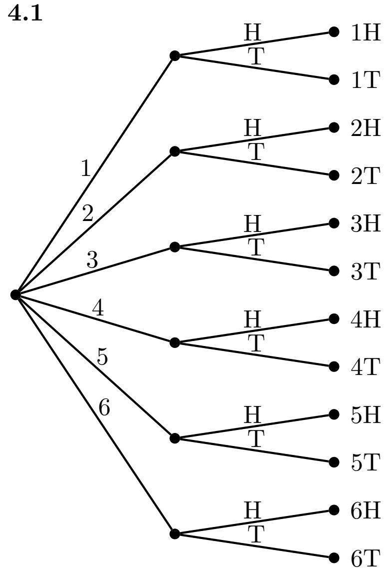
3.113 **(a)** 0.9063
(b) $s^2 = 0.0877 = (32/31)(0.9063)(1 - 0.9063)$
(c) $\sigma^2 = 0.0850 = (0.9063)(1 - 0.9063)$

3.114 **(a)** $\overline{x} = 40.3867$, $s = 3.3532$ **(b)** 14
(c) $\sum_{i=1}^{n} z_i^2 = n - 1$

Chapter 4

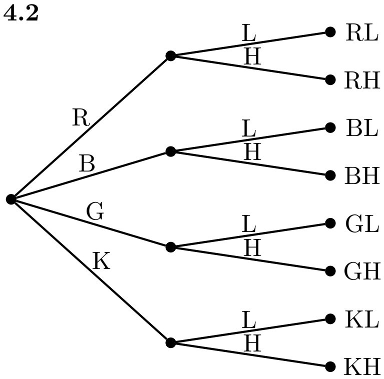
Section 4.1

4.1



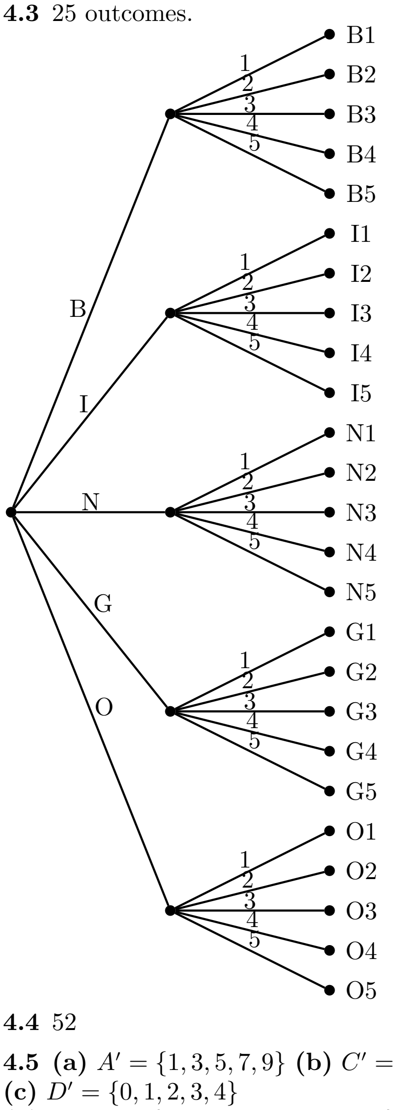
$S =$
{1H, 2H, 3H, 4H, 5H, 6H, 1T, 2T, 3T, 4T, 5T, 6T}

4.2



$S = \{$RL, RH, BL, BH, GL, GH, KL, KH$\}$

4.3 25 outcomes.



4.4 52

4.5 **(a)** $A' = \{1, 3, 5, 7, 9\}$ **(b)** $C' = \{5, 6, 7, 8, 9\}$
(c) $D' = \{0, 1, 2, 3, 4\}$
(d) $A \cup B = \{0, 1, 2, 3, 4, 5, 6, 7, 8, 9\} = S$
(e) $A \cup C = \{0, 1, 2, 3, 4, 6, 8\}$
(f) $A \cup D = \{0, 2, 4, 5, 6, 7, 8, 9\}$

4.6 **(a)** $B \cap C = \{1, 3\}$ **(b)** $B \cap D = \{5, 7, 9\}$
(c) $A \cap B = \{\ \}$ **(d)** $A \cap C = \{0, 2, 4\}$
(e) $(B \cap C)' = \{0, 2, 4, 5, 6, 7, 8, 9\}$
(f) $B' \cup C' = \{0, 2, 4, 5, 6, 7, 8, 9\}$

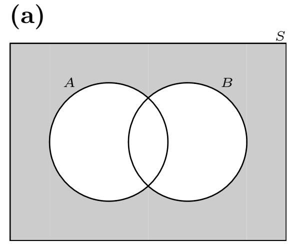
4.7 **(a)** $A' = \{b, d, f, h, i, j, k\}$ **(b)** $C' = \{a, b, d, e, j, k\}$
(c) $D' = \{c, f, i\}$ **(d)** $A \cap B = \{c\}$ **(e)** $A \cap C = \{c, g\}$
(f) $C \cap D = \{g, h\}$

4.8 **(a)** $A \cup B \cup D = \{a, b, c, d, e, f, g, h, j, k\}$
(b) $B \cup C \cup D = \{a, b, c, d, e, f, g, h, i, j, k\}$
(c) $B \cap C \cap D = \{\ \}$ **(d)** $A \cap B \cap C = \{c\}$

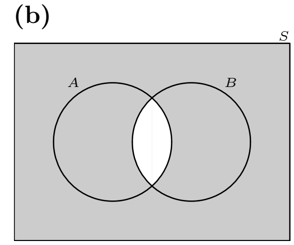
4.9 **(a)** $(A \cap B \cap C)' = \{a, b, d, e, f, g, h, i, j, k\}$
(b) $A \cup B \cup C \cup D = \{a, b, c, d, e, f, g, h, i, j, k\}$
(c) $(B \cup C \cup D)' = \{\ \}$ **(d)** $B' \cap C' \cap D' = \{\ \}$

4.10

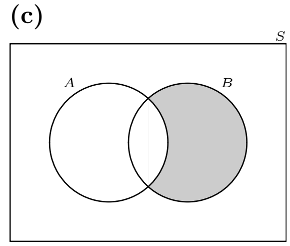
(a)



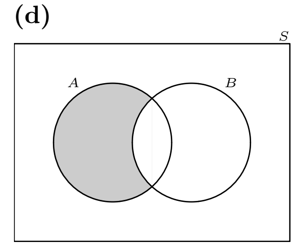
(b)



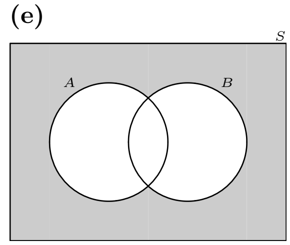
(c)



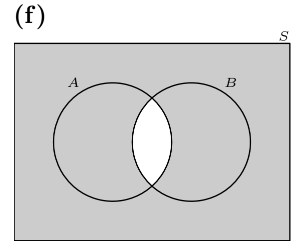
(d)



(e)

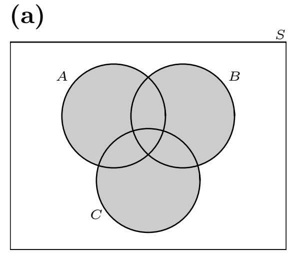


(f)

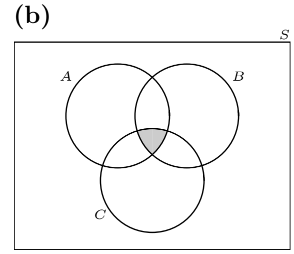


4.11

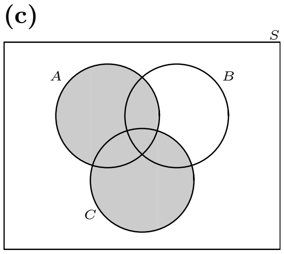
(a)



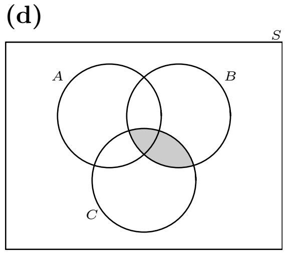
(b)



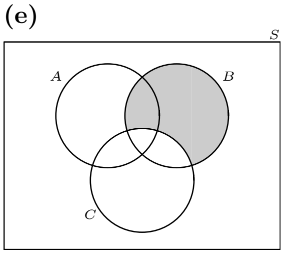
(c)



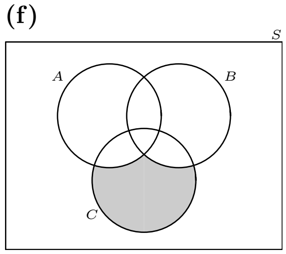
(d)



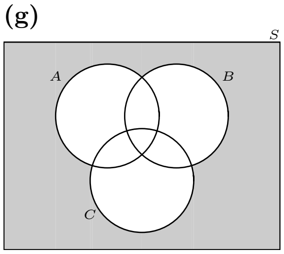
(e)



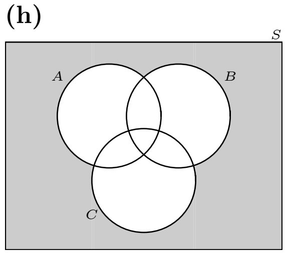
(f)



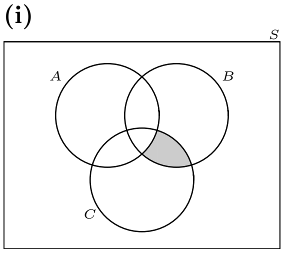
(g)



(h)



(i)

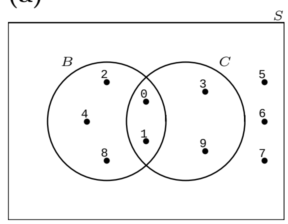


4.12

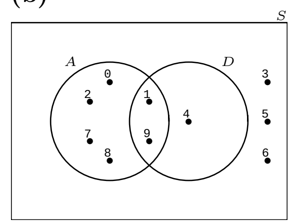
(a) $A = \{$YNN, NYN, NNY$\}$,
$B = \{$YNN, NYN, NNY$\}$,
$C = \{$YNN, NYN, NNY, YYN, YNY, NYY, YYY$\}$,
$D = \{$YYY, YYN, YNY, NYY$\}$
(b) $A \cup D =$
$\{$NNY, NYN, NYY, YNN, YNY, YYN, YYY$\}$
(c) $D' = \{$NNN, NNY, NYN, YNN$\}$
(d) $B \cap C = \{$NNY, NYN, YNN$\}$
(e) $D = \{$YYY, YYN, YNY, NYY$\}$

4.13

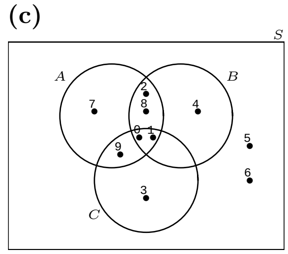
(a)



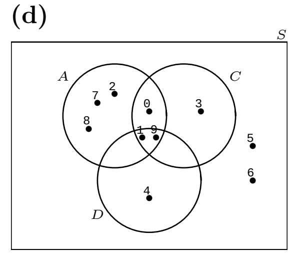
(b)



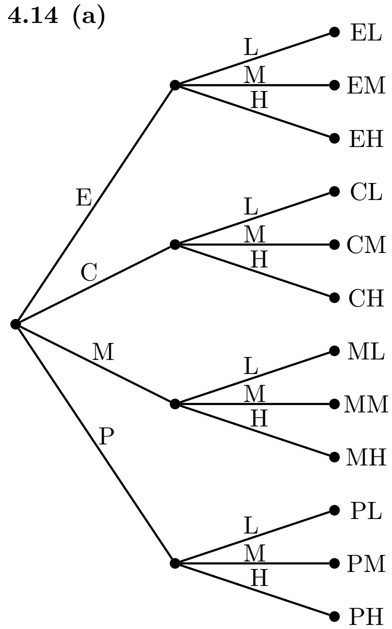
(c)



(d)

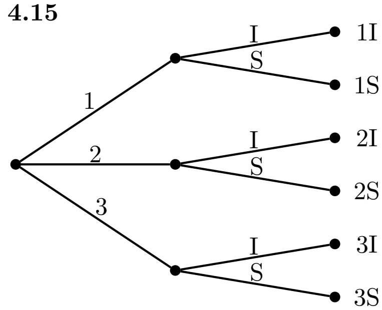


4.14 **(a)**



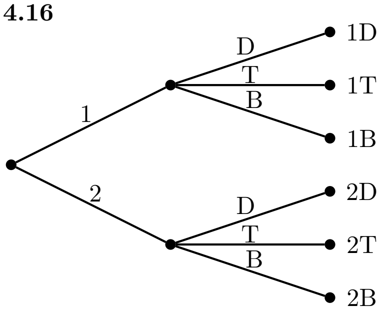
(b) $S = \{$EL, EM, EH, CL, CM, CH, ML, MM, MH, PL, PM, PH$\}$

4.15



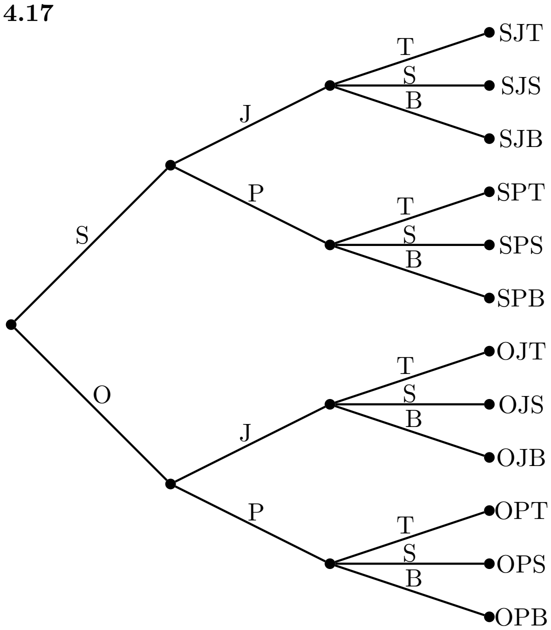
$S = \{$1I, 1S, 2I, 2S, 3I, 3S$\}$

4.16



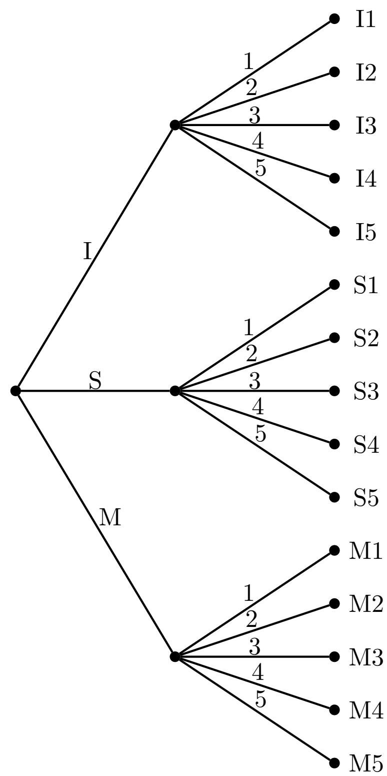
$S = \{$1D, 1T, 1B, 2D, 2T, 2B$\}$

4.17



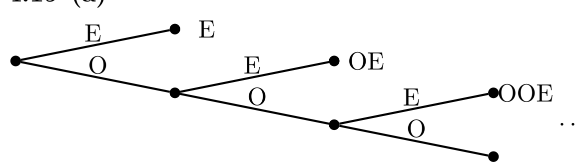
$S = \{$SJT, SJS, SJB, SPT, SPS, SPB,
OJT, OJS, OJB, OPT, OPS, OPB$\}$

4.18 **(a)**



(b) $S = \{$I1, I2, I3, I4, I5, S1, S2, S3, S4, S5,
M1, M2, M3, M4, M5$\}$

4.19 **(a)**



(b) $S = \{$E, OE, OOE, OOOE, $\ldots\}$

4.20 **(a)** 4 **(b)** No. The experiment is over as soon as the bad battery is found.

4.21 111

4.22 398

4.23 **(a)** Infinite. **(b)** H, BH, BBH, BBBH, BBBBH

4.24 **(a)** $S = \{$1G, 1R, 1I, 2G, 2R, 2I, 3G, 3R, 3I, 4G, 4R, 4I$\}$ **(b)** $A = \{$1G, 2G, 3G, 4G$\}$,
$B = \{$2G, 2R, 2I$\}$, $C = \{$3G, 3R, 3I, 1I, 2I, 4I$\}$,
$D = \{$4G$\}$ **(c)** $A \cup B = \{$1G, 2G, 2R, 2I, 3G, 4G$\}$,
$A \cap B = \{$2G$\}$

4.25 **(a)** $S = \{$LS, LU, LV, LP, RS, RU, RV, RP, SS, SU, SV, SP$\}$ **(b)** $A = \{$LV, RV, SV$\}$,
$B = \{$LS, LP, RS, RP, SS, SP$\}$,
$C = \{$LS, LU, LV, LP$\}$,

$D = \{$RS, RU, RV, RP, SS, SU, SV, SP$\}$
(c) $C \cup D = S$, $C \cap D = \{\ \}$

4.26
(a) $S = \{$0L, 1L, 2L, 3L, 4L, 0T, 1T, 2T, 3T, 4T$\}$
(b) $A =$ the patient is late. $B =$ The patient has 3 or 4 cavities. $C =$ The patient has 1 or 3 cavities. $D =$ The patient has 0 cavities. $E =$ The patient has 0 cavities or is late. $F =$ The patient has 4 cavities and is on time.

4.27 **(a)** $S =$ $\{$A0, A1, A2, A3, A4, A5, F0, F1, F2, F3, F4, F5$\}$
(b) $A =$ The passenger has 0 bags. $B =$ The passenger is Foreign. $C =$ The passenger has 1 or 2 bags. $D =$ The passenger is Foreign and has 0 or 5 bags. $E =$ The passenger has an odd number of bags.

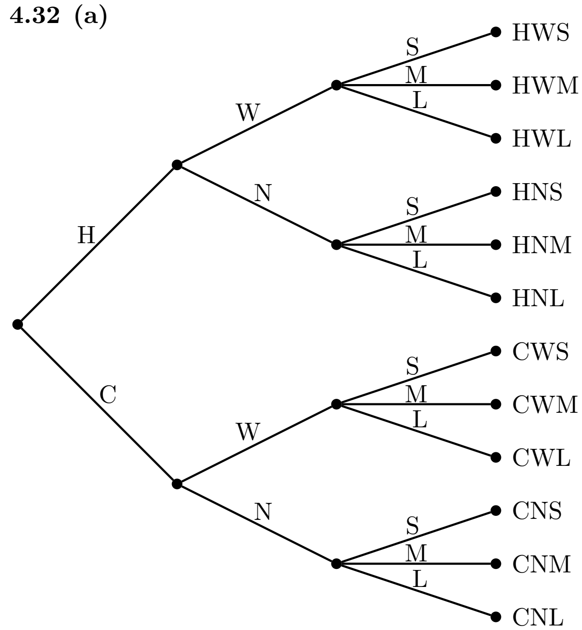
4.28 **(a)** $S = \{$MCY, MCD, MCR, MOY, MOD, MOR, FCY, FCD, FCR, FOY, FOD, FOR$\}$ **(b)** $A =$ The customer is male. $B =$ The customer orders a combo and is retired. $C =$ The customer is young. $D =$ The order type is other.

4.29 **(a)** $S = \{$R1, R2, R3, R4, R5, J1, J2, J3, J4, J5, N1, N2, N3, N4, N5, C1, C2, C3, C4, C5$\}$
(b) $A' = \{$C1, C2, C3, C4, C5, J1, J2, J3, J4, J5, N1, N2, N3, N4, N5$\}$ $A \cup C = \{$C1, C2, J1, J2, N1, N2, R1, R2, R3, R4, R5$\}$ $A \cap D = \{\ \}$ $C \cap D = \{$C1$\}$
$A \cap C \cap D = \{\ \}$ $A \cap B = \{\ \}$

4.30 **(a)** $S = \{$1U, 2U, 3U, 4U, 5U, 6U, 1O, 2O, 3O, 4O, 5O, 6O$\}$ **(b)** $B' = \{$4U, 5U, 6U, 4O, 5O, 6O$\}$
$A \cup B = \{$1U, 2U, 3U, 1O, 2O, 3O, 4O, 5O, 6O$\}$
$A \cap B = \{$1O, 2O, 3O$\}$ $C \cap D = \{$6O$\}$
$A \cap C \cap D = \{$2O$\}$
$(A \cap D)' = \{$1U, 2U, 3U, 4U, 5U, 6U, 1O, 3O, 5O$\}$

4.31
(a) $S = \{$B0, B1, B2, B3, B4, P0, P1, P2, P3, P4$\}$
(b) $A \cup B = \{$B0, B1, B2, B3, B4, P0$\}$ $A \cap B = \{$B0$\}$
$B \cup C = \{$B0, B1, P0, P1$\}$ $B \cap C = \{$B0, P0$\}$
$A \cap D =$ B3$\}$ $A \cap B \cap C \cap D = \{\ \}$

4.32 **(a)**



(b) $S = \{$HWS, HWM, HWL, HNS, HNM, HNL, CWS, CWM, CWL, CNS, CNM, CNL$\}$
(c) $A \cup B = \{$HWS, CWS, HNS, CNS, CWM, CWL, CNM, CNL$\}$ $B \cup C = S$ $B \cap C = \{$CWS, CNS$\}$
$C' = \{$SWM, CWL, CNM, CNL$\}$

Section 4.2

4.33 **(a)** 0.29 **(b)** 0.45 **(c)** 0.84 **(d)** 0.78 **(e)** 0.07 **(f)** 0.49 **(g)** 0.71 **(h)** 0.22 **(i)** 0.71 **(j)** 0.55 **(k)** 0.16 **(l)** 0.13

4.34 **(a)** 0.5 **(b)** 0.3333 **(c)** 0.3333 **(d)** 0.5

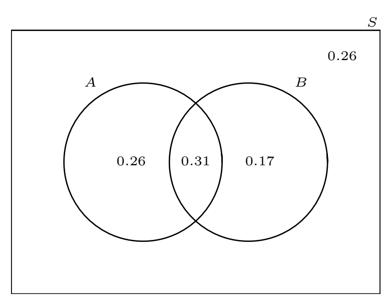
4.35 **(a)** 0.2727 **(b)** 0.5 **(c)** 0.5 **(d)** 0.1364

4.36 **(a)** 0.85 **(b)** 0.15 **(c)** 0.4 **(d)** 0.7

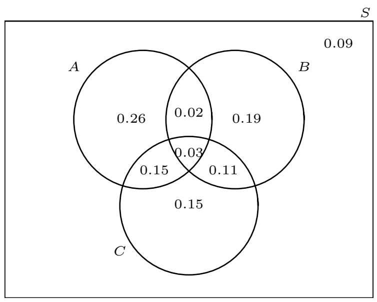
4.37 **(a)** 0.14 **(b)** 0.74 **(c)** 0.86 **(d)** 0.21

4.38 **(a)** 0.532 **(b)** 0.468 **(c)** 0.594 **(d)** 0.771

4.39



4.40



4.41 **(a)** 10, {HLP, HLD, HLV, HPD, HPV, HDV, LPD, LPV, LDV, PDV} **(b)** 0.6 **(c)** 0.3

4.42 **(a)** 0.2222 **(b)** 0.4444 **(c)** 0.6667 **(d)** 0.1111

4.43 **(a)** 0.591 **(b)** 0.033 **(c)** 0.999

4.44 **(a)** 10 **(b)** 0.7 **(c)** 0.6 **(d)** 0.6364, 0.6364

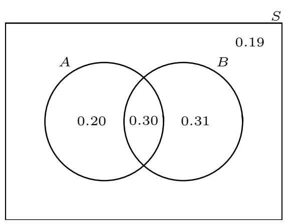
4.45 **(a)** 0.049 **(b)** 0.878 **(c)** 0.231

4.46 **(a)** 0.48 **(b)** 0.28 **(c)** 0.62

4.47 **(a)** 0.23, 0.52, 0.40 **(b)** 0.75, 0, 0.12 **(c)** 0.77, 0.17, 0 **(d)** 0.20, 0.20

4.48 **(a)** 1000 **(b)** 0.01 **(c)** 0.008

4.49 **(a)**



(b) 0.81 **(c)** 0.19 **(d)** 0.2

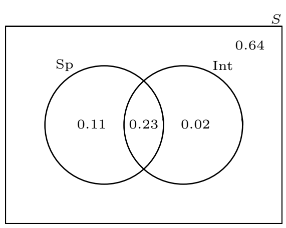
4.50 **(a)** 0.29 **(b)** 0.25 **(c)** 0.24 **(d)** 0.95

4.51 **(a)** 0.85 **(b)** 0.10 **(c)** 0.56 **(d)** 0.184

4.52 **(a)** 0.18, 0.49, 0.26 **(b)** 0.18, 0.44, 0 **(c)** 0.82, 1.0

4.53 **(a)** G_1G_2, G_1G_3, G_1G_4, G_1G_5, G_1G_6, G_1B_1, G_1B_2, G_2G_3, G_2G_4, G_2G_5, G_2G_6, G_2B_1, G_2B_2, G_3G_4, G_3G_5, G_3G_6, G_3B_1, G_3B_2, G_4G_5, G_4G_6, G_4B_1, G_4B_2, G_5G_6, G_5B_1, G_5B_2, G_6B_1, G_6B_2, B_1B_2 **(b)** 0.5357 **(c)** 0.4643 **(d)** 0.0357

4.54 **(a)**



(b) 0.36 **(c)** 0.64 **(d)** 0.13

4.55 **(a)** 0.7 **(b)** 0.3 **(c)** 0.203, 0.097

Section 4.3

4.56 **(a)** 1680 **(b)** 1663200 **(c)** 11880 **(d)** 3628800 **(e)** 10 **(f)** 1 **(g)** 72 **(h)** 380 **(i)** 9900

4.57 **(a)** 126 **(b)** 126 **(c)** 3432 **(d)** 1 **(e)** 10 **(f)** 1 **(g)** 220 **(h)** 11440 **(i)** 190

4.58 362880

4.59 **(a)** 600 **(b)** 4200

4.60 390700800

4.61 240

4.62 6840

4.63 **(a)** 38760 **(b)** 18564 **(c)** 680

4.64 **(a)** 64000 **(b)** 0.0156 **(c)** 59280, 0.0121

4.65 **(a)** 1024 **(b)** 0.0098 **(c)** 59049, 0.0867

4.66 **(a)** 3628800 **(b)** 0.0222 **(c)** 0.2 **(d)** 0.004

4.67 **(a)** 0.1538 **(b)** 0.4615 **(c)** 0.8462

4.68 **(a)** 216 **(b)** 144 **(c)** 36

4.69 **(a)** 1001 **(b)** 0.0699
(c) P(every member a Democrat) = 0.0150. No, I do not believe the selection process was random because the probability of selecting a committee with all Democrats is so small.

4.70 **(a)** 150 **(b)** 30 **(c)** 120

4.71 **(a)** 0.3626 **(b)** 0.0088 **(c)** 0.6374

4.72 **(a)** 5079110400 **(b)** 0.0511

4.73 **(a)** 19958400 **(b)** 0.0076 **(c)** 0.0909

4.74 **(a)** 252 **(b)** 0.5 **(c)** 0.9167

4.75 **(a)** 455 **(b)** 0.022 **(c)** 0.2637 **(d)** 0.8

4.76 **(a)** 77520 **(b)** 0.0015 **(c)** 390700800

4.77 **(a)** 40320 **(b)** 0.125

4.78 **(a)** 0.4242 **(b)** 0.0141

4.79 **(a)** 2550 **(b)** 0.84 **(c)** 0.4706

4.80 **(a)** 1326 **(b)** 0.0045 **(c)** 0.0588 **(d)** 0.2353

4.81 **(a)** 3268760 **(b)** 0.0009
(c) P(none from COST) = 0.0000003. If none of the books are from COST faculty, the process was probably not random since this probability is so small.

4.82 **(a)** 20 **(b)** P(two girls selected) = 0.10. Since this probability is so small, there is evidence to suggest the process was not random.

Section 4.4

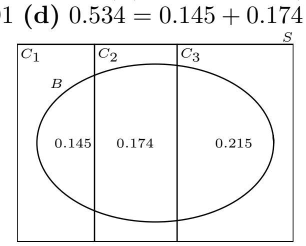
4.83 **(a)** Unconditional. **(b)** Conditional. **(c)** Unconditional. **(d)** Unconditional. **(e)** Conditional.

4.84 **(a)** Conditional. **(b)** Unconditional. **(c)** Unconditional. **(d)** Conditional. **(e)** Unconditional.

4.85 **(a)** Valid. **(b)** Columns: 0.17, 0.22, 0.21, 0.21, 0.19. Rows: 0.74, 0.26 **(c)** 0.12, 0.07, 0.02 **(d)** 0.1923, 0.9048, 0 **(e)** $0.21 = 0.17 + 0.04$

4.86 **(a)** 0.118, 0.396, 0.486 **(b)** 0.455, 0.442, 0.103 **(c)** 0.095, 0.188, 0.093 **(d)** 0.2088, 0.8051, 0.9578 **(e)** 0.4747, 0.1914

4.87 **(a)** 0.466, 0.299 **(b)** 0.135, 0.215 **(c)** 0.3258, 0.4893, 0.4491 **(d)** $0.534 = 0.145 + 0.174 + 0.215$



4.88 **(a)**

	B_1	B_2	B_3	
A_1	178	231	406	815
A_2	123	150	244	517
A_3	165	202	335	702
	466	583	985	2034

(b) 2034 **(c)** 0.4007, 0.2542, 0.3451 **(d)** 0.0875, 0.0737, 0.1647 **(e)** 0.3541, 0.2901, 0.3425

4.89 **(a)** 0.13, 0.36, 0.62, These events are not mutually exclusive and exhaustive. **(b)** 0, 0.15 **(c)** 0.2419, 0.4167 **(d)** 0.2031, 0.7126, 0 **(e)** 0.3056, 0.2778, 0.4167, Given B has occurred, either 3, 4, or 5 must occur.

4.90 **(a)** 0.574, 0.488, 0.465 **(b)** 0.297, 0.218 **(c)** 0.6086, 0.4688, 0.3333 **(d)** 0.2523, 0.1355, 0.7477 **(e)** 0.2910, 0.2623, 0.1291

4.91 **(a)** 0.0784 **(b)** 0.0588 **(c)** 0.2353 **(d)** 0.25

4.92 0.6

4.93 **(a)** 0.8449 **(b)** 0.6544 **(c)** 0.3456

4.94 **(a)** 0.75 **(b)** 0.75

4.95 **(a)** 0.023 **(b)** 0.037 **(c)** 0.963

4.96 **(a)** 0.6 **(b)** 0.2 **(c)** 0.6857

4.97 **(a)** 0.7234 **(b)** 0.2857 **(c)** Fence. P(F | N) largest of the three conditional probabilities.

4.98 **(a)** 0.5299 **(b)** 0.4085 **(c)** 0.5491 **(d)** 0.3254

4.99 **(a)** 0.3441 **(b)** 0.1062 **(c)** 0.2471 **(d)** 0.3779

4.100 **(a)** 0.016 **(b)** 0.4109 **(c)** 0.7124 **(d)** Coliform. Given the well is contaminated, the probability the contaminant is coliform is highest.

4.101
(a)

		Response				
		Very safe	Safe	Unsafe	Very unsafe	
Age	18-24	0.094	0.158	0.022	0.006	0.280
	25-44	0.119	0.177	0.021	0.003	0.320
	45-64	0.090	0.144	0.023	0.003	0.260
	65+	0.038	0.082	0.017	0.003	0.140
		0.341	0.561	0.083	0.015	1.000

(b) 0.144 **(c)** 0.2048 **(d)** 0.0938

4.102 **(a)** 0.09 **(b)** 0.1 **(c)** 0.8934

4.103 **(a)**

		Arrival mode			
		Bus	Car	Walk	
Lunch	Carries	625	466	142	1233
	Buys	345	122	500	967
		970	588	642	2200

(b) 0.2118 **(c)** 0.3557 **(d)** 0.7003 **(e)** Walk.

4.104 **(a)** 0.5385 **(b)** 0.4615 **(c)** 0.3

4.105 **(a)** 0.247 **(b)** 0.388 **(c)** 0.5601

4.106 **(a)** 0.0071 **(b)** 0.4595 **(c)** 0.2194 **(d)** 0.1284

Section 4.5

4.107 **(a)** Dependent. **(b)** Dependent. **(c)** Independent. **(d)** Dependent.

4.108 **(a)** Independent. **(b)** Dependent. **(c)** Dependent. **(d)** Dependent.

4.109 **(a)** 0.085, 0.66, 0.165 **(b)** 0.0527, 0.38, 0.323 **(c)** Not enough information to determine independence or dependence.

4.110 **(a)** 0.2475, 0.1925, 0.1575 **(b)** 0.0866, 0.1609 **(c)** 0.1966, 0.0709

4.111 **(a)** 0.1, 0.18, 0.12 **(b)** Not enough information to determine independence or dependence. **(c)** 0.75. No, $P(B \mid A) + P(C \mid A) + P(D \mid A) = 1$

4.112 **(a)** 0.0283 **(b)** 0.1212 **(c)** 0.3511

4.113 **(a)** $P(A') = 0.65$, $P(C \mid A) = 0.18$, $P(B \mid A') = 0.36$ **(b)** 0.630, 0.234 **(c)** 0.451

4.114 **(a)** $P(A') = 0.65$, $P(B' \mid A) = 0.72$, $P(B \mid A') = 0.24$, $P(C' \mid A \cap B) = 0.63$, $P(C \mid A \cap B') = 0.45$, $P(C \mid A' \cap B) = 0.92$, $P(C' \mid A' \cap B') = 0.36$ **(b)** 0.0363, 0.0562 **(c)** 0.6093. No, $P(B \cap C) \neq P(B)P(C)$.

4.115 **(a)** 0.0011 **(b)** 0.9351 **(c)** 0.0638

4.116 **(a)** 0.01 **(b)** 0.81 **(c)** 0.18

4.117 **(a)** 0.25 **(b)** 0.5 **(c)** 0.75

4.118 **(a)** 0.983 **(b)** 0.17 **(c)** 9606, 0.0394

4.119 **(a)** 0.0393 **(b)** 0.0021 **(c)** 0.9979 **(d)** 2002 eruptions: Asama, no; Krakatau, no; Veniaminof, yes; White Island, no. The probability of this outcome: 0.0000549

4.120 **(a)** 0.9998 **(b)** 0.0002 **(c)** 13863

4.121 **(a)** 0.3285 **(b)** 0.075

4.122 **(a)** 0.24 **(b)** 0.695 **(c)** 0.0072

4.123 **(a)** 0.0016 **(b)** 0.4096 **(c)** 0.1808

4.124 **(a)** A = mass stranding of whales in this area. $P(A) = 0.01$. B = military exercise in this area. $P(B) = 0.001$. $P(A \mid B) = 0.17$ **(b)** 0.00017 **(c)** No. $P(A \cap B) \neq P(A)P(B)$

4.125 **(a)** 0.0475 **(b)** 0.0665 **(c)** 0.7143

4.126 **(a)** 0.0311 **(b)** 0.1132 **(c)** 0.3560

4.127 **(a)** 0.1265 **(b)** 0.2393, 0.7607 **(c)** American Airlines.

4.128 **(a)** 0.2646 **(b)** 0.1554 **(c)** 0.3402

4.129 **(a)** 0.992 **(b)** 0.008 **(c)** 6

4.130 **(a)** 0.2036 **(b)** 0.0021 **(c)** 0.0000003

4.131 **(a)** $P(L) = 0.366$, $P(T' \mid D) = 0.774$, $P(T \mid L) = 0.156$, $P(B' \mid D \cap T) = 0.545$, $P(B' \mid D \cap T') = 0.622$, $P(B' \mid L \cap T) = 0.105$, $P(B' \mid L \cap T') = 0.005$ **(b)** 0.0652 **(c)** 0.3909 **(d)** 0.5803

4.132 **(a)** 0.0317 **(b)** 0.2197 **(c)** 0.2027

4.133 **(a)** 0.7531 **(b)** 0.0057 **(c)** 0.2412

4.134 **(a)** 0.0588, 0.0769, No, $P(A_2 \mid A_1) \neq P(A_2)$ **(b)** 0.0740, 0.0769, No, $P(A_2 \mid A_1) \neq P(A_2)$ **(c)** 0.0057, 0.0059

4.135 **(a)** 0.4428 **(b)** 0.3285 **(c)** 0.0063

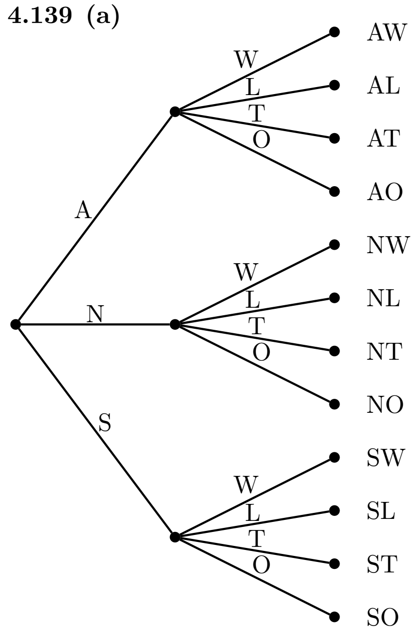
4.136 **(a)** 0.1 **(b)** 0.1497 **(c)** 0.3498

Chapter Exercises

4.137 **(a)** 1140 **(b)** 0.0447 **(c)** 0.4035

4.138 **(a)** S = {BL, BM, BH, GL, GM, GH, EL, EM, EH} **(b)** A = {EL, EM, EH}, B = {BH, GH, EH}, C = {BL, BM, BH, GL, EL}, D = {GM} **(c)** $A \cup B$ = {BH, EH, EL, EM, GH}, $B \cup C$ = {BH, BL, BM, EH, EL, GH, GL}, D' = {BH, BL, BM, EH, EL, EM, GH, GL} **(d)** $A \cap B$ = {EH}, $C \cap D$ = { }, $(B \cup D)'$ = {BL, BM, EL, EM, GL}

4.139 **(a)**



(b) S = {AW, AL, AT, AO, NW, NL, NT, NO, SW, SL, ST, SO} **(c)** E = {SW, SL, ST, SO}, F = {AW, NW, SW}, G = {AO, NW, NL, NT, NO, SO}, H = {AL} **(d)** $E \cup G$ = {AW, NW, SL, SO, ST, SW}, $F \cap G$ = {NW}, H' = {AO, AT, AW, NL, NO, NT, NW, SL, SO, ST, SW} **(e)** $E \cup H'$ = {AO, AT, AW, NL, NO, NT, NW, SL, SO, ST, SW}, $E \cup F \cup G'$ = {AL, AT, AW, NW, SL, SO, ST, SW}, $F \cup G'$ = {AL, AT, AW, NW, SL, ST, SW}

4.140 **(a)** 0.234, 0.92, 0.193 **(b)** 0.234, 0.427, 0.92 **(c)** 0.807, 1.0, 0.08

4.141 **(a)** 0.3 **(b)** 0.81 **(c)** 0.5263

4.142 **(a)** 0.16 **(b)** 0.265 **(c)** 0.2264

4.143 **(a)** 0.99999999, 0.99999997 **(b)** Four engines: 0.999999999996. Six engines: 0.999999999999998. The six-engine plane.

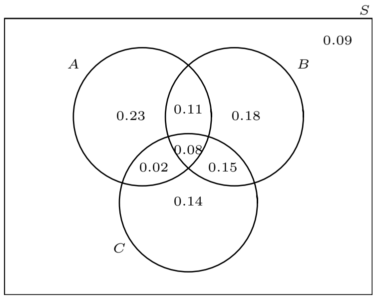
4.144 **(a)** 0.0016 **(b)** 0.4096 **(c)** 0.1536

4.145 **(a)** 0.95 **(b)** 0.05 **(c)** 0.25 **(d)** 0.2143 **(e)** 0.3025

4.146 **(a)** 0.0630 **(b)** 0.4475 **(c)** 0.5520

4.147 **(a)** 0.5470 **(b)** 0.4530 **(c)** Claim: $p = 0.86$. Experiment: $x = 0$. Likelihood: $P(X = 0) = 0.000384$. Conclusion: Since this probability is so small, there is evidence to suggest the study's claim is false.

4.148 **(a)**



(b) 0.23 **(c)** 0.09 **(d)** 0.2564, 0.8, 0.1818

4.149 **(a)** 0.2857 **(b)** 0.2449 **(c)** 0.5974 **(d)** 0.4998

4.150 **(a)** 0.9 **(b)** 0.038 **(c)** 0.342

4.151 **(a)** 0.0631 **(b)** 0.1956 **(c)** 0.1149 **(d)** 0.2994

4.152 **(a)** 0.0642 **(b)** 0.1106 **(c)** 0.1501 **(d)** 0.0114

4.153 **(a)** 0.7225 **(b)** 0.0225 **(c)** 0.0811

4.154 **(a)** 0.0039 **(b)** 0.3164 **(c)** 0.2109

4.155 **(a)** 0.3481 **(b)** 0.0289 **(c)** 0.3111 **(d)** No. Those people who know the Supreme Court Justices are probably less likely to know the Three Stooges.

4.156 **(a)** 0.0838 **(b)** 0.7468 **(c)** 0.1341 **(d)** 0.0135 **(e)** 0.9004 **(f)** No. $P(W \cap O) \neq P(W)P(O)$ **(g)** 0.0049

Exercises′

4.157 **(a)** 4 **(b)** 8 **(c)** 16 **(d)** 2^n

4.158 **(a)** 0.4226 **(b)** 0.0475 **(c)** 0.0211 **(d)** 0.0039 **(e)** 0.0019

4.159 $(n-1)!$

4.160 637408200

4.161 **(a)** 5.7190×10^{21} **(b)** 3.6791×10^{-10} (pretty close to 0) **(c)** 0.2008

4.162 **(a)** 0.0535 **(b)** 0.5429 **(c)** 0.7658 **(d)** 0.2810 **(e)** 0.4563

Chapter 5

Section 5.1

5.1 **(a)** Discrete. **(b)** Continuous. **(c)** Continuous. **(d)** Discrete. **(e)** Discrete. **(f)** Continuous. **(g)** Discrete. **(h)** Discrete.

5.2 **(a)** Discrete. **(b)** Continuous. **(c)** Discrete. **(d)** Discrete. **(e)** Continuous. **(f)** Continuous.

5.3 **(a)** Discrete. **(b)** Continuous. **(c)** Continuous. **(d)** Discrete. **(e)** Continuous. **(f)** Discrete.

5.4 **(a)** $S =$ {MM, MW, MB, MG, WM, WW, WB, WG, BM, BW, BB, BG, GM, GW, GB, GG} **(b)** 0, 1, 2. Discrete. X can assume only a finite number of values.

5.5 Continuous. Measuring a length of time.

5.6 **(a)** Discrete. **(b)** Continuous. **(c)** Discrete. **(d)** Continuous.

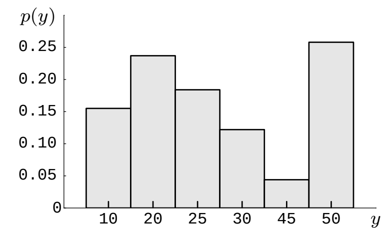
5.7 Continuous. Measuring a distance.

5.8 Continuous. Measuring acceleration.

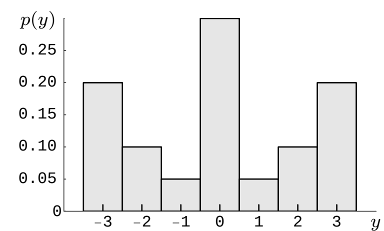
Section 5.2

5.9 **(a)** 0.07 **(b)** 0.62, 0.42 **(c)** 0.7 **(d)** 0.38

5.10 **(a)** 0.044 **(b)** 0.608, 0.424 **(c)** 0.772 **(d)**



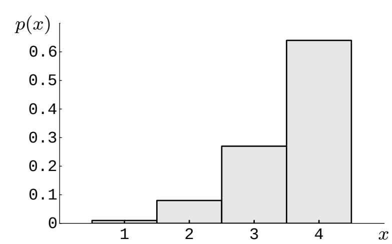
5.11 **(a)** 0.65, 0.35 **(b)** 0.6 **(c)** 0.4615 **(d)**



5.12 **(a)** Not valid. Sum of the probabilities is greater than 1. **(b)** Not valid. $P(8) < 0$. **(c)** Valid.

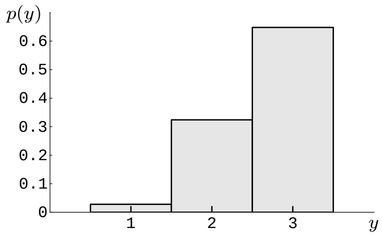
5.13

x	1	2	3	4
$p(x)$	0.01	0.08	0.27	0.64

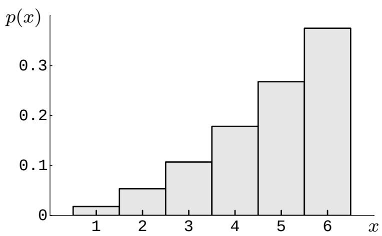


5.14

x	1	2	3
$p(x)$	0.028	0.324	0.648



5.15 **(a)** $p(x) \geq 0$ for all x and $\sum_{x=1}^{6} p(x) = 1$
(b) 0.1786 **(c)** 0.9286 **(d)** 0.2857
(e)



5.16 **(a)** 0.9 **(b)** 0.975 **(c)** 0.000625 **(d)** 0.049, 0.020

5.17 **(a)** 0.35 **(b)** 0.95 **(c)** 0.04 **(d)** 0.01 **(e)** 0.5775

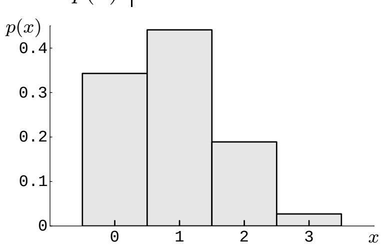
5.18 **(a)** 0.3679 **(b)** 0.6321 **(c)** 0.9197 **(d)** 0
(e) 0.0719

5.19 **(a)** 0.1 **(b)** 0.65 **(c)** 0.3025 **(d)** 0.0023
(e)

y	50	100	150	200	250
$p(y)$	0.55	0.35	0.07	0.02	0.01

5.20 **(a)**

x	0	1	2	3
$p(x)$	0.343	0.441	0.189	0.027



(b) 0.027 **(c)** 0.657

5.21

y	0	1	2	3	4
$p(y)$	0.0003	0.0095	0.0977	0.3849	0.5076

(b) 0.9997 **(c)** 0.5126

5.22

x	0	1	2
$p(x)$	0.4000	0.5333	0.0667

5.23 **(a)** $S = \{\text{Y, NY, NNY, NNNY}, \ldots\}$
(b) P(Y) = 0.2, P(NY) = 0.16, P(NNY) = 0.128, P(NNNY) = 0.1024
(c)

Outcome	x
Y	1
NY	2
NNY	3
NNNY	4

(d) $P(X = x) = (0.8)^{x-1}(0.2)$

5.24 **(a)**

m	100	250	500	1000
$p(m)$	0.0667	0.1333	0.4667	0.3333

(b) 0.1111

5.25

x	2	3	4	5	6	7	8
$p(x)$	0.01	0.03	0.0725	0.175	0.2125	0.25	0.25

5.26
(a)

x	0	1	2	3	4
$p(x)$	0.0039	0.0469	0.2109	0.4219	0.3164

(b) Claim: probability of getting a meal in under two minutes is 0.75.
Experiment: $x = 0$.
Likelihood: $P(X = 0) = 0.0039$.
Conclusion: There is evidence to suggest the manager's claim is false since this probability is so low.

Section 5.3

5.27 $\mu = 7.2$, $\sigma^2 = 8.96$, $\sigma = 2.9933$

5.28 **(a)** $\mu = 13.5$, $\sigma^2 = 12.75$, $\sigma = 3.5707$ **(b)** 0.25 **(c)** The mean should be close to 15 since this value has the highest probability.

5.29 **(a)** $\mu = 0$, $\sigma^2 = 270$, $\sigma = 16.4317$ **(b)** 1 **(c)** 0.55, 0.45

5.30 **(a)** $\mu = 6.45$, $\sigma^2 = 14.6475$, $\sigma = 3.8272$
(b) $\mu = 13.9$, $\sigma^2 = 58.59$, $\sigma = 7.6544$ **(c)** $\mu = 57.25$, $\sigma^2 = 3012.7875$, $\sigma = 54.8889$

5.31 **(a)** $\mu = 7.35$, $\sigma^2 = 24.6275$, $\sigma = 4.9626$ **(b)** 0.4 **(c)** 0.95

5.32 **(a)** Valid. $p(x) \geq 0$ for all x and $\sum_{\text{all } x} p(x) = 1$.
(b) $\mu = 1.025$, $\sigma^2 = 1.8744$, $\sigma = 1.3691$ **(c)** 0.75
(d) 0.01

5.33 **(a)** $\mu = 1.085$ **(b)** $\sigma^2 = 0.1503$, $\sigma = 0.3877$
(c) 0.7 **(d)** 0.84

5.34 **(a)** $p(x) \geq 0$ for all x and $\sum_{\text{all } x} p(x) = 1$.
(b) $\mu = 7.3725$, $\sigma^2 = 64.5576$, $\sigma = 8.0348$ **(c)** 0.2591

5.35 **(a)** $\mu = 12.725$, $\sigma^2 = 2.1594$, $\sigma = 1.4695$
(b) 0.81 **(c)** $\mu = 16.45$, $\sigma^2 = 8.6375$, $\sigma = 2.939$

5.36 **(a)** $\mu = 2.61$, $\sigma^2 = 1.2779$, $\sigma = 1.1304$
(b) 0.0561 **(c)** 0.23

5.37 **(a)** $\mu = 366.75$, $\sigma^2 = 2294.4375$, $\sigma = 47.9003$
(b) 0.022 **(c)** 0.432

5.38 **(a)** $p(x) \geq 0$ for all x and $\sum_{\text{all } x} p(x) = 1$.
(b) $\mu = 0$, $\sigma^2 = 5.2632$, $\sigma = 2.2942$ **(c)** 0.0028

5.39 **(a)** $\mu = 15.55$, $\sigma^2 = 40.4475$, $\sigma = 6.3598$
(b) 0.82 **(c)** 0.92 **(d)** 386

5.40 **(a)** $\mu = 10.71$, $\sigma^2 = 2.7459$, $\sigma = 1.6571$ **(b)** 0.14
(c) 0.1693

5.41 **(a)** $\mu = 7.998$, $\sigma^2 = 6.706$, $\sigma = 2.5896$ **(b)** 0.6
(c) 0.000144

Section 5.4

5.42 **(a)** 0.2361 **(b)** 0.0802 **(c)** 0.0393 **(d)** 0.0566
(e) 0.7638

5.43 **(a)** 0.0565 **(b)** 0.8829 **(c)** 0.9997 **(d)** 0.5920

5.44 **(a)** ≈ 1 **(b)** 0.9995 **(c)** 0.5118 **(d)** 0.8047

5.45 **(a)** $\mu = 20$, $\sigma^2 = 4$, $\sigma = 2$ **(b)** 0.7927 **(c)** 0.211

5.46 **(a)** $\mu = 12$, $\sigma^2 = 7.2$, $\sigma = 2.6833$
(b) $(9.3167, 14.6833)$, $(6.6334, 17.3666)$,
$(3.9501, 20.0499)$ **(c)** 0.000856 **(d)** 0.9788

5.47 **(a)**

x	$p(x)$
0	0.0010
1	0.0098
2	0.0439
3	0.1172
4	0.2051
5	0.2461
6	0.2051
7	0.1172
8	0.0439
9	0.0098
10	0.0010

(b) $\mu = 5$, $\sigma^2 = 2.5$, $\sigma = 1.5811$ **(c)** $\mu = 5$, $\sigma^2 = 2.5$,
$\sigma = 1.5811$

5.48 **(a)** 0.0432 **(b)** 0.9999 **(c)** 18 **(d)** 0.1230

5.49 **(a)** 0.1484 **(b)** 0.2361
(c) Claim: $p = 0.75 \implies X \sim \text{B}(15, 0.75)$
Experiment: $x = 9$
Likelihood: $\text{P}(X \leq 9) = 0.1484$
Conclusion: There is no evidence to suggest the claim is false.

5.50 **(a)** 24 **(b)** 0.9744 **(c)** 0.0095

5.51 **(a)** 0.1171 **(b)** 0.1256 **(c)** 0.5841
(d) Claim: $p = 0.60 \implies X \sim \text{B}(20, 0.60)$
Experiment: $x = 19$
Likelihood: $\text{P}(X \geq 19) = 0.0005$
Conclusion: There is evidence to suggest the claim is false.

5.52 **(a)** $\mu = 45$, $\sigma^2 = 4.5$, $\sigma = 2.1213$ **(b)** 0.9421
(c) 0.8304
(d) Claim: $p = 0.9 \implies X \sim \text{B}(50, 0.9)$
Experiment: $x = 41$
Likelihood: $\text{P}(X \leq 41) = 0.0579$
Conclusion: There is no evidence to suggest the claim is false.

5.53 **(a)** $\mu = 7.5$, $\sigma^2 = 5.625$, $\sigma = 2.3717$ **(b)** 0.6008
(c) 0.0322
(d) Claim: $p = 0.25 \implies X \sim \text{B}(30, 0.25)$
Experiment: $x = 10$
Likelihood: $\text{P}(X \geq 10) = 0.1966$
Conclusion: There is no evidence to suggest the claim is false.

5.54 **(a)** 0.1408 **(b)** 0.1011
(c) Claim: $p = 0.34 \implies X \sim \text{B}(35, 0.34)$
Experiment: $x = 8$
Likelihood: $\text{P}(X \leq 8) = 0.1103$
Conclusion: There is no evidence to suggest the claim is false.

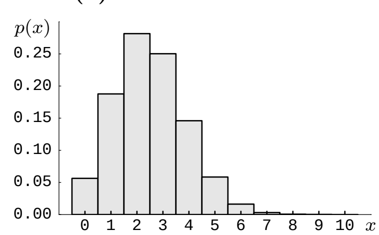
5.55 **(a)** 0.1326 **(b)** 2 **(c)** 0.3233
(d) Claim: $p = 0.02 \implies X \sim \text{B}(100, 0.02)$
Experiment: $x = 6$
Likelihood: $\text{P}(X \geq 6) = 0.0155$
Conclusion: There is evidence to suggest the claim is false.

5.56 **(a)** 0.2023 **(b)** 0.1018 **(c)** 0.3789 **(d)** 0.1721

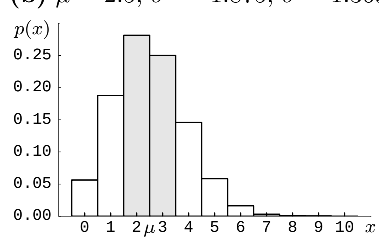
5.57 **(a)** 0.2277 **(b)** $\mu = 6$, 0.1916 **(c)** 0.0019

5.58 **(a)** 0.1651 **(b)** 0.5699
(c) Claim: $p = 597/3000 \implies X \sim \text{B}(40, 597/3000)$
Experiment: $x = 40$
Likelihood: $\text{P}(X \geq 14) = 0.0186$
Conclusion: There is evidence to suggest the probability of a conviction has increased.

5.59 **(a)**



(b) $\mu = 2.5$, $\sigma^2 = 1.875$, $\sigma = 1.3693$ **(c)** 0.5318



5.60 **(a)** 0.2880, 0.0640 **(b)** 0.9744 **(c)** 0.9898 **(d)** $n \geq 8$

5.61 **(a)** $\mu = 15$, $\sigma^2 = 7.5$, $\sigma = 2.7386$ **(b)** 0.9572, Chebyshev's Rule: at least 0.75. **(c)** 0.2472

5.62 **(a)** 0.0014 **(b)** 0.9659 **(c)** 0.9064

5.63 **(a)** $\mu = 15.9$, $\sigma^2 = 7.4730$, $\sigma = 2.7337$
(b) 0.0447 **(c)** 0.1344
(d) Claim: $p = 0.53 \implies X \sim \mathrm{B}(30, 0.53)$
Experiment: $x = 12$
Likelihood: $\mathrm{P}(X \leq 12) = 0.1068$
Conclusion: There is no evidence to suggest the claim is false.

5.64 **(a)** $\mu = 6.5$, $\sigma^2 = 4.81$, $\sigma = 2.1932$
(b) $(4.3068, 8.8632)$, $(2.1136, 10.8864)$, $(-0.0796, 13.0796)$ **(c)** 3.8756. A very unlikely observation.

5.65 **(a)** 0.1103 **(b)** 0.8174
(c) Claim: $p = 0.67 \implies X \sim \mathrm{B}(50, 0.67)$
Experiment: $x = 25$
Likelihood: $\mathrm{P}(X \leq 25) = 0.0094$
Conclusion: There is evidence to suggest the claim is false.

5.66 **(a)** 0.1593 **(b)** 0.0979
(c) Claim: $p = 0.75 \implies X \sim \mathrm{B}(30, 0.75)$
Experiment: $x = 17$
Likelihood: $\mathrm{P}(X \leq 17) = 0.0216$
Conclusion: There is evidence to suggest the proportion of volunteer firefighters has decreased.
(d) 0.0688

Section 5.5

5.67 **(a)** 0.0961 **(b)** 0.4225 **(c)** 0.5775 **(d)** 0.4225

5.68 **(a)** 0.25 **(b)** 0.4290 **(c)** 0.0563

5.69 **(a)** 0.1353 **(b)** 0.5938 **(c)** 0.0166 **(d)** 0.9955

5.70 **(a)** 0.4679 **(b)** 0.1125 **(c)** 0.3606 **(d)** 0.9597

5.71 **(a)** 0.3788 **(b)** 0.0076 **(c)** $\mu = 2.5$, $\sigma^2 = 0.7955$, $\sigma = 0.8919$

5.72 **(a)** 4, 5, 6, 7, 8 **(b)** $\mu = 6$, $\sigma^2 = 0.8$, $\sigma = 0.8944$ **(c)** 0.2462 **(d)** 0.0385

5.73 **(a)** 0.0630 **(b)** 0.30 **(c)** 1.4286 **(d)** 71.4286

5.74 **(a)** 0.2510 **(b)** 0.1226 **(c)** 0.0055

5.75 **(a)** 0.2275 **(b)** 0.0264 **(c)** 2.8571 **(d)** 0.1785

5.76 **(a)** 0.2584 **(b)** 0.9940 **(c)** 0.2166 **(d)** 0.0127

5.77 **(a)** 0.4789 **(b)** 0.0789 **(c)** 0.6 **(d)** 10

5.78 **(a)** 0.2384 **(b)** 0.1523
(c) Claim: $\mu = 2.8 \implies X$ is Poisson with mean 2.8
Experiment: $x = 8$
Likelihood: $\mathrm{P}(X \geq 8) = 0.0081$
Conclusion: There is evidence to suggest the mean is different from (greater than) 2.8.

5.79 **(a)** 0.7442 **(b)** 0.0231 **(c)** 0.0000000413

5.80 **(a)** 0.99 **(b)** 1.1111 **(c)** 0.00001

5.81 **(a)** 0.1280 **(b)** 0.5379 **(c)** 0.2621 **(d)** 0.5120 **(e)** 0.5120

5.82 **(a)** 0.0821 **(b)** 0.0042 **(c)** 0.9580

5.83 **(a)** 0.0041 **(b)** 1.2048 **(c)** 0.9951 **(d)** 0.0289

5.84 **(a)** 0.3297 **(b)** 0.0037 **(c)** 0.8462

5.85 **(a)** 0.0202 **(b)** 0.7014 **(c)** 0.0069

5.86 **(a)** 0.0091 **(b)** 0.1954 **(c)** 0.0959

5.87 **(a)** 0.0183, 0.0733, 0.1465 **(b)** 0.0003, 0.0027, 0.0107 **(c)** 0.0003, 0.0027, 0.0107 **(d)** Same. Poisson random variable is additive.

Chapter Exercises

5.88 **(a)** 0.1138 **(b)** 0.7376
(c) Claim: $p = 0.855 \implies X \sim \mathrm{B}(30, 0.855)$
Experiment: $x = 20$
Likelihood: $\mathrm{P}(X \leq 20) = 0.0076$
Conclusion: There is evidence to suggest the claim is false, that the proportion of vehicles that pass an initial IM240 test has changed.

5.89 **(a)** $\mu = 3$, $\sigma^2 = 2$, $\sigma = 1.4142$ **(b)** $\mu = 3.5$, $\sigma^2 = 2.9167$, $\sigma = 1.7078$ **(c)** $\mu = (n+1)/2$, $\sigma^2 = (n^2-1)/12$, $\sigma = \sqrt{(n^2-1)/12}$

5.90 **(a)** $\mu = 20$, $\sigma^2 = 4$, $\sigma = 2$ **(b)** 0.8909
(c) Claim: $p = 0.8 \implies X \sim \mathrm{B}(25, 0.8)$
Experiment: $x = 21$
Likelihood: $\mathrm{P}(X \geq 21) = 0.4207$
Conclusion: There is no evidence to suggest the supervisor's claim is false.

5.91 **(a)** $\mu = 5.93$, $\sigma^2 = 4.4651$, $\sigma = 2.1131$ **(b)** 0.24 **(c)** 0.16 **(d)** 0.75

5.92 **(a)** 0.0573 **(b)** 12.5 **(c)** 0.1887

5.93 **(a)** 0.4966 **(b)** 0.00009 **(c)** 0.6016

5.94 **(a)** 0.2021 **(b)** 0.9999 **(c)** 0.000087

5.95 **(a)** 0.0698 **(b)** 0.7323, 0.3450 **(c)** 0.0299, 0.8462, 0.5

5.96 **(a)**

x	10	20	30	40
$p(x)$	0.2500	0.4725	0.1800	0.0975

(b) $\mu = 21.25$, $\sigma^2 = 80.4375$, $\sigma = 8.9687$ **(c)** 0.75

5.97 **(a)** 0.0498 **(b)** 0.7673
(c) Claim: $\mu = 3 \implies X$ is Poisson with mean 3
Experiment: $x = 9$
Likelihood: $P(X \geq 9) = 0.0038$
Conclusion: There is evidence to suggest the mean number of rescues per hour has changed (increased).

5.98 **(a)** 0.0774 **(b)** 0.8041 **(c)** 0.0238 **(d)** 0.6476

5.99 **(a)** 0.2721 **(b)** 0.0004 **(c)** 336

5.100 **(a)** 0.2205 **(b)** 0.0567 **(c)** 1.8795×10^{-12}

5.101 **(a)** $\mu = 42$, $\sigma^2 = 6.72$, $\sigma = 2.5923$ **(b)** 0.8339 **(c)** 0.9213

5.102 **(a)** 0.1257 **(b)** 0.0042 **(c)** 7.491×10^{-10}

5.103 **(a)** 0.2194 **(b)** 0.4512
(c) Claim: $p = 0.85 \implies X \sim B(50, 0.85)$
Experiment: $x = 35$
Likelihood: $P(X \leq 35) = 0.0053$
Conclusion: There is evidence to suggest the claim is false, that the poll results are wrong.

5.104 **(a)** 0.1353 **(b)** 9
(c) Claim: $p = 0.31 \implies X \sim B(40, 0.31)$
Experiment: $x = 18$
Likelihood: $P(X \geq 18) = 0.0436$
Conclusion: There is evidence to suggest the claim is false, that the proportion of skiers 45 or older has changed.

5.105 **(a)** $\mu = 5.4$, $\sigma^2 = 4.428$, $\sigma = 2.1043$ **(b)** 0.1582 **(c)** 0.0197

Exercises′

5.106 **(a)** $\mu = 0.6$, $\sigma^2 = 0.24$, $\sigma = 0.4899$ **(b)** $\mu = 0.7$, $\sigma^2 = 0.21$, $\sigma = 0.4583$ **(c)** $\mu = 0.8$, $\sigma^2 = 0.16$, $\sigma = 0.4000$ **(d)** $\mu = p$, $\sigma^2 = p(1-p)$, $\sigma = \sqrt{p(1-p)}$ **(e)** $p = 0.5$

5.107 $\mu_Y = a\mu_X + b$, $\sigma_Y^2 = a^2\sigma_X^2$

5.108

$$\begin{aligned} E[(X-\mu)^2] &= \sum_{\text{all } x}(x-\mu)^2 p(x) = \sum_{\text{all } x}(x^2 - 2x\mu + \mu^2)p(x) \\ &= \sum_{\text{all } x} x^2 p(x) - 2\mu \sum_{\text{all } x} x p(x) + \mu^2 \sum_{\text{all } x} p(x) \\ &= E(X^2) - 2\mu\mu + \mu^2 = E(X^2) - \mu^2 \end{aligned}$$

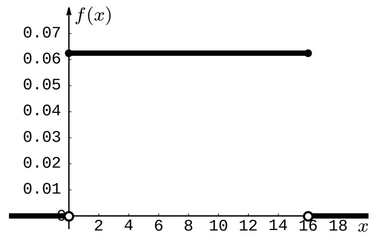
5.109 $\mu_Y = 0$, $\sigma_Y^2 = 1$, $\sigma_Y = 1$

5.110 1.782, 1.9249, 1.9775. This number is converging to $\mu = 2$.

Chapter 6

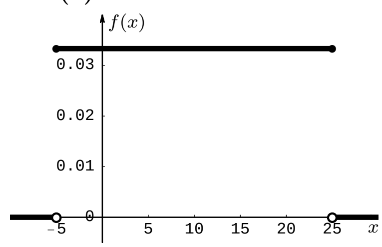
Section 6.1

6.1 **(a)**



(b) $\mu = 8$, $\sigma^2 = 21.3333$, $\sigma = 4.6188$ **(c)** 0.75 **(d)** 0.625 **(e)** 0.4375

6.2 **(a)**



(b) $\mu = 10$, $\sigma^2 = 75$, $\sigma = 8.6603$ **(c)** 0.1333 **(d)** 0.8333, 0.8333 **(e)** 0.3333

6.3 **(a)** $\mu = 75$, $\sigma^2 = 208.3333$, $\sigma = 14.4338$ **(b)** 0.5774 **(c)** 0 **(d)** $c = 60$

6.4 **(a)** $\mu = 45$, $\sigma^2 = 133.3333$, $\sigma = 11.5470$ **(b)** 0 **(c)** $c = 49$ **(d)** 0.0625

6.5 **(a)** 0.8647 **(b)** 0.6065 **(c)** 0.5578 **(d)** 0.4551

6.6 **(a)** 0.0625 **(b)** 0.4375 **(c)** 0 **(d)** 0.3125 **(e)** 0.4444 **(f)** 2.8284. The distribution is not symmetric.

6.7 **(a)** 0.875 **(b)** 0.375 **(c)** $\mu = 8.5$, 0.5774 **(d)** $t = 9.5$

6.8 **(a)** 0.2143 **(b)** 0.3 **(c)** 0.0571

6.9 **(a)** 0.2857 **(b)** 0.2143 **(c)** $\mu = 0.043$, $\sigma^2 = 0.0000163$, $\sigma = 0.004$

6.10 **(a)** 0.5 **(b)** 0.3333 **(c)** 37.5 **(d)** 0.1667

6.11 **(a)** $f(x) \geq 0$ and total area is 1. **(b)** 0.4375 **(c)** 0.3125 **(d)** $t = 5.8579$ **(e)** 0.0056, 0.8741, 0.2751

6.12 **(a)** 0.8 **(b)** 0.4 **(c)** 0.6

6.13 **(a)** 0.5 **(b)** 0.08 **(c)** 0.08 **(d)** 0.84

6.14 **(a)** $f(x) \geq 0$ and total area is 1. **(b)** 0.75 **(c)** 0.75 **(d)** 0.25

6.15 **(a)** $f(x) \geq 0$ and total area is 1. **(b)** 0.3125 **(c)** 0.3750 **(d)** $c = 1.8636$

6.16 **(a)** 0.6321 **(b)** 0.2231 **(c)** 0.2492

6.17 **(a)** 0.3333 **(b)** $\mu = 2$, 0 **(c)** 3.75 **(d)** 0.00013

Section 6.2

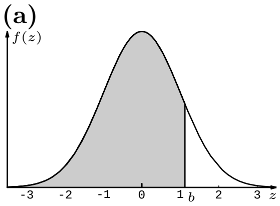
6.18 **(a)** 0.9846 **(b)** 0.9846 **(c)** 0.3192 **(d)** 0.7673 **(e)** 0.0401 **(f)** 0.3790 **(g)** 1 **(h)** 0 **(i)** 1

6.19 **(a)** 0.0918 **(b)** 0.9906 **(c)** 0.0048 **(d)** 0.2284 **(e)** 0.4409 **(f)** 0.2963 **(g)** 0.0038 **(h)** 0.9222 **(i)** 0.0455 **(j)** 0.1392

6.20 **(a)** 0.6827 **(b)** 0.9545 **(c)** 0.9973. These are the Empirical Rule probabilities.

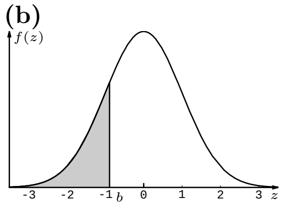
6.21

(a)



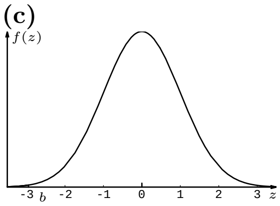
$b = 1.1198$

(b)



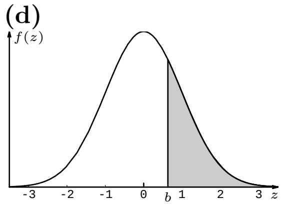
$b = -0.8901$

(c)



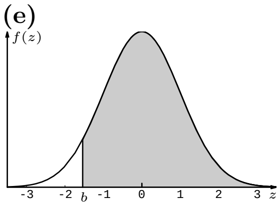
$b = -2.9478$

(d)



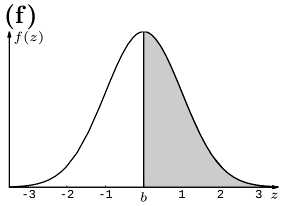
$b = 0.6301$

(e)



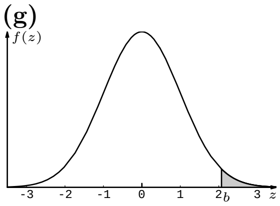
$b = -1.5398$

(f)



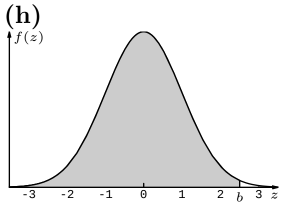
$b = 0$

(g)



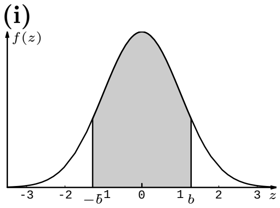
$b = 2.0706$

(h)



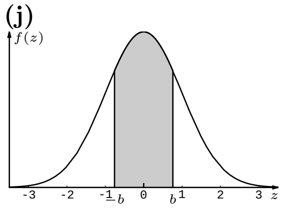
$b = 2.5006$

(i)



$b = 1.2804$

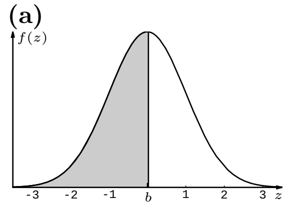
(j)



$b = 0.7601$

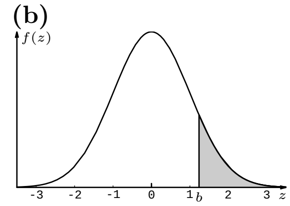
6.22

(a)



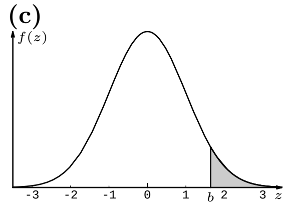
$b = 0.0251$

(b)



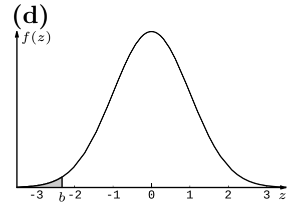
$b = 1.2372$

(c)



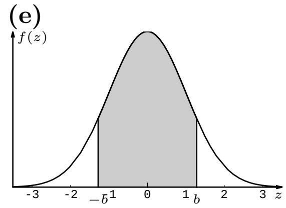
$b = 1.6449$

(d)



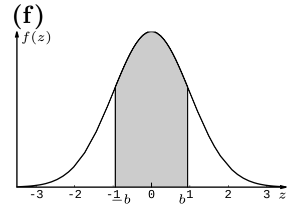
$b = -2.3264$

(e)



$b = 1.2816$

(f)



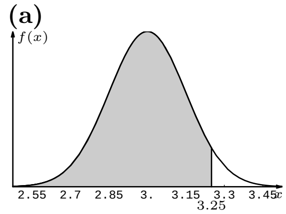
$b = 0.9416$

6.23 **(a)** -1.2816 **(b)** -0.6128 **(c)** 1.0364 **(d)** -0.2533 **(e)** -0.0251 **(f)** 0.2793

6.24 **(a)** -0.6745, 0.6745 **(b)** -2.6980, 2.6980 **(c)** 0.0070 **(d)** -4.7214, 4.7214 **(e)** 0.00000234

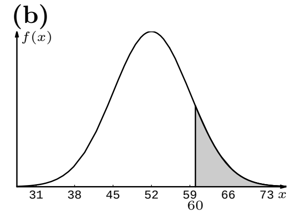
6.25

(a)



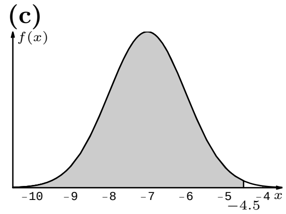
$P(X \leq 3.25) = 0.9522$

(b)



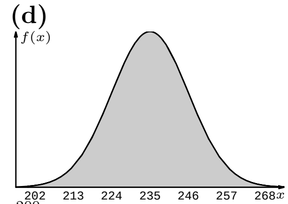
$P(X > 60) = 0.1265$

(c)



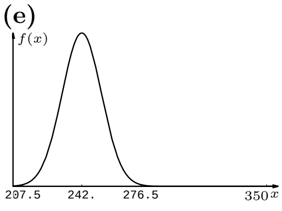
$P(X \leq -4.5) = 0.9938$

(d)



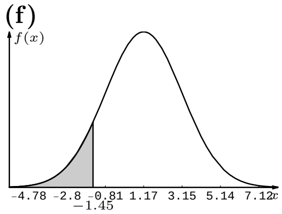
$P(X > 200) = 0.9993$

(e)



$P(X \geq 350) = 0$

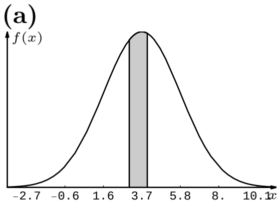
(f)



$P(X < -1.45) = 0.0934$

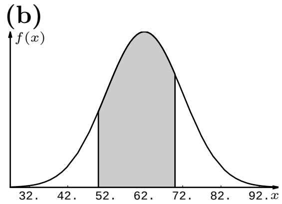
6.26

(a)



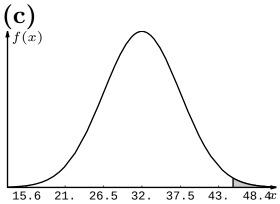
$P(3 \leq X \leq 4) = 0.1845$

(b)



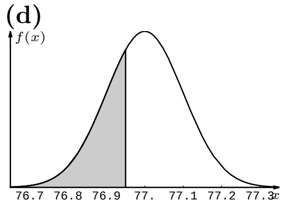
$P(50 < X < 70) = 0.6731$

(c)



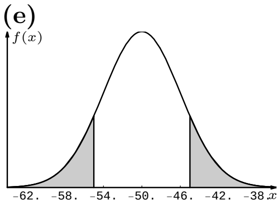
$P(X \geq 45) = 0.0088$

(d)



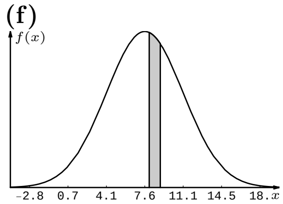
$P(X < 76.95) = 0.3085$

(e)



$P(X < -55 \cup X > -45)$
$= 0.1110$

(f)



$P(8 \leq X \leq 9) = 0.2113$

6.27 **(a)** 20.5691 **(b)** 289.2382 **(c)** 8.2243
(d) −11.4551 **(e)** 38.4917 **(f)** 23.0566

6.28 **(a)** 20.9531, 29.0469 **(b)** 8.8123, 41.1878
(c) 0.0070 **(d)** −3.3286, 53.3286 **(e)** 0.00000234

6.29 **(a)** 0.2811 **(b)** 0.1717 **(c)** 32.8427

6.30 **(a)** 0.2798 **(b)** 0.8596 **(c)** 0.0030

6.31 **(a)** 0.0345 **(b)** 0.1471 **(c)** 50.7798

6.32 **(a)** 0.0613 **(b)** 0.4481 **(c)** 0.0021
(d) $(20.7172, 23.3828)$

6.33 **(a)** 0.7335 **(b)** 0.7107 **(c)** 0.9233 **(d)** 0.2294

6.34 **(a)** 0.0013 **(b)** 0.7745 **(c)** 0.0000317
(d) $(91.2011, 208.7989)$

6.35 **(a)** 0.8186 **(b)** 0.0062 **(c)** 0.0013 **(d)** 0.1499

6.36 **(a)** 0.4648 **(b)** 0.4194 **(c)** 0.2370 **(d)** 0.0043

6.37 **(a)** 0.0384 **(b)** 0.1323 **(c)** 0.9427
(d) $(33.7293, 34.4307)$, quartiles.

6.38 **(a)** 0.1957 **(b)** 0.3852 **(c)** 0.0003 **(d)** 0.0580

6.39 **(a)** 0.8186 **(b)** 0.1336 **(c)** 3.8372 **(d)** 0.9946

6.40 **(a)** 0.3446 **(b)** 0.2195 **(c)** 0.0044 **(d)** 103.6

6.41 **(a)** 0.4680 **(b)** 0.0455 **(c)** 0.0304
(d) Claim: $\mu = 60 \implies X \sim N(60, 3.2^2)$
Experiment: $x = 55$
Likelihood: $P(X \leq 55) = 0.0591$
Conclusion: There is no evidence to suggest the claim is wrong, that the mean weight is less than 60 grams. (Yes, it's close, but the probability is greater than 0.05.)

6.42 **(a)** 0.6536 **(b)** 0.5800 **(c)** 0.2753 **(d)** 134.7

6.43 **(a)** 0.7273 **(b)** 0.0013 **(c)** 0.0118 **(d)** 0.3664

6.44 **(a)** 0.3913 **(b)** 0.3886 **(c)** 0.5567
(d) Claim: $\mu = 14.6 \implies X \sim N(14.6, 5.8^2)$
Experiment: $x = 27$
Likelihood: $P(X \geq 27) = 0.0163$
Conclusion: There is evidence to suggest the claim is false, that the mean has increased.

6.45 **(a)** $\sigma = 2.3$ **(b)** 0.9851 **(c)** 0.0024

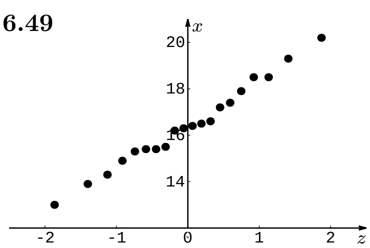
6.46 **(a)** 0.3540 **(b)** 0.000469
(c) Claim: $\mu = 35 \implies X \sim N(35, 2.67^2)$
Experiment: $x = 33.5$
Likelihood: $P(X \leq 33.5) = 0.2871$
Conclusion: There is no evidence to suggest the claim is false.

6.47 **(a)** 0.0968 **(b)** 0.3227 **(c)** 0.9836

6.48 **(a)** 89.4 **(b)** 0.0039 **(c)** 83.7, 86.3 **(d)** 83.25

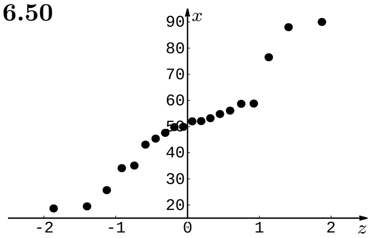
Section 6.3

6.49



There is no evidence to suggest a non-normal population.

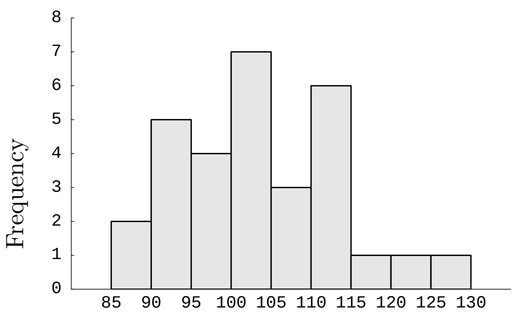
6.50



There is evidence to suggest a non-normal population. The points do not appear to fall on a straight line.

6.51 **(a)** There is no evidence to suggest the data are from a non-normal population. **(b)** There is evidence to suggest the data are from a non-normal population. The points do not appear to fall on a straight line. **(c)** There is evidence to suggest the data are from a non-normal population. The points do not appear to fall on a straight line. **(d)** There is no evidence to suggest the data are from a non-normal population.

6.52

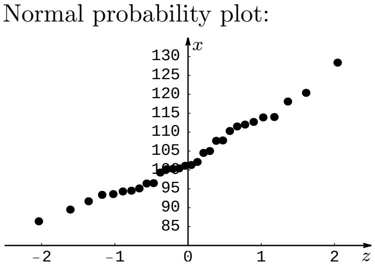


Backwards Empirical Rule

Interval	Proportion
(93.47, 113.36)	0.70
(83.53, 123.30)	0.97
(73.58, 133.25)	1.00

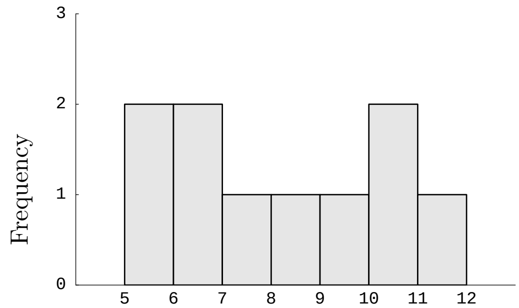
$IQR/s = 1.65$

Normal probability plot:



There is no overwhelming evidence to suggest the data are from a non-normal population.

6.53

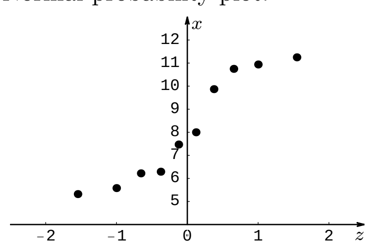


Backwards Empirical Rule

Interval	Proportion
(5.83, 10.51)	0.5
(3.48, 12.85)	1.0
(1.14, 15.20)	1.0

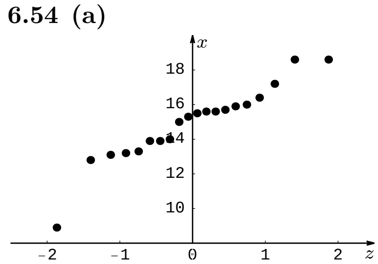
$IQR/s = 1.93$

Normal probability plot:



There is evidence to suggest the data are from a non-normal population.

6.54 **(a)**



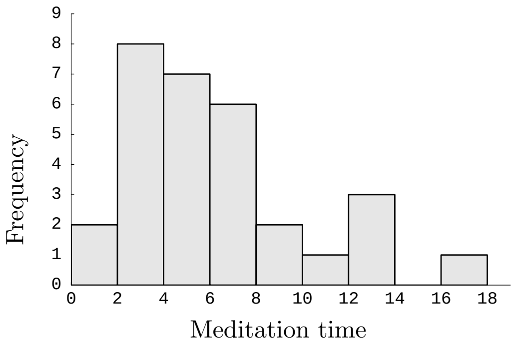
There is evidence to suggest non-normality.

(b) Backwards Empirical Rule

Interval	Proportion
(12.73, 17.12)	0.80
(10.54, 19.31)	0.95
(8.35, 21.50)	1.00

There is evidence to suggest non-normality.

6.55

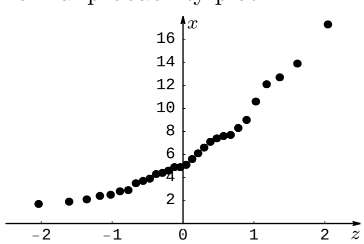


Backwards Empirical Rule

Interval	Proportion
$(\ \ 2.37, 10.14)$	0.73
$(-1.51, 14.02)$	0.97
$(-5.39, 17.90)$	1.00

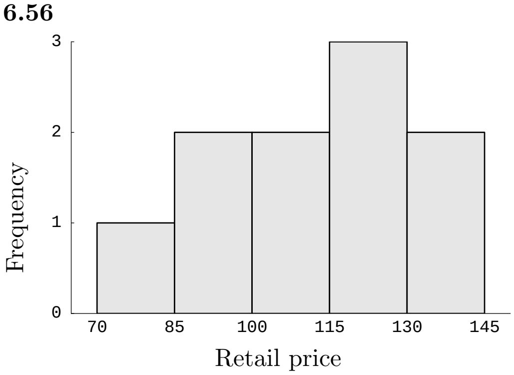
$IQR/s = 1.083$

Normal probability plot:



There is evidence to suggest the data are from a non-normal population.

6.56

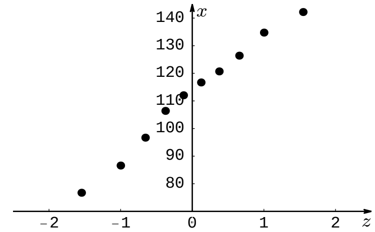


Backwards Empirical Rule

Interval	Proportion
$(91.14, 132.71)$	0.60
$(70.36, 153.49)$	1.00
$(49.57, 174.28)$	1.00

$IQR/s = 1.429$

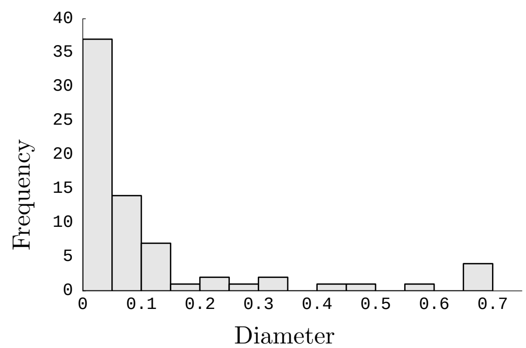
Normal probability plot:



With only 10 observations, this is a difficult decision. There is not enough evidence to suggest non-normality.

6.57 **(a)** $\overline{x} = 10.2894$, $s = 1.7593$ **(b)** $(8.53, 12.05)$, $(6.77, 13.81)$, $(5.01, 15.57)$ **(c)** 0.72, 0.96, 1.00. There is no evidence to suggest the data are from a non-normal population.

6.58

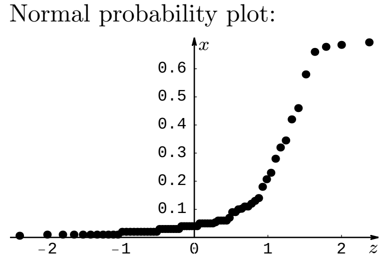


Backwards Empirical Rule

Interval	Proportion
$(-0.0618, 0.2939)$	0.87
$(-0.2397, 0.4718)$	0.93
$(-0.4176, 0.6497)$	0.93

$IQR/s = 0.5059$

Normal probability plot:

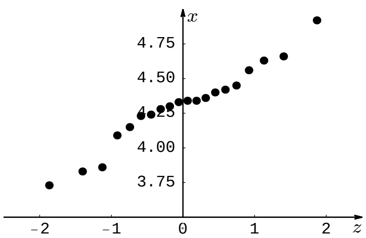


There is evidence to suggest the data are from a non-normal population.

6.59 **(a)**

37	3
38	36
39	
40	9
41	5
42	348
43	03446
44	025
45	6
46	36
47	
48	
49	2

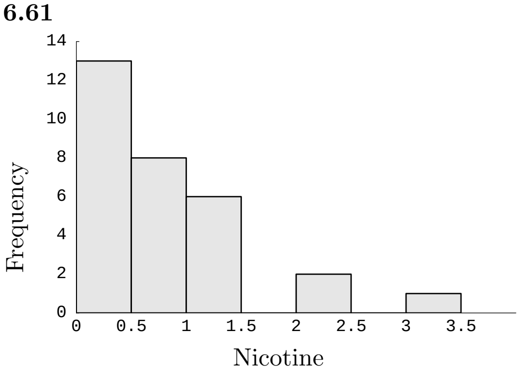
Stem: tenths; Leaf: hundredths.
(b) $IQR/s = 0.8551$
(c)



(d) There is some evidence to suggest this data is from a non-normal distribution. The stem-and-leaf plot has some outliers, the ratio IQR/s is far from 1.3, and the normal probability plot exhibits non-linearity.

6.60 The normal probability plot suggests the data are from a non-normal population. The plot exhibits a non-linear pattern.

6.61

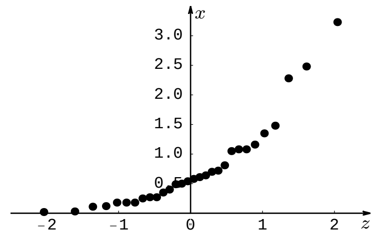


Backwards Empirical Rule

Interval	Proportion
$(\ \ 0.0078, 1.5349)$	0.90
$(-0.7558, 2.2984)$	0.93
$(-1.5193, 3.0620)$	0.97

$IQR/s = 1.0864$

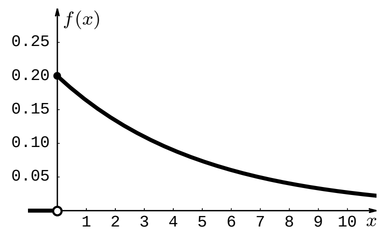
Normal probability plot:



There is evidence to suggest the data are from a non-normal population.

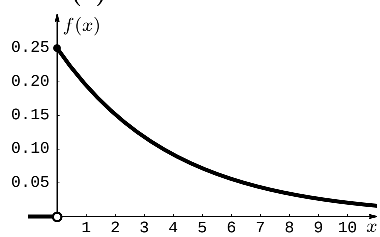
Section 6.4

6.62 **(a)**



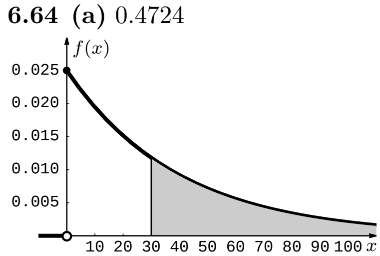
(b) $\mu = 10$, $\sigma^2 = 100$, $\sigma = 10$ **(c)** 0.2592 **(d)** 0.4983

6.63 **(a)**



(b) 0.0099 **(c)** 0.9851

6.64 **(a)** 0.4724



(b) 0.6025 **(c)** 0.6025

6.65 0.08

6.66 0.0015

6.67 **(a)** 0.00016236 **(b)** 0.2728 **(c)** 0.2469 **(d)** 0.0780

6.68 **(a)** 0.00002 **(b)** 0.3012 **(c)** 0.2474 **(d)** 0.3297

6.69 **(a)** 0.6065 **(b)** 46.0517 **(c)** 0.6065

6.70 **(a)** 15 **(b)** 0.9502 **(c)** 20.79 **(d)** 0.7364

6.71 **(a)** 0.3935 **(b)** 0.4109 **(c)** 0.3679 **(d)** 0.0067

6.72 **(a)** 0.0488 **(b)** 0.0861 **(c)** 0.7408

6.73 **(a)** 0.9436 **(b)** 0.1534 **(c)** $\mu = 8$, $\sigma^2 = 64$, $\sigma = 8$ **(d)** 2.3015

6.74 **(a)** 0.7788 **(b)** 0.8825, 0.9200, 0.9394 **(c)** 0.9984

6.75 **(a)** $\mu = 30$, $\sigma^2 = 900$, $\sigma = 30$ **(b)** 0.2636 **(c)** 0.1790 **(d)** 69.0776 **(e)** 0.3893

6.76 **(a)** 0.3935 **(b)** 0.7165 **(c)** 0.0360

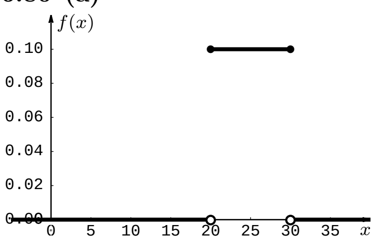
Chapter Exercises

6.77 **(a)** 2.5 **(b)** 0.1813 **(c)** 0.1353 **(d)** 9.7801

6.78 **(a)** 0.7601 **(b)** 0.7139 **(c)** $(859.27, 1352.73)$
(d) Claim: $\mu = 1106 \implies X \sim \mathrm{N}(1106, 150^2)$
Experiment: $x = 750$
Likelihood: $\mathrm{P}(X \leq 750) = 0.0088$
Conclusion: There is evidence to suggest the claim is false, that the mean amount of sodium is less than 1106.

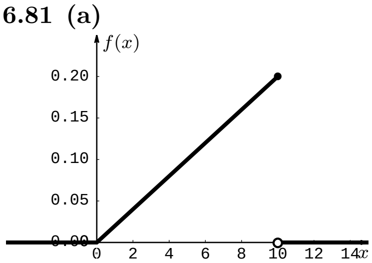
6.79 **(a)** 0.0401 **(b)** 0.2417 **(c)** 0.9796 **(d)** 0.000149

6.80 **(a)**



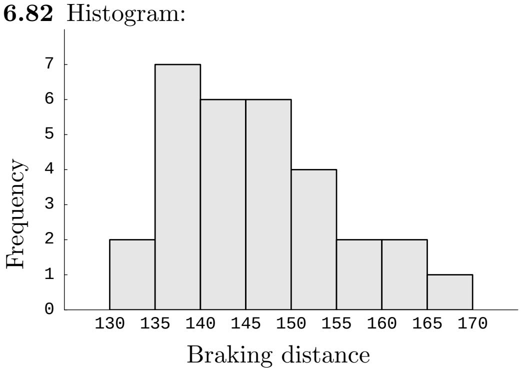
(b) 0.2 **(c)** 0.4 **(d)** 12.5

6.81 **(a)**



(b) 0.25 **(c)** 0.36 **(d)** 0.32 **(e)** 0.25

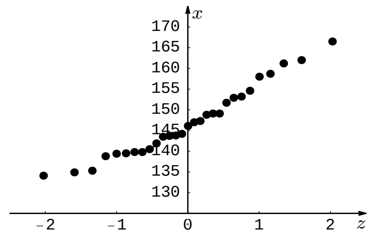
6.82 Histogram:



Backwards Empirical Rule

Interval	Proportion
$(138.13, 155.40)$	0.70
$(129.49, 164.04)$	0.97
$(120.85, 172.68)$	1.00

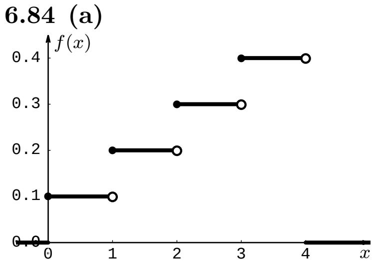
$IQR/s = 1.52$
Normal probability plot:



There is some evidence to suggest the data are from a non-normal population. The histogram is positively skewed, IQR/s is not close to 1.3, and the normal probability plot has a slight arc.

6.83 **(a)** 0.0912 **(b)** 0.4950 **(c)** 3.4941, 4.5059
(d) Claim: $\mu = 4 \implies X \sim \mathrm{N}(4, 0.75^2)$
Experiment: $x = 7$
Likelihood: $\mathrm{P}(X \geq 7) = 0.0000317$
Conclusion: There is evidence to suggest the claim is false, that the mean time to make a room reservation is greater than 4 minutes.

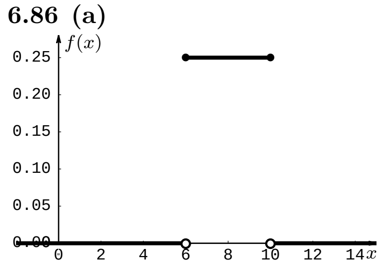
6.84 **(a)**



(b) 0.2 **(c)** 0.4 **(d)** 0.7 **(e)** 0.1667

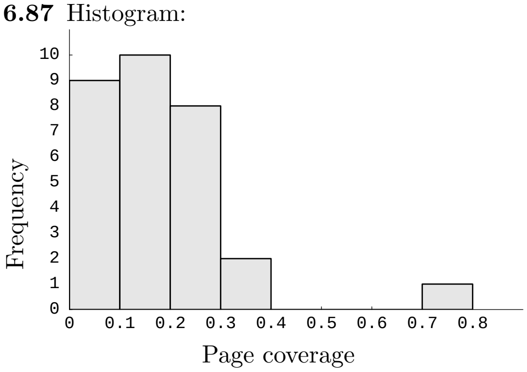
6.85 **(a)** 0.8054 **(b)** 0.0013 **(c)** 0.000337 **(d)** 0.0040

6.86 **(a)**



(b) 0.25 **(c)** 0.25 **(d)** 9.6

6.87 Histogram:

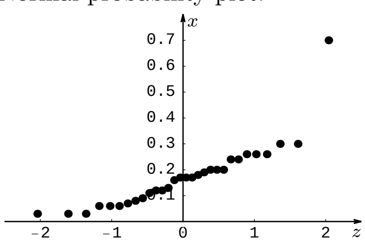


Backwards Empirical Rule

Interval	Proportion
(0.0441, 0.3019)	0.87
(−0.0847, 0.4307)	0.97
(−0.2136, 0.5596)	0.97

$IQR/s = 1.241$

Normal probability plot:



There is some evidence the data are from a non-normal population. The histogram and the normal probability plot indicate an outlier, and the backwards Empirical Rule proportions are inconsistent.

6.88 **(a)** 0.75 **(b)** 0.5, 1.0, 1.5, 2.0 **(c)** 0.0026 **(d)** 0.25

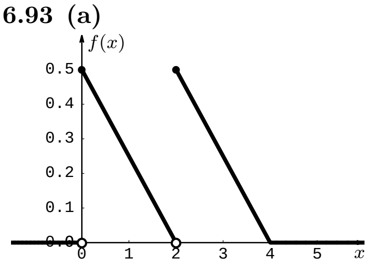
6.89 **(a)** 0.2023 **(b)** 0.9044 **(c)** 50.9901
(d) Claim: $\mu = 52 \implies X \sim \mathrm{N}(52, 1.2^2)$
Experiment: $x = 57$
Likelihood: $\mathrm{P}(X \geq 57) = 0.00001546$
Conclusion: There is evidence to suggest the claim is false, that the mean weight is greater than 52 kg.

6.90 **(a)** 0.0985 **(b)** 0.6421 **(c)** 0.0049

6.91 **(a)** 0.2091 **(b)** 0.3516 **(c)** 70.2349 **(d)** 0.6536

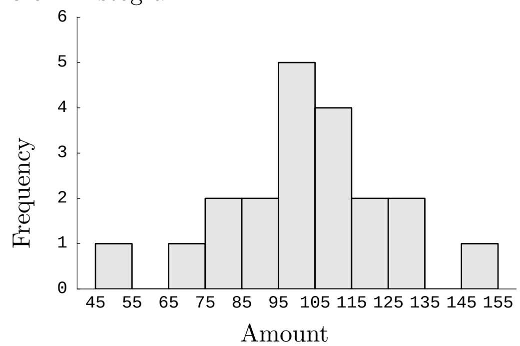
6.92 **(a)** 0.0599 **(b)** 0.4191 **(c)** (8180.16, 25819.84)
(d) 0.0025

6.93 **(a)**



(b) 0.375 **(c)** 0.125 **(d)** 0.5

6.94 Histogram:

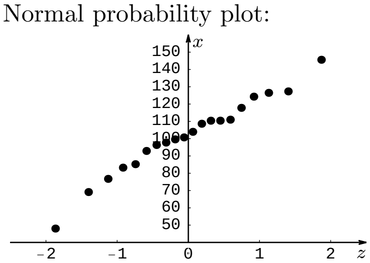


Backwards Empirical Rule

Interval	Proportion
(79.34, 124.21)	0.65
(56.91, 146.65)	0.95
(34.47, 169.08)	1.00

$IQR/s = 1.129$

Normal probability plot:



There is no evidence to suggest the data are from a non-normal population.

6.95 **(a)** 0.5 **(b)** 0.0923 **(c)** 0.000687

Exercises′

6.96 Note: let $\sigma = 0.04$ **(a)** 0.8818 **(b)** 0.3781

6.97

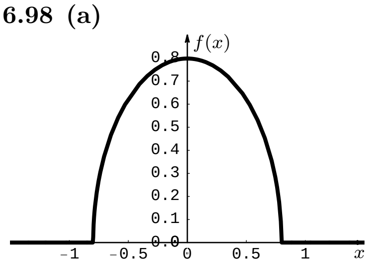
$\mathrm{P}(X \geq a) = 1 - \mathrm{P}(X \leq a) = 1 - (1 - e^{-\lambda a}) = e^{-\lambda a}$

$\mathrm{P}(X \geq a + b \mid X \geq b)$

$$= \frac{\mathrm{P}(X \geq a + b \cap X \geq b)}{\mathrm{P}(X \geq b)} = \frac{\mathrm{P}(X \geq a + b)}{\mathrm{P}(X \geq b)}$$

$$= \frac{1 - (1 - e^{-\lambda(a+b)})}{1 - (1 - e^{-\lambda b})} = \frac{e^{-\lambda(a+b)}}{e^{-\lambda b}} = e^{-\lambda a}$$

6.98 **(a)**



(b) 0.8183

Chapter 7

Section 7.1

7.1 **(a)** Statistic. **(b)** Parameter. **(c)** Statistic. **(d)** Parameter. **(e)** Statistic.

7.2 **(a)** Statistic. **(b)** Parameter. **(c)** Statistic. **(d)** Statistic. **(e)** Parameter.

7.3 **(a)** $\mu = 16$, $\widetilde{\mu} = 15$ **(b)** Sampling distribution:

$\overline{x}$	12.33	13.33	14.33	15.00	15.67
$p(\overline{x})$	0.1	0.1	0.1	0.1	0.1

$\overline{x}$	16.67	17.33	17.67	18.33	19.33
$p(\overline{x})$	0.1	0.1	0.1	0.1	0.1

$\mu_{\overline{X}} = 16$, $\sigma^2_{\overline{X}} = 4.6$, $\sigma_{\overline{X}} = 2.1448$
(c) Sampling distribution:

$\widetilde{x}$	12	15	18
$p(\widetilde{x})$	0.3	0.4	0.3

$\mu_{\widetilde{X}} = 15$, $\sigma^2_{\widetilde{X}} = 5.4$, $\sigma_{\widetilde{X}} = 2.3238$ **(d)** The mean of the sample mean is the population mean. The mean of the sample median is the population median.

7.4 **(a)** Sampling distribution, without replacement:

$\overline{x}$	596.5	619.0	664.5	686.5	732.5	754.5
$p(\overline{X})$	1/6	1/6	1/6	1/6	1/6	1/6

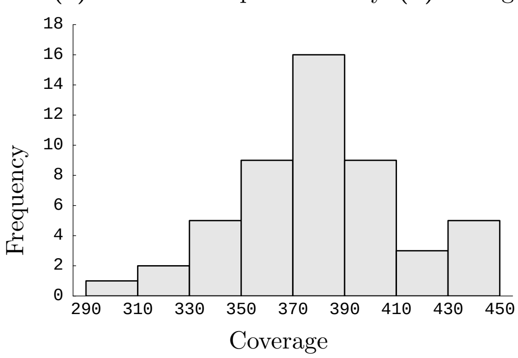
(b) Sampling distribution, with replacement:

$\overline{x}$	529.0	596.5	619.0	664.0	664.5
$p(\overline{x})$	0.0625	0.1250	0.1250	0.0625	0.1250

$\overline{x}$	686.5	709.0	732.0	754.5	800.0
$p(\overline{x})$	0.1250	0.0625	0.1250	0.1250	0.0625

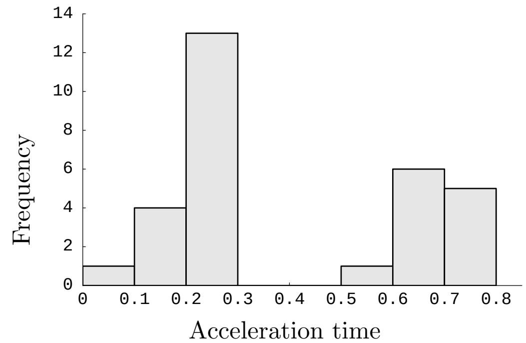
(c) Both symmetric. Both center at 675.5. More variability and more possible values in the second distribution.

7.5 **(a)** Random samples will vary. **(b)** Histogram:



(c) Approximately normal. Approximate mean: 380
(d) $\mu = 379.7$, almost the same.

7.6 **(a)** Random samples will vary. **(b)** Histogram:



(c) Positively skewed. **(d)** $\sigma = 0.3736$, Approximate mean of the sampling distribution: 0.38. These numbers are close.

7.7 **(a)** 65.1 **(b)** Distribution of $\overline{X}$:

$\overline{x}$	64.0	64.5	65.0	65.5	66.0
$p(\overline{x})$	0.01	0.14	0.53	0.28	0.04

(c) 65.1, same.

7.8 **(a)** 0.7875 **(b)** Distribution of S^2:

s^2	0.0	0.5	2.0	4.5
$p(s^2)$	0.365	0.405	0.180	0.050

(c) 0.7875, same.

7.9 **(a)** Distribution of $\widetilde{X}$:

$\widetilde{x}$	0.0	0.5	1.0	1.5	2.0
$p(\widetilde{x})$	0.2500	0.2500	0.1625	0.1500	0.1100

$\widetilde{x}$	2.5	3.0	3.5	4.0
$p(\widetilde{x})$	0.0450	0.0200	0.0100	0.0025

(b) $\mu_{\widetilde{X}} = 0.95$, $\sigma^2_{\widetilde{X}} = 0.7238$, $\sigma_{\widetilde{X}} = 0.8507$

7.10 **(a)** Distribution of the minimum time:

m	97.76	99.35	100.74
$p(m)$	0.5556	0.3333	0.1111

(b) Distribution of the total time:

t	195.52	197.11	198.50	198.70	200.09	201.48
$p(t)$	0.1111	0.2222	0.2222	0.1111	0.2222	0.1111

7.11 **(a)** Distribution of the maximum weight:

m	83	95	100
$p(m)$	0.1667	0.3333	0.5000

(b) Distribution of the total weight:

t	153	165	170	178	183	195
$p(t)$	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

7.12 **(a)** Distribution of the sample mean:

$\overline{x}$	14.67	16.33	17.33	17.67	18.67
$p(\overline{x})$	0.1	0.1	0.1	0.1	0.2

$\overline{x}$	20.00	20.33	21.67	22.67
$p(\overline{x})$	0.1	0.1	0.1	0.1

(b) Distribution of the total:

t	44	49	52	53	56	60	61	65	68
$p(t)$	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1

7.13 Distribution of D:

d	0	1	2	3	4	5	7	9	10
$p(d)$	0.20	0.08	0.16	0.08	0.08	0.16	0.08	0.08	0.08

7.14 **(a)** Distribution of $\overline{X}$:

$\overline{x}$	6.90	6.95	7.05	8.25	8.35	8.40	8.45	8.50	9.80
$p(\overline{x})$	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1

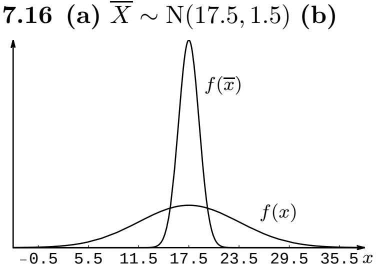
(b) Distribution of the total:

t	13.8	13.9	14.1	16.5	16.7	16.8	16.9	17.0	19.6
$p(t)$	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1

Section 7.2

7.15 **(a)** $\overline{X} \sim \mathrm{N}(10, 6.25/7)$, 0.1450
(b) $\overline{X} \sim \mathrm{N}(10, 6.25/12)$, 0.0188
(c) $\overline{X} \sim \mathrm{N}(10, 6.25/15)$, 0.5614
(d) $\overline{X} \sim \mathrm{N}(10, 6.25/25)$, 0.3085
(e) $\overline{X} \sim \mathrm{N}(10, 6.25/100)$, 0.4237

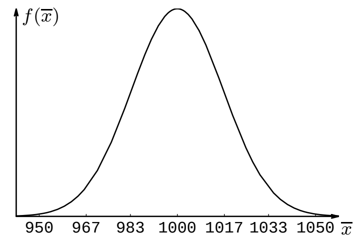
7.16 **(a)** $\overline{X} \sim \mathrm{N}(17.5, 1.5)$ **(b)**



(c) 0.2798, 0.0021 **(d)** 0.2602, 0.8691

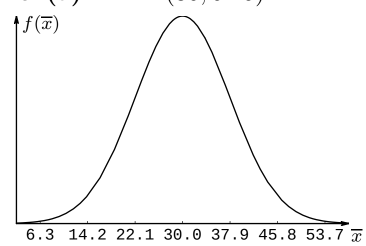
7.17 **(a)** $X \overset{\bullet}{\sim} \mathrm{N}(50, 49/38)$. The shape of the underlying distribution is not known. **(b)** 0.1893 **(c)** 0.0391 **(d)** 0.5769 **(e)** 51.1769

7.18 **(a)** $X \overset{\bullet}{\sim} \mathrm{N}(1000, 277.78)$



(b) 0.9332 **(c)** 0.9641 **(d)** 0.6827 **(e)** $(967.33, 1032.67)$

7.19 **(a)** $X \overset{\bullet}{\sim} \mathrm{N}(30, 62.5)$



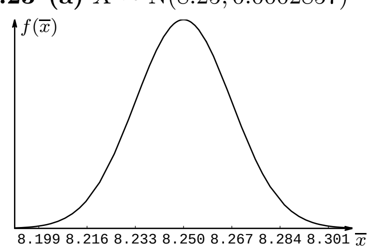
(b) 0.1558 **(c)** 0.7941 **(d)** 0.0289 **(e)** 5.57

7.20 Solid curve: X. Short dash: $\overline{X}$, $n = 5$. Long dash: $\overline{X}$, $n = 15$

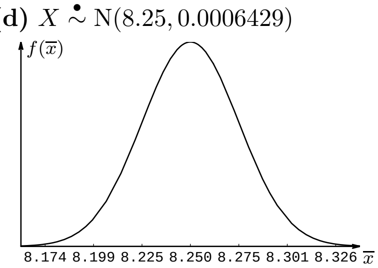
7.21 Solid curve: X. Short dash: $\overline{X}$, $n = 5$. Long dash: $\overline{X}$, $n = 15$

7.22 **(a)** 0.1505 **(b)** 0.00000000243 **(c)** 0.8353 **(d)** 0.9744

7.23 **(a)** $\overline{X} \overset{\bullet}{\sim} \mathrm{N}(8.25, 0.0002857)$



(b) Approximately 1. **(c)** 0.9985
(d) $X \overset{\bullet}{\sim} \mathrm{N}(8.25, 0.0006429)$



Approximately 1. 0.9757.

7.24 **(a)** $\overline{X} \sim \mathrm{N}(1750, 4166.67)$ **(b)** 0.2193 **(c)** 0.8787 **(d)** $(1623.5, 1876.5)$

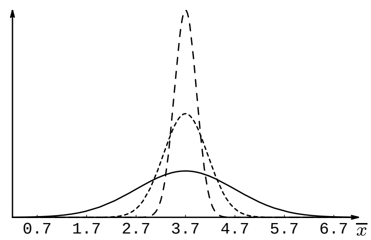
7.25 **(a)** 0.1459 **(b)** 0.2402
(c) Claim: $\mu = 100 \implies \overline{X} \overset{\bullet}{\sim} \mathrm{N}(100, 144/40)$
Experiment: $\overline{x} = 98.5$

Likelihood: $P(\overline{X} \leq 98.5) = 0.2146$
Conclusion: There is no evidence to suggest the claim is false, that μ is less than 100.

7.26 **(a)** 0.000429 **(b)** Because $\sigma_{\overline{X}}$ is so small.
(c) Yes. There is evidence to suggest $\mu < 12$. This tail probability (likelihood) is very small (≤ 0.05).

7.27 **(a)** $\overline{X} \overset{\bullet}{\sim} N(6.5, 0.4571)$ **(b)** 0.2298
(c) Claim: $\mu = 6.5 \implies X \overset{\bullet}{\sim} N(6.5, 0.4571)$
Experiment: $\overline{x} = 5.1$
Likelihood: $P(\overline{X} \leq 5.1) = 0.3834$
Conclusion: There is no evidence to suggest the claim is false, that the mean police standoff time is lower.

7.28 **(a)** $\overline{X}_5 \sim N(3.7, 0.2)$, $\overline{X}_{20} \sim N(3.7, 0.05)$
(b) Solid curve: X; short dash: $\overline{X}_5$; long dash: $\overline{X}_{20}$.



(b) 0.2420, 0.0588, 0.0008726 **(c)** 0.0797, 0.1769, 0.3453

7.29 **(a)** $T \overset{\bullet}{\sim} N(525, 140)$ **(b)** 0.8975 **(c)** 0.1120
(d) 552.53

7.30 **(a)** 0.0855 **(b)** 0.0142 **(c)** $(69, 81)$

7.31 **(a)** $T \overset{\bullet}{\sim} N(480, 22.5)$ **(b)** 0.00001242 **(c)** 0.9650
(d) 0.5

7.32 **(a)** 0.0124 **(b)** 0.9332, 0.6915 **(c)** 0.0455, 0.8400, 0.5000

7.33 **(a)** 0.1168 **(b)** 0.3832 **(c)** 0.0095

7.34 **(a)** 0.9431 **(b)** 0.0569 **(c)** 0.2635

7.35 **(a)** $\overline{X} \sim N(4.125, 0.0667)$ **(b)** 0.0732 **(c)** 0.3335
(d) 0.0077

7.36 **(a)** 0.0432 **(b)** 0.3318
(c) Claim: $\mu = 28 \implies \overline{X} \overset{\bullet}{\sim} N(28, 0.98)$
Experiment: $\overline{x} = 29.75$
Likelihood: $P(\overline{X} \geq 29.75) = 0.0385$
Conclusion: There is evidence to suggest the claim is false, that the mean vertical leap has increased.

7.37 **(a)** 0.0228 **(b)** 0.6827
(c) Claim: $\mu = 320 \implies \overline{X} \overset{\bullet}{\sim} N(320, 25)$
Experiment: $\overline{x} = 310$
Likelihood: $P(\overline{X} \leq 310) = 0.0228$
Conclusion: There is evidence to suggest the claim is false, that the mean ozone-layer thickness is less than 320 DU.

7.38 **(a)** $T \overset{\bullet}{\sim} N(325, 16)$ **(b)** 0.2266 **(c)** 0.1056
(d) 329.15

Section 7.3

7.39 **(a)** $np = 25 \geq 5$, $n(1-p) = 75 \geq 5$, $\widehat{P} \overset{\bullet}{\sim} N(0.25, 0.0019)$ **(b)** $np = 135 \geq 5$, $n(1-p) = 15 \geq 5$, $\widehat{P} \overset{\bullet}{\sim} N(0.90, 0.0006)$
(c) $np = 75 \geq 5$, $n(1-p) = 25 \geq 5$, $\widehat{P} \overset{\bullet}{\sim} N(0.75, 0.0019)$ **(d)** $np = 850 \geq 5$, $n(1-p) = 150 \geq 5$, $\widehat{P} \overset{\bullet}{\sim} N(0.85, 0.0001275)$
(e) $np = 30 \geq 5$, $n(1-p) = 4970 \geq 5$, $\widehat{P} \overset{\bullet}{\sim} N(0.006, 0.000001928)$

7.40 **(a)** 0.1932 **(b)** 0.0745 **(c)** 0.4363 **(d)** 0.0433

7.41 **(a)** 0.8145 **(b)** 0.9101 **(c)** 0.3237 **(d)** 0.9747

7.42 **(a)** 0.2817 **(b)** 0.4741 **(c)** 0.1045

7.43 **(a)** 0.2275 **(b)** 0.2853 **(c)** 0.0353
(d) $Q_1 = 0.2408$, $Q_3 = 0.2592$

7.44 **(a)** $\widehat{P} \overset{\bullet}{\sim} N(0.85, 0.00051)$ **(b)** 0.0920 **(c)** 0.3290
(d) 0.9732

7.45 **(a)** $\widehat{P} \overset{\bullet}{\sim} N(0.5219, 0.0006238)$ **(b)** 0.1903
(c) 0.0100 **(d)** 0.4638

7.46 **(a)** $\widehat{P} \overset{\bullet}{\sim} N(0.35, 0.0019)$ **(b)** 0.0108 **(c)** 0.8746
(d) $(0.2784, 0.4216)$

7.47 **(a)** $\widehat{P} \overset{\bullet}{\sim} N(0.46, 0.00333)$ **(b)** 0.1486 **(c)** 0.5690
(d) $(0.3118, 0.6082)$

7.48 **(a)** 0.1731 **(b)** 0.0279 **(c)** 0.4906

7.49 **(a)** 0.0533 **(b)** 0.3842
(c) Claim: $p = 0.33 \implies \widehat{P} \overset{\bullet}{\sim} N(0.33, 0.0025)$
Experiment: $\widehat{p} = 0.40$
Likelihood: $P(\widehat{P} \geq 0.40) = 0.0789$
Conclusion: There is no evidence to suggest the claim is false.

7.50 **(a)** 0.6585 **(b)** 0.1331
(c) Claim: $p = 0.40 \implies \widehat{P} \overset{\bullet}{\sim} N(0.40, 0.0024)$
Experiment: $\widehat{p} = 0.47$
Likelihood: $P(\widehat{P} \geq 0.47) = 0.0765$
Conclusion: There is no evidence to suggest the claim is false, that the acceptance rate has increased.

7.51 **(a)** 0.0745 **(b)** 0.2799
(c) Claim: $p = 0.10 \implies \widehat{P} \overset{\bullet}{\sim} N(0.10, 0.0003)$
Experiment: $\widehat{p} = 0.16$
Likelihood: $P(\widehat{P} \geq 0.16) = 0.000266$
Conclusion: There is evidence to suggest the claim is false, that the funding rate has increased.

7.52 **(a)** $\widehat{P} \overset{\bullet}{\sim} N(0.006, 0.000005964)$ **(b)** 0.2064
(c) 0.0507 **(d)** 0.0039

7.53 **(a)** 0.0066 **(b)** 0.8781

7.54 **(a)** 0.0047 **(b)** 0.000000328 **(c)** 0.3187

7.55 **(a)** 0.0236 **(b)** 0.6790 **(c)** 0.5434

7.56 **(a)** 0.2476 **(b)** 0.4621
(c) Claim: $p = 0.295 \implies \widehat{P} \overset{\bullet}{\sim} \text{N}(0.295, 0.00048366)$
Experiment: $\widehat{p} = 119/430 = 0.2767$
Likelihood: $\text{P}(\widehat{P} \leq 0.2767) = 0.2027$
Conclusion: There is no evidence to suggest the claim is false, that the true proportion of cigarette debris items is different from 0.295.

Chapter Exercises

7.57 **(a)** $\overline{X} \overset{\bullet}{\sim} \text{N}(0.20, 0.0000833)$
(b) Claim: $\mu = 0.10 \implies \overline{X} \overset{\bullet}{\sim} \text{N}(0.20, 0.0000833)$
Experiment: $\overline{x} = 0.1267$
Likelihood: $\text{P}(\overline{X} \geq 0.1267) = 0.0017$
Conclusion: There is evidence to suggest the claim is false, that the mean amount of hydrogen peroxide in each bottle is more than 0.10.

7.58 Claim: $\mu = 0.5 \implies \overline{X} \overset{\bullet}{\sim} \text{N}(0.5, 0.0008)$
Experiment: $\overline{x} = 0.6$
Likelihood: $\text{P}(\overline{X} \geq 0.6) = 0.0002$
Conclusion: There is evidence to suggest the claim is false, that the mean coefficient of static friction is greater than 0.5.

7.59 **(a)** Distribution of $\overline{X}$:

$\overline{x}$	1.0	1.5	2.0	2.5	3.0
$p(\overline{x})$	0.0100	0.1000	0.2900	0.2300	0.2000

$\overline{x}$	3.5	4.0	4.5	5.0
$p(\overline{x})$	0.1100	0.0425	0.0150	0.0025

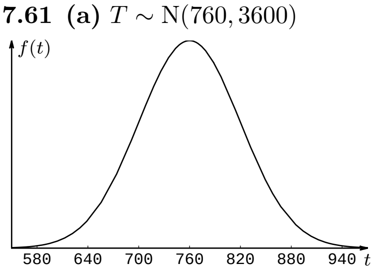
(b) 2.55, 0.5238, 0.7237

7.60 **(a)** Distribution of M:

m	1	2	3	4	5	6
$p(m)$	0.0004	0.102	0.074	0.342	0.328	0.1536

(b) 4.356, 1.3013, 1.1407

7.61 **(a)** $T \sim \text{N}(760, 3600)$

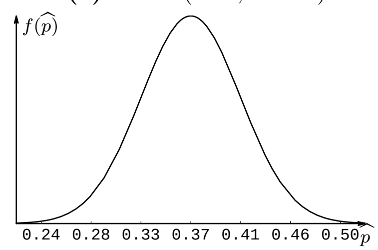


(b) 0.4338 **(c)** 0.000031686

7.62 **(a)** 0.0455 **(b)** 0.3010
(c) Claim: $\mu = 7.5 \implies \overline{X} \overset{\bullet}{\sim} \text{N}(7.5, 0.0875)$
Experiment: $\overline{x} = 8.1$
Likelihood: $\text{P}(\overline{X} \geq 8.1) = 0.0213$
Conclusion: There is evidence to suggest the claim is false, that the mean oxygen produced is greater than 7.5.
(d) 0.2151, 0.1534
Claim: $\mu = 7.5 \implies \overline{X} \overset{\bullet}{\sim} \text{N}(7.5, 0.4018)$
Experiment: $\overline{x} = 8.1$
Likelihood: $\text{P}(\overline{X} \geq 8.1) = 0.1719$
Conclusion: There is no evidence to suggest the claim is false.

7.63 **(a)** 0.8582 **(b)** 363.9 **(c)** 30.7437

7.64 **(a)** $\widehat{P} \overset{\bullet}{\sim} \text{N}(0.37, 0.0019)$



(b) 0.0561 **(c)** 0.4270
(d) Claim: $p = 0.37 \implies \widehat{P} \overset{\bullet}{\sim} \text{N}(0.37, 0.0019)$
Experiment: $\widehat{p} = 0.42$
Likelihood: $\text{P}(\widehat{P} \geq 0.42) = 0.1283$
Conclusion: There is no evidence to suggest the claim is false.

7.65 **(a)** 0.0095 **(b)** 0.2075 **(c)** 135.25

7.66 **(a)** 0.6440 **(b)** 0.0043 **(c)** 192

7.67 **(a)** $\overline{X} \sim \text{N}(8, 0.0039)$ **(b)** 0.0548 **(c)** 0.0082
(d) 0.1216

7.68 **(a)** 0.0124 **(b)** 0.0062 **(c)** 0.0000002871

7.69 **(a)** $\mu_X = 0.84$, $\sigma_X^2 = 1.1944$, $\sigma_X = 1.0929$
(b) Distribution of T:

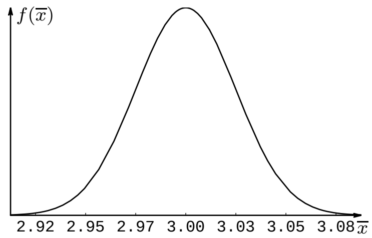
t	0	1	2	3	4	5
$p(t)$	0.2500	0.3000	0.1900	0.1300	0.0720	0.0360

t	6	7	8	9	10
$p(t)$	0.0149	0.0048	0.0018	0.0004	0.00001

(c) $\mu_T = 1.68$, $\sigma_T^2 = 2.3888$. **(d)** $\mu_T = 2\mu_X$, $\sigma_T^2 = 2\sigma_X^2$.

7.70 **(a)** Statistic. **(b)** Parameter. **(c)** Statistic.
(d) Parameter. **(e)** Statistic.

7.71 **(a)** $\overline{X} \overset{\bullet}{\sim} \text{N}(3, 0.00064)$

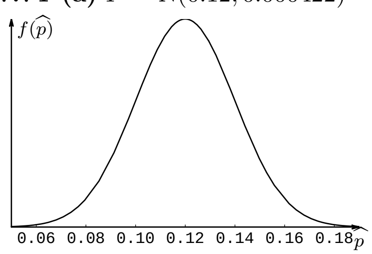


(b) Claim: $\mu = 3 \implies \overline{X} \overset{\bullet}{\sim} \mathrm{N}(3, 0.00064)$
Experiment: $\overline{x} = 3.0338$
Likelihood: $\mathrm{P}(\overline{X} \geq 3.0338) = 0.0908$
Conclusion: There is no evidence to suggest the claim is false.

7.72 **(a)** f_1: underlying distribution, f_2: distribution of the sample mean. **(b)** f_1: underlying distribution, f_2: distribution of the sample mean. **(c)** f_1: distribution of the sample mean, f_1: underlying distribution. **(d)** f_1: underlying distribution, f_2: distribution of the sample mean.

7.73 **(a)** $T \sim \mathrm{N}(9.0, 1.225)$
(b) Claim: $\mu = 0.9 \implies T \sim \mathrm{N}(9.0, 1.225)$
Experiment: $t = 10.38$
Likelihood: $\mathrm{P}(T \geq 10.38) = 0.1062$
Conclusion: There is no evidence to suggest the claim is false.

7.74 **(a)** $\widehat{P} \overset{\bullet}{\sim} \mathrm{N}(0.12, 0.000422)$



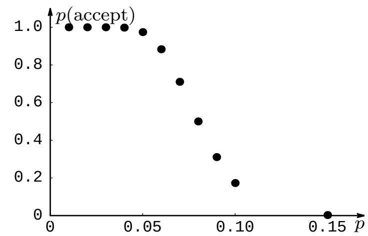
(b) 0.0722 **(c)** 0.0906
(d) Claim: $p = 0.12 \implies \widehat{P} \overset{\bullet}{\sim} \mathrm{N}(0.12, 0.000422)$
Experiment: $\widehat{p} = 0.09$
Likelihood: $\mathrm{P}(\widehat{P} \leq 0.09) = 0.0722$
Conclusion: There is no evidence to suggest the claim is false.

7.75 **(a)** $\overline{X} \overset{\bullet}{\sim} \mathrm{N}(70, 0.6944)$ **(b)** 0.1151
(c) Claim: $\mu = 70 \implies \overline{X} \overset{\bullet}{\sim} \mathrm{N}(70, 0.6944)$
Experiment: $\overline{x} = 68.25$
Likelihood: $\mathrm{P}(\overline{X} \leq 68.25) = 0.0179$
Conclusion: There is evidence to suggest the claim is false, that the mean amount of dextran is less than 70%.

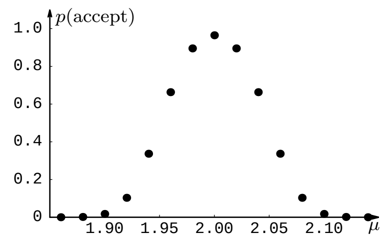
7.76 **(a)** $\widehat{P} \overset{\bullet}{\sim} \mathrm{N}(0.65, 0.0002275)$, $np = 650 \geq 5$, $n(1-p) = 350 \geq 5$. **(b)** 0.2537 **(c)** 0.6539 **(d)** 0.6149

Exercises′

7.77 **(a)** 1, 1, 1, 0.9981, 0.9742, 0.8832, 0.7103, 0.5, 0.3106, 0.1729, 0.0028. **(b)** OC curve:

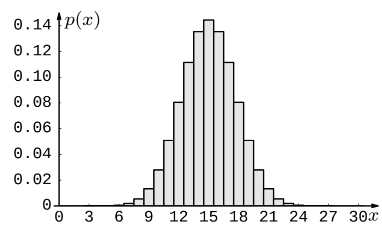


7.78 **(a)** 0.0001, 0.0016, 0.0176, 0.1031, 0.3368, 0.6632, 0.8953, 0.9648, 0.8953, 0.6632, 0.3368, 0.1031, 0.0176, 0. **(b)** OC curve:



7.79 0.5

7.80 **(a)** Probability histogram:



0.6074 **(b)** $X \overset{\bullet}{\sim} \mathrm{N}(15, 7.5)$, 0.5058. **(c)** Probabilities are close, but the normal approximation is less than the actual probability. **(d)** 0.6074. Now the two probabilities are the same. This is a better approximation because it includes the halves of rectangles in the probability histogram (left out in part (b)). This is called the continuity correction.

7.81 **(a)** S_2. Centered at θ, smaller variance. **(b)** S_2. Smaller variance. **(c)** S_2. Smaller variance. **(d)** Tough choice. S_2. Even though the distribution is not centered at θ, it has much smaller variance.

Chapter 8

Section 8.1

8.1 $\widehat{\theta}_2$: unbiased and small variance.

8.2 $\widehat{\theta}_2$: only unbiased statistic.

8.3 The value of the unbiased estimator is, on average, θ.

8.4 Select the one with the smallest variance. This estimator will, on average, yield an estimate closer to the true value.

8.5 0.8125

8.6 **(a)** $\overline{x} = 15.005$ **(b)** $\widetilde{x} = 15.1$ **(c)** $s^2 = 7.161$ **(d)** 0.45

8.7 0.18

8.8 **(a)** 7.2, 7.5 **(b)** 7.2

8.9 **(a)** 95 **(b)** 104 **(c)** $(95, 104)$

8.10 **(a)** 0.15 **(b)** 0.12 **(c)** 0.03

8.11 **(a)** 0.7535 **(b)** 0.2052 **(c)** 0.30, 0.87

Section 8.2

8.12 **(a)** 1.2816 **(b)** 1.6449 **(c)** 1.9600 **(d)** 2.3263 **(e)** 2.5758 **(f)** 3.0902 **(g)** 3.2905 **(h)** 3.7190

8.13 **(a)** $(13.507, 17.693)$ **(b)** $(6232.2, 6411.8)$ **(c)** $(-51.06, -40.50)$ **(d)** $(0.0763, 0.0827)$ **(e)** $(36.287, 39.073)$

8.14 **(a)** $(14.042, 21.158)$ **(b)** $(127.03, 146.57)$ **(c)** $(310.14, 361.26)$ **(d)** $(-7.426, -5.974)$ **(e)** $(18.984, 21.236)$

8.15 **(a)** 9.7 **(b)** 95% CI: $(8.55, 10.85)$, 99.9% CI: $(8.40, 11.0)$. For a higher confidence level (all else being equal), the CI has to be larger.

8.16 **(a)** 39 **(b)** 31 **(c)** 1637099 **(d)** 406 **(e)** 8189

8.17 $(95.914, 116.37)$

8.18 **(a)** $(136.57, 143.43)$ **(b)** Random sample, $n = 36$ is large, and σ is known.

8.19 **(a)** $(1.377, 1.588)$ **(b)** $(1.344, 1.621)$ **(c)** Larger confidence level.

8.20 **(a)** $(0.6649, 0.8151)$ **(b)** 75 **(c)** $(0.9561, 1.1439)$ **(d)** 76

8.21 **(a)** $(350.80, 369.20)$ **(b)** Yes. 270 is not in the CI found in part (a).

8.22 **(a)** $(8.725, 9.220)$ **(b)** $(9.324, 9.696)$ **(c)** Yes. The CIs do not overlap.

8.23 **(a)** $(31.255, 36.245)$ **(b)** 29 **(c)** The distribution of lighthouse heights is assumed normal.

8.24 **(a)** $(19.422, 22.078)$ **(b)** Yes. The CI does not include 23.

8.25 **(a)** $(0.5834, 0.8606)$ **(b)** No. 1 is not in the CI. **(c)** 97 **(d)** No. It is probably skewed to the right.

8.26 **(a)** $(122496, 127904)$ **(b)** $(145000, 166800)$ **(c)** Yes. The CIs do not overlap.

8.27 **(a)** Range-of-motion: $(23.539, 26.861)$. Strengthening: $(68.728, 78.472)$. Endurance: $(77.109, 87.291)$ **(b)** Yes. The CI for range-of-motion does not overlap with either strengthening or endurance.

8.28 **(a)** Football: $(61.109, 70.431)$. Basketball: $(49.427, 58.373)$. Hockey: $(64.899, 72.001)$ **(b)** There is evidence to suggest the mean coping skills level is different for football and basketball players. The CIs do not overlap. **(c)** Football: 191. Basketball: 151. Hockey: 101

8.29 **(a)** $(15.877, 17.994)$ **(b)** $(19.748, 21.821)$ **(c)** There is evidence to suggest the mean powder depths at these two ski resorts are different. The CIs do not overlap. **(d)** Random sample, large sample size, and σ is known.

8.30 **(a)** $(44205, 50795)$ **(b)** 22 **(c)** 196

8.31 **(a)** $(5185.7, 5520.3)$ **(b)** No. 5200 is in the CI constructed in part (a).

8.32 **(a)** $(0.1248, 0.1372)$ **(b)** It's close, but $1/8 = 0.125$ is captured by the CI in part (a). Therefore, there is no evidence to suggest the true mean is greater than 0.125. The town should not embark on the safety program.

8.33 **(a)** $(8.3397, 8.8603)$ **(b)** The normality assumption seems reasonable. Even though we are counting the number of lightning strikes, the distribution is likely to be approximately normal.

8.34 **(a)** $(6.4539, 6.7461)$ **(b)** $(6.5270, 6.6730)$ **(c)** $(6.4539, 6.7461)$ is an interval in which we are 95% confident the true mean wingspan lies.

8.35 **(a)** Cashew: $(5.0591, 5.2809)$. Filbert: $(4.0737, 4.4063)$. Pecan: $(2.3367, 2.8633)$. Cashews and pecans: yes. The CIs do not overlap. Filberts and pecans: yes. The CIs do not overlap. **(b)** Cashew: $(4.9852, 5.3548)$. Filbert: $(3.9628, 4.5172)$. Pecan: $(2.1611, 3.0389)$ Cashews and pecans: yes. The CIs do not overlap. Filberts and pecans: yes. The CIs do not overlap.

Section 8.3

8.36 **(a)** 1.4759 **(b)** 0.8569 **(c)** 2.8609 **(d)** 2.3646 **(e)** 2.9467 **(f)** 5.2076 **(g)** 3.7676 **(h)** 22.2037

8.37 **(a)** 2.1448 **(b)** 2.5280 **(c)** 2.7500 **(d)** 4.0150 **(e)** 5.9212 **(f)** 5.5407

8.38 **(a)** 1.0931 **(b)** 1.5286 **(c)** 3.1534 **(d)** 2.4377 **(e)** 2.6981 **(f)** 1.9921 **(g)** 2.1150 **(h)** 2.8652

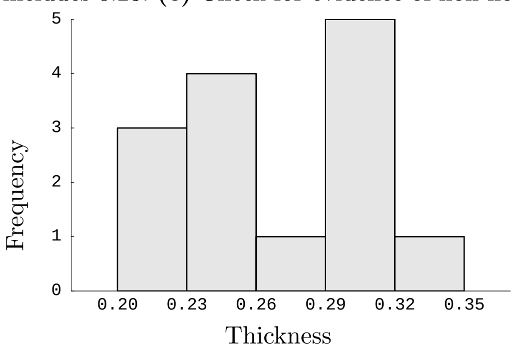
8.39 **(a)** $(193.6478, 228.7522)$ **(b)** $(46.0475, 102.7925)$ **(c)** $(127.2235, 150.5765)$ **(d)** $(-47.643, -8.957)$ **(e)** $(948.3804, 1080.6196)$

8.40 **(a)** $(0.1908, 0.2772)$ **(b)** $(217.5618, 301.6382)$ **(c)** $(19.005, 26.695)$ **(d)** $(367.9725, 393.8275)$ **(e)** $(72.4005, 103.7995)$

8.41 **(a)** $z_{0.01} < t_{0.01,27} < t_{0.01,17} < t_{0.01,5}$
(b) $z_{0.025} < t_{0.025,45} < t_{0.025,13} < t_{0.025,11}$
(c) $t_{0.05,15} < t_{0.025,15} < t_{0.02,15} < t_{0.001,15}$
(d) $t_{0.1,21} < t_{0.05,21} < t_{0.005,21} < t_{0.0001,21}$
(e) $t_{0.10,6} < t_{0.05,17} < t_{0.001,26} < z_{0.0001}$

8.42 **(a)** $(68.6122, 71.7878)$ **(b)** $(71.0587, 73.1413)$ **(c)** The underlying populations are normal. **(d)** No. The two CIs overlap.

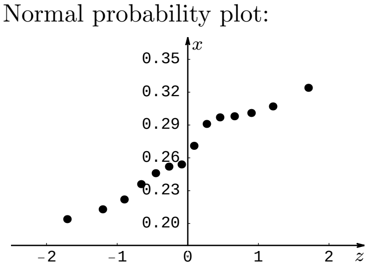
8.43 **(a)** $(0.2345, 0.2963)$ **(b)** No. The CI in part (a) includes 0.25. **(c)** Check for evidence of non-normality:



Backwards Empirical Rule

Interval	Proportion
$(0.2271, 0.3038)$	0.64
$(0.1887, 0.3421)$	1.00
$(0.1503, 0.3805)$	1.00

$IQR/s = 1.615$
Normal probability plot:



There is evidence to suggest the data are from a non-normal population.

8.44 **(a)** $(35.5795, 40.0205)$ **(b)** $(35.5795, 40.0205)$ is an interval in which we are 90% confident the true mean main-wash cycle time lies. **(c)** Larger: $(35.1144, 40.4856)$

8.45 **(a)** $(964.0170, 1043.8164)$ **(b)** No. The CI in part (a) includes 1000.

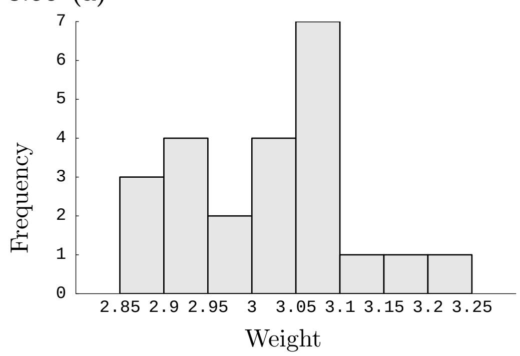
8.46 **(a)** Ohio: $(153.8227, 207.3773)$. California: $(149.7693, 175.6307)$. Massachusetts: $(104.6758, 125.9242)$. **(b)** Ohio and California: no. The CIs overlap. California and Massachusetts: yes. The CIs do not overlap.

8.47 **(a)** $(281.7269, 288.9397)$ **(b)** $(249.4027, 266.0973)$ **(c)** Yes. The CIs do not overlap. **(d)** Yes. Atrial-flutter is a measurement, probably not a skewed distribution.

8.48 $(118.8967, 136.1033)$ is an interval in which we are 95% confident the true mean depth of the upper mantle lies.

8.49 **(a)** $(15.3816, 18.0184)$ **(b)** No. The CI in part (a) suggests the true mean length is under 20 miles.

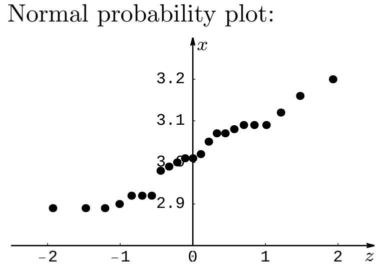
8.50 **(a)**



Backwards Empirical Rule

Interval	Proportion
$(2.9242, 3.1071)$	0.57
$(2.8328, 3.1985)$	0.96
$(2.7413, 3.2900)$	1.00

$IQR/s = 1.86$
Normal probability plot:

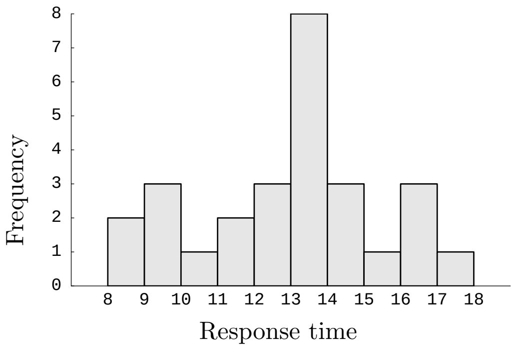


There is some evidence to suggest the data are from a non-normal population. **(b)** $(2.96.19, 3.0694)$ **(c)** No. 3 is in the CI.

8.51 **(a)** $(29.2575, 29.7908)$ **(b)** Yes. The CI does not contain 30.

8.52 **(a)** $(48.4171, 82.9829)$ **(b)** $(51.6028, 115.7972)$ **(c)** No. The two CIs overlap.

8.53 **(a)** $(11.6981, 14.2989)$ **(b)** $(7.8028, 9.7044)$ **(c)** Check for evidence of non-normality: rural areas.

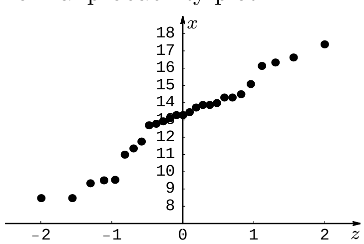


Backwards Empirical Rule

Interval	Proportion
(10.5668, 15.4302)	0.67
(8.1351, 17.8619)	1.00
(5.7035, 20.2936)	1.00

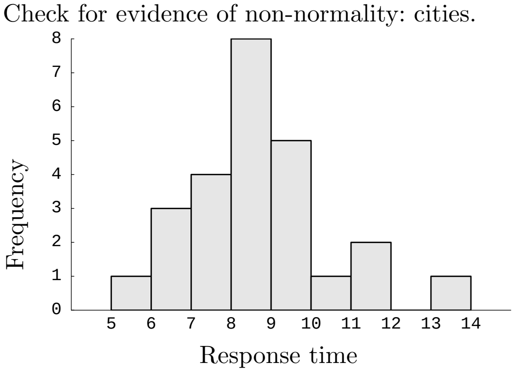
$IQR/s = 1.213$

Normal probability plot:



There is no evidence to suggest the data are from a non-normal population.

Check for evidence of non-normality: cities.

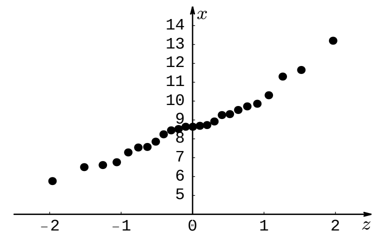


Backwards Empirical Rule

Interval	Proportion
(7.0539, 10.4533)	0.72
(5.3543, 12.1529)	0.96
(3.6546, 13.8526)	1.00

$IQR/s = 1.153$

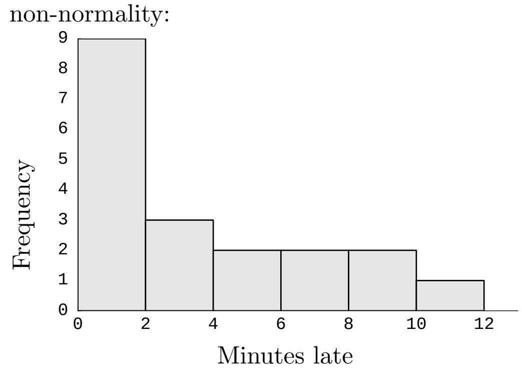
Normal probability plot:



There is no evidence to suggest the data are from a non-normal population.

(d) Yes. The two CIs do not overlap.

8.54 **(a)** $(1.9916, 4.9821)$ **(b)** Check for evidence of non-normality:

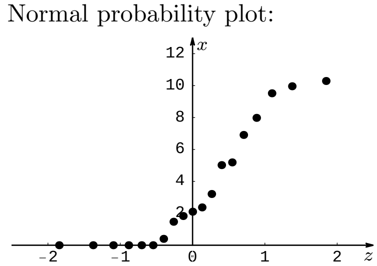


Backwards Empirical Rule

Interval	Proportion
(−0.2717, 7.2454)	0.79
(−4.0302, 11.0039)	1.00
(−7.7888, 14.7624)	1.00

$IQR/s = 1.838$

Normal probability plot:



There is evidence to suggest the data are from a non-normal population.

(c) No. Although it is close, the CI in part (a) does not include 5.

8.55 **(a)** $(664.68, 1056.82)$ **(b)** Yes. The lower bound on the CI in part (a) is greater than 500.

8.56 **(a)** Tees: $(0.3523, 0.4077)$. Fairways: $(0.4502, 0.5198)$. Greens: $(0.1061, 0.1239)$. Primary rough: $(4.4278, 5.8122)$. Intermediate rough: $(1.1786, 1.4614)$. **(b)** The sample standard deviation is larger. **(c)** No. The CI includes 0.5.

8.57 **(a)** OB/GYN: $(58798.03, 66201.97)$. Heart surgeon: $(58045.50, 61134.50)$. General surgeon: $(46841.22, 48168.78)$. **(b)** OB/GYN: No. The CI contains 60,000. Heart surgeon: Yes. 56,000 is not in the CI. General surgeon: Yes. 40,000 is not in the CI.

8.58 $(11.0687, 15.8695)$

8.59 **(a)** Men: $(36.8592, 40.9408)$. Women: $(34.1608, 37.0392)$. **(b)** No. The CIs overlap. **(c)** $(240.1594, 274.8406)$ is an interval in which we are 99% confident the true mean distance traveled lies.

8.60 **(a)** $(663.08, 665.92)$ **(b)** Yes. The lower bound of the CI in part (a) is greater than 660.79.

Section 8.4

8.61

	$n\widehat{p}$	$n(1-\widehat{p})$	Approx. normal Yes	Approx. normal No
(a)	85	20	X	
(b)	1645	105	X	
(c)	220	5	X	
(d)	3	180		X
(e)	350	27	X	
(f)	478	2		X

8.62 **(a)** $(0.3868, 0.5465)$ **(b)** $(0.2186, 0.3592)$ **(c)** $(0.9180, 0.9540)$ **(d)** $(0.5383, 0.7881)$ **(e)** $(0.3698, 0.4350)$

8.63 **(a)** $(0.7187, 0.7798)$ **(b)** $(0.8543, 0.9005)$ **(c)** $(0.3761, 0.5886)$ **(d)** $(0.8223, 0.9090)$ **(e)** $(0.0449, 0.1212)$

8.64 **(a)** 381 **(b)** 241 **(c)** 80 **(d)** 145426 **(e)** 2065

8.65 **(a)** 461 **(b)** 97 **(c)** 338244 **(d)** 271 **(e)** 68

8.66 **(a)** Decreases. **(b)** Decreases. **(c)** Decreases.

8.67 **(a)** Increases. **(b)** Increases. **(c)** Decreases. **(d)** Decreases.

8.68 **(a)** $(0.1467, 0.2439)$ **(b)** Yes. 0.25 is not included in the CI in part (a).

8.69 **(a)** High-school graduate: $(0.4647, 0.6248)$. Some college: $(0.4923, 0.6235)$. College graduate: $(0.3694, 0.5159)$. **(b)** High-school graduate versus college graduate: No. The CIs overlap. Some college versus college graduate: No. The CIs overlap.

8.70 **(a)** $(0.3750, 0.4424)$ **(b)** 1025

8.71 **(a)** $n\widehat{p} = 132 \geq 5$, $n(1-\widehat{p}) = 820 \geq 5$. The non-skewness criteria are satisfied. The distribution of $\widehat{P}$ is approximately normal. **(b)** $(0.1167, 0.1606)$ **(c)** Yes. The lower bound on the CI is greater than 0.10.

8.72 **(a)** $(0.0524, 0.1876)$ **(b)** 542

8.73 **(a)** $(0.8450, 0.8966)$ **(b)** $(0.7856, 0.8452)$ **(c)** $(0.6855, 0.7545)$ **(d)** Part (a). $\widehat{p}$ is the farthest away from 0.5.

8.74 **(a)** $(0.1527, 0.2400)$ **(b)** $(0.0856, 0.1564)$ **(c)** No. The CIs overlap, just barely.

8.75 **(a)** $(0.1833, 0.2574)$ **(b)** $(0.1852, 0.2350)$ **(c)** No. The CIs overlap.

8.76 **(a)** Democrat: $(0.2373, 0.3534)$. Republican: $(0.4245, 0.5239)$. Independent: $(0.0924, 0.2044)$. **(b)** Independent versus Democrat: Yes. The CIs do not overlap. Independent versus Republican: Yes. The CIs do not overlap. **(c)** Assuming no knowledge of p: 2401

8.77 **(a)** $(0.4893, 0.5311)$ **(b)** $(0.2905, 0.3292)$ **(c)** $(0.2518, 0.2889)$

8.78 **(a)** $(0.1365, 0.1870)$ **(b)** 1691

8.79 **(a)** $(0.2575, 0.3914)$ **(b)** 1153

8.80 **(a)** $(0.5982, 0.7618)$ **(b)** $(0.1866, 0.3229)$ **(c)** $(0.3160, 0.4757)$

8.81 **(a)** $(0.2901, 0.3509)$ **(b)** No. 0.30 is included in the CI (just barely).

8.82 **(a)** Treatment: $(0.1005, 0.1619)$. Placebo: $(0.0506, 0.1442)$. **(b)** No. The two CIs overlap. **(c)** Treatment: $(0.0398, 0.0936)$. Placebo: $(0.0145, 0.1024)$. **(d)** No. The two CIs overlap.

8.83 **(a)** $(0.0474, 0.0812)$ **(b)** Yes. The CI does not contain 0.03. The lower bound is greater than 0.03.

8.84 **(a)** Northeast: $(0.7313, 0.8687)$. Midwest: $(0.7510, 0.8722)$. South Central: $(0.7084, 0.8332)$. South Atlantic: $(0.7850, 0.8758)$. West: $(0.7801, 0.8811)$. **(b)** Northeast. $\widehat{p}$ is farthest from 0.5.

8.85 **(a)** $(0.4204, 0.4732)$ **(b)** No. 0.46 is included in the CI in part (a).

Section 8.5

8.86 **(a)** 9.2364 **(b)** 61.0983 **(c)** 26.2962 **(d)** 35.4789 **(e)** 3.0535 **(f)** 7.2609 **(g)** 11.6886 **(h)** 1.7349

8.87 **(a)** 6.3038 **(b)** 30.5779 **(c)** 5.2865 **(d)** 12.8382 **(e)** 4.9123 **(f)** 58.9639 **(g)** 9.8028 **(h)** 82.0623

8.88 **(a)** 10.2829, 36.4789 **(b)** 17.8867, 61.5812 **(c)** 2.5582, 23.2093 **(d)** 18.4927, 43.7730 **(e)** 0.4844, 11.1433 **(f)** 14.4012, 70.5881

8.89 **(a)** $(3.6966, 9.6990)$ **(b)** $(25.7367, 98.9676)$ **(c)** $(27.2889, 156.5229)$ **(d)** $(5.4213, 11.8821)$ **(e)** $(8.6728, 622.6415)$ **(f)** $(32.9791, 209.8371)$

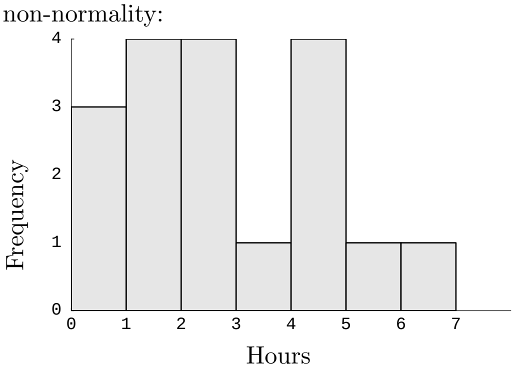
8.90 **(a)** $(1.3427, 11.2313)$ **(b)** $(31.2940, 197.4147)$ **(c)** $(31.9769, 183.4121)$ **(d)** $(3.0994, 26.5425)$ **(e)** $(18.5739, 64.0850)$ **(f)** $(5.8969, 36.9707)$

8.91 **(a)** 61.6562 **(b)** 98.1051 **(c)** 102.8163 **(d)** 78.5672 **(e)** 64.7494 **(f)** 26.0651 **(g)** 51.7705 **(h)** 52.9419

8.92 **(a)** $(2.5912, 8.2250)$ **(b)** $(1.6097, 2.8679)$

8.93 **(a)** $(58.7993, 247.2213)$ **(b)** The underlying population is normal. **(c)** No. 100 is included in the CI.

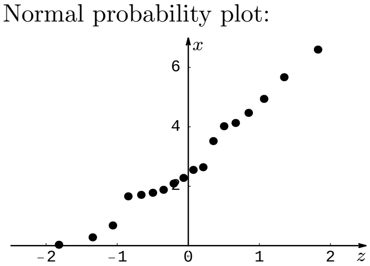
8.94 **(a)** $(1.7229, 8.9829)$ **(b)** Check for evidence of non-normality:



Backwards Empirical Rule

Interval	Proportion
$(0.9894, 4.6695)$	0.67
$(-0.8507, 6.5096)$	0.94
$(-2.6908, 8.3497)$	1.00

$IQR/s = 1.315$
Normal probability plot:

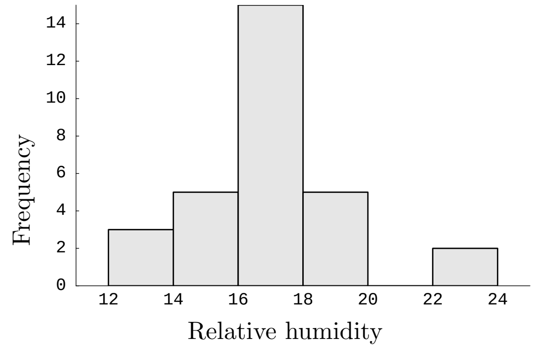


There is no overwhelming evidence to suggest the data are from a non-normal population.

8.95 **(a)** $(0.1975, 0.7877)$ **(b)** No. The CI in part (a) includes 0.50.

8.96 **(a)** $(3.6957, 10.1632)$ **(b)** $(4.7881, 14.1916)$ **(c)** No. The CIs overlap. **(d)** The underlying populations are normal.

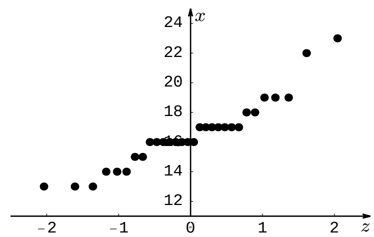
8.97 **(a)** $(3.4877, 9.9374)$ **(b)** Check for evidence of non-normality:



Backwards Empirical Rule

Interval	Proportion
$(14.1884, 18.8783)$	0.63
$(11.8434, 21.2233)$	0.94
$(9.4984, 23.5682)$	1.00

$IQR/s = 0.853$
Normal probability plot:



There is some evidence to suggest the data are from a non-normal population. IQR/s is far away from 1.3, and the normal probability plot is not very linear.

8.98 **(a)** <250: $(0.0013, 0.0103)$. 250–1100: $(0.0190, 0.1194)$. 1100–2250: $(0.2536, 1.3070)$. **(b)** Yes. 1100–2250.

8.99 **(a)** $(0.9514, 2.7108)$ **(b)** $(0.5268, 1.8176)$ **(c)** No. The CIs overlap.

8.100 **(a)** $(0.3346, 1.1053)$ **(b)** $(0.5785, 1.0513)$ **(c)** No. The CI includes 1.

8.101 $(53.5276, 246.6703)$

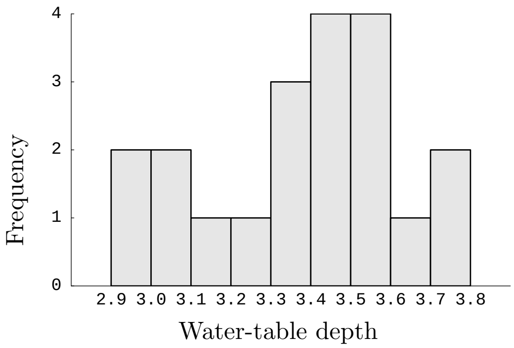
8.102 **(a)** $(0.0476, 0.1411)$ **(b)** $(0.2182, 0.3757)$ **(c)** 0.0793, 0.2123

8.103 **(a)** $(0.5611, 2.2381)$ **(b)** $(15.5896, 71.8413)$ **(c)** Veteran. The CI suggests the population variance for the veteran is much smaller than for the rookie.

8.104 **(a)** $(0.0714, 0.2072)$ **(b)** Yes. The lower bound on the CI is greater than 0.06.

8.105 **(a)** $(0.0238, 0.2783)$, $(94.1776, 627.5906)$ **(b)** $(0.0400, 0.2152)$, $(122.6953, 515.8717)$ **(c)** Column water vapor: no. The CIs overlap. IB: no. The CIs overlap.

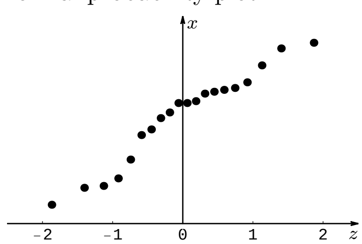
8.106 **(a)** $(0.0319, 0.1515)$ **(b)** $(0.17817, 0.3892)$ **(c)** Check for evidence of non-normality:



Backwards Empirical Rule

Interval	Proportion
(3.1243, 3.6177)	0.65
(2.8777, 3.8643)	1.00
(2.6310, 4.1110)	1.00

$IQR/s = 1.257$
Normal probability plot:



There is some evidence to suggest the data are from a non-normal population. The histogram does not appear normal, and the normal probability plot has distinct curves.

8.107 **(a)** $(0.3181, 1.1733)$ **(b)** No. The CI includes 0.40.

8.108 **(a)** $(0.7665, 4.8353)$ **(b)** $(1.4511, 4.6060)$ **(c)** No. The CIs overlap.

8.109 **(a)** $(1.3481 \times 10^{16}, 6.2555 \times 10^{16})$ **(b)** $(571509.18, 2.6520 \times 10^{6})$ **(c)** Absolutely. The CI does not include 1 and is nowhere near 1.

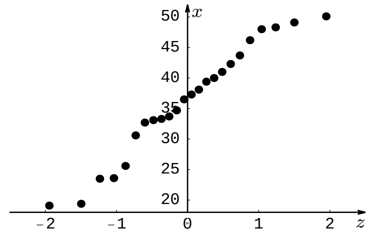
8.110 $(17.6309, 1265.7672)$

8.111 **(a)** $(6.5503, 23.3373)$ **(b)** No. The CI includes 12.

Chapter Exercises

8.112 **(a)** $(0.2194, 0.3086)$ **(b)** $(0.0095, 0.0363)$ **(c)** Yes. The CIs do not overlap.

8.113 **(a)** $(32.3143, 40.1274)$ **(b)** $(51.7008, 168.4160)$ **(c)** Normal probability plot:



There is some evidence to suggest the data are from a non-normal population.

8.114 **(a)** $(46.0574, 65.4826)$ **(b)** 9

8.115 **(a)** $\widehat{p} = 0.70$. $n\widehat{p} = 189 \geq 5$, $n(1-\widehat{p}) = 81 \geq 5$. **(b)** $(0.6282, 0.7718)$ **(c)** 664

8.116 **(a)** $(0.2832, 0.3168)$ **(b)** $(0.3292, 0.3708)$ **(c)** Yes. The CIs do not overlap.

8.117 **(a)** $(86.5634, 89.1638)$ **(b)** $(4.3620, 22.4793)$ **(c)** Yes. The CI for the population mean does not include 90.

8.118 **(a)** $\widehat{p} = 0.56$. $n\widehat{p} = 280 \geq 5$, $n(1-\widehat{p}) = 220 \geq 4$. **(b)** $(0.5028, 0.6172)$ **(c)** No. The CI for p includes 0.60.

8.119 **(a)** $(0.4387, 0.4941)$ **(b)** $(0.3108, 0.3590)$ **(c)** Yes. The CIs do not overlap.

8.120 **(a)** $(117.4437, 122.8063)$ **(b)** No. The CI includes 120.

8.121 **(a)** $(0.0047, 0.0158)$ **(b)** No. The CI includes 0.01.

8.122 **(a)** $\widehat{p} = 0.24$. $n\widehat{p} = 300 \geq 5$, $n(1-\widehat{p}) = 950 \geq 5$. **(b)** $(0.2163, 0.2637)$ **(c)** 2401

8.123 **(a)** $(4.5138, 4.8102)$ **(b)** $(1.9568, 2.2012)$ **(c)** No. Neither CI includes 5. **(d)** There is evidence to suggest the mean mercury concentration is different for the two groups. The CIs do not overlap.

8.124 **(a)** $(2.7452, 3.3668)$ **(b)** $(0.2618, 0.9355)$ **(c)** The underlying population is normal. **(d)** Yes. The lower bound in the CI for the population mean is greater than 2.

8.125 **(a)** $(49.1185, 55.4815)$ **(b)** $(49.1981, 55.4019)$. The CI based on the Z distribution is slightly smaller. **(c)** $(84.0416, 168.9512)$

8.126 **(a)** $(0.2740, 0.4294)$ **(b)** $(0.3567, 0.4403)$ **(c)** No. The CIs overlap.

8.127 **(a)** $(395.77, 424.73)$ **(b)** $(74986, 2380.24)$ **(c)** $(27.38, 48.79)$

8.128 **(a)** $(74.52, 181.48)$ **(b)** No. The CI includes 100. **(c)** $(2661.55, 17736.36)$ **(d)** Yes. The CI does not include 2500.

8.129 **(a)** $(0.00095, 0.00112)$ **(b)** $(0.00290, 0.00312)$ **(c)** Yes. The CIs do not overlap.

8.130 **(a)** $(70.7980, 80.0020)$ **(b)** No. The CI includes 78.4.

8.131 **(a)** White: $(0.1168, 0.1553)$. Black: $(0.1664, 0.2132)$. Hispanic: $(0.3050, 0.3593)$. **(b)** Yes. Black and Hispanic. These two CIs do not include 0.146.

Exercises′

8.132 **(a)** $\mu < \overline{x} + z_\alpha(\sigma/\sqrt{n})$ **(b)** $\mu > \overline{x} - z_\alpha(\sigma/\sqrt{n})$ **(c)** $\mu \le 2.4467$

8.133 It is the *shortest* $100(1-\alpha)\%$ CI for μ.

8.134 **(a)** $\mu < \overline{x} + t_{\alpha,n-1}(s/\sqrt{n})$, $\mu > \overline{x} - t_{\alpha,n-1}(s/\sqrt{n})$. **(b)** $\mu > 255.0906$

8.135 **(a)** $\mu < \widehat{p} + z_\alpha\sqrt{\dfrac{\widehat{p}(1-\widehat{p})}{n}}$, $\mu > \widehat{p} - z_\alpha\sqrt{\dfrac{\widehat{p}(1-\widehat{p})}{n}}$, **(b)** $\mu < 0.7024$

8.136 **(a)** $0 < \sigma^2 < \dfrac{(n-1)s^2}{\chi^2_{1-\alpha,n-1}}$, $\sigma^2 > \dfrac{(n-1)s^2}{\chi^2_{\alpha,n-1}}$. **(b)** $0 < \sigma^2 < 880{,}691{,}497$

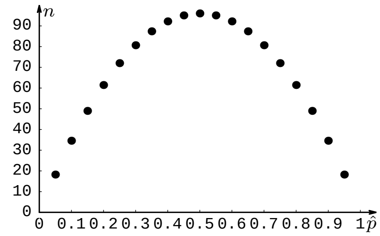
8.137 **(a)** $(0.5040, 0.6960)$, $(0.5020, 0.6906)$. The Wilson interval is shorter. It is more precise.

(b)

n	Traditional CI	Wilson CI
120	$(0.5123, 0.6877)$	$(0.5106, 0.6832)$
140	$(0.5188, 0.6812)$	$(0.5172, 0.6774)$
160	$(0.5241, 0.6759)$	$(0.5226, 0.6727)$
180	$(0.5284, 0.6716)$	$(0.5271, 0.6688)$
200	$(0.5321, 0.6679)$	$(0.5308, 0.6654)$
220	$(0.5353, 0.6647)$	$(0.5341, 0.6625)$
240	$(0.5380, 0.6620)$	$(0.5369, 0.6599)$
260	$(0.5405, 0.6595)$	$(0.5394, 0.6577)$
280	$(0.5426, 0.6574)$	$(0.5416, 0.6557)$
300	$(0.5446, 0.6554)$	$(0.5436, 0.6538)$
320	$(0.5463, 0.6537)$	$(0.5454, 0.6522)$
340	$(0.5479, 0.6521)$	$(0.5471, 0.6507)$
360	$(0.5494, 0.6506)$	$(0.5486, 0.6493)$
380	$(0.5507, 0.6493)$	$(0.5500, 0.6480)$
400	$(0.5520, 0.6480)$	$(0.5513, 0.6468)$
420	$(0.5531, 0.6469)$	$(0.5524, 0.6457)$
440	$(0.5542, 0.6458)$	$(0.5535, 0.6447)$
460	$(0.5552, 0.6448)$	$(0.5546, 0.6438)$
480	$(0.5562, 0.6438)$	$(0.5555, 0.6429)$
500	$(0.5571, 0.6429)$	$(0.5565, 0.6420)$

As n increases in the Wilson CI, $\widehat{p}$ is closer to the center of the interval.

8.138



The pattern is parabolic. n is largest when $\widehat{p} = 0.5$.

8.139

(a) $\left(\dfrac{s^2(n-1)}{z_{\alpha/2}\sqrt{2(n-1)}+(n-1)} < \sigma^2 < \dfrac{s^2(n-1)}{-z_{\alpha/2}\sqrt{2(n-1)}+(n-1)}\right)$

(b) $(11.3763, 25.1102)$. $(11.6739, 26.7267)$. The interval based on the normal distribution is wider since this is based on an approximate distribution.

Chapter 9

Section 9.1

9.1 **(a)** Valid, null hypothesis. **(b)** Invalid. **(c)** Invalid. **(d)** Invalid. **(e)** Valid, alternative hypothesis. **(f)** Valid, alternative hypothesis. **(g)** Invalid. **(h)** Valid, null hypothesis.

9.2 **(a)** Valid, null hypothesis. **(b)** Invalid. **(c)** Valid, alternative hypothesis. **(d)** Invalid. **(e)** Invalid. **(f)** Valid, alternative hypothesis. **(g)** Valid, alternative hypothesis. **(h)** Valid, null hypothesis.

9.3 **(a)** Valid. **(b)** Invalid. Could be $H_a : \mu > 9.7$. **(c)** Invalid. Could be $H_a : \sigma^2 \neq 98.6$. **(d)** Valid.

9.4 **(a)** Valid. **(b)** Valid. **(c)** Invalid. The null hypothesis should be stated so that p (a parameter) equals a single value. **(d)** Invalid. The null and alternative hypotheses are always about a parameter, not a statistic.

9.5 **(a)** Valid. **(b)** Valid. **(c)** Invalid. The null hypothesis should be stated so that μ (a parameter) equals a single value. **(d)** Valid.

9.6 **(a)** Not permissible. We never *accept* a null hypothesis. **(b)** Permissible. **(c)** Not permissible. We conduct a hypothesis test in order to try and prove the alternative hypothesis. **(d)** Permissible. **(e)** Permissible. **(f)** Permissible.

9.7 $H_0 : \mu = 1026$, $H_a : \mu > 1026$.

9.8 $H_0 : p = 0.11$, $H_a : p > 0.11$.

9.9 $H_0 : \mu = 17060$, $H_a : \mu < 17060$.

9.10 $H_0 : p = 0.47$, $H_a : p \neq 0.47$.

9.11 (a) is appropriate. The software company is looking for evidence that the mean age is greater than 25.

9.12 $H_0 : \sigma^2 = 32$, $H_a : \sigma^2 < 32$.

9.13 $H_0 : p = 0.75$, $H_a : p > 0.75$.

9.14 $H_0 : \mu = 172$ (minutes), $H_a : \mu < 172$.

9.15 (c) is appropriate. The bus company is looking for evidence that the true proportion of parents who favor seat-belt installation is greater than 0.50.

9.16 $H_0 : p = 0.65$, $H_a : p > 0.65$.

9.17 $H_0 : p = 0.35$, $H_a : p < 0.35$.

9.18 $H_0 : \widetilde{\mu} = 350$, $H_a : \widetilde{\mu} > 350$.

9.19 $H_0 : \sigma = 7$, $H_a : \sigma < 7$.

9.20 $H_0 : \mu = 525$, $H_a : \mu < 525$.

9.21 $H_0 : p = 0.60$, $H_a : p > 0.60$.

9.22 $H_0 : \mu = 1235$, $H_a : \mu > 1235$.

9.23 (c) is appropriate. The City Council is looking for evidence that the true proportion of residents who favor a new marina is greater than 0.80.

9.24 $H_0 : \mu = 1925$, $H_a : \mu < 1925$.

9.25 $H_0 : \widetilde{\mu} = 125.50$, $H_a : \widetilde{\mu} < 125.50$.

Section 9.2

9.26 **(a)** Type I error. **(b)** Correct decision. **(c)** Type II error. **(d)** Type I error.

9.27 **(a)** Correct decision. **(b)** Type II error. **(c)** Type II error. **(d)** Correct decision.

9.28 **(a)** Type I error. **(b)** Type II error. **(c)** Correct decision. **(d)** Correct decision.

9.29 **(a)** $\beta(11) > \beta(15)$. As the alternative value of μ moves farther from the hypothesized value, the probability of a type II error decreases. There is a better chance of detecting the difference. **(b)** The probability of a type II error decreases.

9.30 There is always a chance of making a mistake in any hypothesis test because we never look at the entire population, only a sample.

9.31 α and β are inversely related. A very small α means β, the probability of a type II error, is very large.

9.32 **(a)** $H_0 : \mu = 40{,}000$, $H_a : \mu > 40{,}000$. **(b)** Type I error: decide the mean is greater than 40,000 when the true mean is 40,000 (or less). Type II error: decide the mean is 40,000 (or less) when the true mean is greater than 40,000. **(c)** DOT is more angry. They really didn't need to build additional toll booths. **(d)** Drivers are more angry. They really need more toll booths.

9.33 **(a)** $H_0 : p = 0.25$, $H_a : p > 0.25$. **(b)** Type I error: decide $p > 0.25$ when the true proportion is really 0.25 (or less). Type II error: decide $p = 0.25$ (or less) when the true proportion is really greater than 0.25. **(c)** $\beta(0.35)$ is smaller.

9.34 **(a)** Type I error: decide $\mu > 10$ when the true mean is really 10 (or less). Type II error: decide $\mu = 10$ (or less) when the true mean is really greater than 10. **(b)** Type II error. The files are really very old and need to be archived. **(c)** Type I error. The files are really not that old and the money does not need to be spent to archive them.

9.35 **(a)** $H_0 : \mu = 0.65$, $H_a : \mu > 0.65$. **(b)** Type I error: decide $\mu > 0.65$ when the true mean is really 0.65 (or less). Type II error: decide $\mu = 0.65$ (or less) when the true mean is really greater than 0.65. **(c)** Type II error. If the mean current velocity is greater than 0.65, it is unsafe for swimmers. **(d)** Type I error. The race would be canceled, but the mean current is really safe.

9.36 **(a)** $H_0 : p = 0.15$, $H_a : p > 0.15$. **(b)** Type I error: decide $p > 0.15$ when the true proportion is really 0.15 (or less). Type II error: decide $p = 0.15$ (or less) when the true proportion is really greater than 0.15. **(c)** The probability of a type I error becomes smaller.

9.37 **(a)** $H_0 : p = 0.08$, $H_a : p < 0.08$. **(b)** Type II error. The new academic policy is really working, but there is no evidence. **(c)** Type I error. The new academic policy is not working, but fewer students are showing up late for exams. This probably means the new policy would remain in effect, but it really isn't necessary.

9.38 **(a)** Type I error: decide $\mu > 0.4$ when the true mean is really 0.4 (or less). Type II error: decide $\mu = 0.4$ (or less) when the true mean is really greater than 0.4. **(b)** Type II error. Chocolate is really increasing the level of antioxidants, but there is no evidence.

9.39 **(a)** $H_0 : p = 0.60$, $H_a : p > 0.60$. **(b)** Type I error: decide $p > 0.60$ when the true proportion is really 0.60 (or less). Type II error: decide $p = 0.60$ (or less) when the true proportion is really greater than 0.60. **(c)** Type II error. Residents are in favor of the extended structure, but the evidence suggests they are not. **(d)** Type I error. The city council believes residents are in favor of the extended structure, but they really aren't.

9.40 **(a)** $H_0 : p = 0.60$, $H_a : p > 0.60$. **(b)** Type I error: decide $p > 0.60$ when the true proportion is really 0.60 (or less). Type II error: decide $p = 0.60$ (or less) when the true proportion is really greater than 0.60.

9.41 **(a)** $H_0 : \mu = 1{,}367$, $H_a : \mu > 1{,}367$. **(b)** Type I error: decide $\mu > 1{,}367$ when the true mean is really 1,367 (or less). Type II error: decide $\mu = 1{,}367$ (or less) when the true mean is really greater than 1,367.

9.42 **(a)** $H_0 : p = 0.50$, $H_a : p > 0.50$. **(b)** Type I error: decide $p > 0.50$ when the true proportion is really 0.50 (or less). Type II error: decide $p = 0.50$ (or less) when the true proportion is really greater than 0.50. **(c)** Type I error. They will be charged additional malpractice insurance premiums, but the true proportion is really 0.5 (or less). **(d)** Type II error. There is no evidence that the perceived lack of consultation is real, but it is.

9.43 **(a)** $H_0 : \sigma^2 = 15$, $H_a : \sigma^2 < 15$. **(b)** Type I error: decide $\sigma^2 < 15$ when the true population variance is really 15 (or more). Type II error: decide $\sigma^2 = 15$ (or more) when the true population variance is really less than 15. **(c)** Type I error. NSF would commit more money, but there is really no evidence TM decreases brain activity. Type II error. No evidence of decreased brain activity, but TM really works!

9.44 **(a)** $H_0 : \mu = 6400$, $H_a : \mu > 6400$. **(b)** $\alpha = 0.1$. This would allow a greater error on the side of safety.

Section 9.3

9.45 **(a)** $Z = (\overline{X} - 170)/(15/\sqrt{38})$
(b) (i) $Z \le -2.3263$ (ii) $Z \le -1.96$ (iii) $Z \le -1.6449$ (iv) $Z \le -1.2816$ (v) $Z \le -3.0902$ (vi) $Z \le -3.7190$

9.46 **(a)** $Z = (\overline{X} - 45.6)/(15/\sqrt{16})$
(b) (i) $Z \ge 2.3263$ (ii) $Z \ge 1.96$ (iii) $Z \ge 1.6449$ (iv) $Z \ge 1.2816$ (v) $Z \ge 2.5758$ (vi) $Z \ge 3.2905$

9.47 **(a)** $Z = (\overline{X} + 11)/(4.5/\sqrt{21})$
(b) (i) $|Z| \ge 2.5758$ (ii) $|Z| \ge 2.3263$ (iii) $|Z| \ge 1.96$ (iv) $|Z| \ge 1.6449$ (v) $|Z| \ge 3.2905$ (vi) $|Z| \ge 3.7190$

9.48 **(a)** 0.05 **(b)** 0.005 **(c)** 0.02 **(d)** 0.01 **(d)** 0.001 **(e)** 0.0001

9.49 **(a)** 0.05 **(b)** 0.10 **(c)** 0.005 **(d)** 0.001 **(e)** 0.20 **(f)** 0.02

9.50 **(a)** 0.0001 **(b)** 0.20 **(c)** 0.01 **(d)** 0.05 **(e)** 0.0005 **(f)** 0.002

9.51 **(a)** H_0: $\mu = 212$; H_a: $\mu > 212$;
TS: $Z = (\overline{X} - \mu_0)/(\sigma/\sqrt{n})$; RR: $Z \ge 2.3263$ **(b)** The underlying population is normal and the population standard deviation is known.
(c) $z = 2.6042$ (≥ 2.3263). There is evidence to suggest the population mean is greater than 212.

9.52 **(a)** H_0: $\mu = 3.14$; H_a: $\mu < 3.14$;
TS: $Z = (\overline{X} - \mu_0)/(\sigma/\sqrt{n})$; RR: $Z \le -3.0902$ **(b)** The sample size is large and the population standard deviation is known. **(c)** $z = -1.2588$. There is no evidence to suggest the population mean is less than 3.14.

9.53 **(a)** H_0: $\mu = 365.25$; H_a: $\mu \ne 365.25$;
TS: $Z = (\overline{X} - \mu_0)/(\sigma/\sqrt{n})$; RR: $|Z| \ge 1.96$ **(b)** The sample size is large and the population standard deviation is known. **(c)** $z = -1.6311$. There is no evidence to suggest the population mean is different from 365.25.

9.54 **(a)** The rejection region is for a left-tailed test. **(b)** The numerator is incorrect. **(c)** Never say, "Accept the null hypothesis." **(d)** The null hypothesis is always stated with an equal sign. **(e)** The probability of a type II error depends on the true value of the population mean.

9.55 **(a)** 0.3644 **(b)** 0.1555, 0.0465 **(c)** 0.2399, 0.0848, 0.0207

9.56 H_0: $\mu = 51500$, $\quad H_a : \mu < 51500$

$$\text{TS: } Z = \frac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}, \quad \text{RR: } Z \le -2.3263$$

$z = -2.8570 \le -2.3263$. There is evidence to suggest the mean income per year of corporate communications workers has decreased.

9.57 H_0: $\mu = 10$, $\quad H_a : \mu \ne 10$

$$\text{TS: } Z = \frac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}, \quad \text{RR: } |Z| \ge 1.96$$

$z = -0.5784$. There is no evidence to suggest the mean lava flow has changed.

9.58 H_0: $\mu = 295$, $\quad H_a : \mu > 295$

$$\text{TS: } Z = \frac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}, \quad \text{RR: } Z \ge 2.3263$$

$z = 1.5670$. There is no evidence to suggest the mean length of international calls has increased. Therefore, there is no evidence to suggest the advertising campaign was successful.

9.59 **(a)** H_0: $\mu = 0.23$, $\quad H_a : \mu < 0.23$

$$\text{TS: } Z = \frac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}, \quad \text{RR: } Z \le -2.3263$$

$z = -4.8189 \le -2.3263$. There is evidence to suggest the mean HC emission has decreased. **(b)** Type I error is more important to the fuel company. If H_0 is rejected, the facility will be built. The fuel company does not want to build the facility unless the mean HC emission is lower. The company would prefer a smaller significance level.

9.60 H_0: $\mu = 12.4$, $\quad H_a : \mu < 12.4$

$$\text{TS: } Z = \frac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}, \quad \text{RR: } Z \le -1.96$$

$z = -1.0722$. There is no evidence to suggest the mean water table is less than 12.4 feet.

9.61 **(a)** H_0: $\mu = 35$, $H_a: \mu > 35$

TS: $Z = \dfrac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}$, RR: $Z \geq 2.3263$

$z = 3.2720 \geq 2.3263$. There is evidence to suggest the mean LOA is greater than 35 feet. **(b)** No.

9.62 H_0: $\mu = 220$, $H_a: \mu < 220$

TS: $Z = \dfrac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}$, RR: $Z \leq -1.6449$

$z = -3.2853 \leq -1.6449$. There is evidence to suggest the mean area is less than 220 square feet.

9.63 **(a)** H_0: $\mu = 2200$, $H_a: \mu < 2200$

TS: $Z = \dfrac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}$, RR: $Z \leq -1.6449$

$z = -1.8860 \leq -1.6449$. There is evidence to suggest the mean caloric intake is less than 2200. **(b)** RR: $Z \leq -2.3263$. $z = -1.8860$ does not lie in the rejection region. There is no evidence to suggest the mean caloric intake is less than 2200.

9.64 H_0: $\mu = 21$, $H_a: \mu > 21$

TS: $Z = \dfrac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}$, RR: $Z \geq 2.5758$

$z = 2.9332 \geq 2.5758$. There is evidence to suggest the mean number of blades of grass has increased.

9.65 **(a)** H_0: $\mu = 23.625$, $H_a: \mu \neq 23.625$

TS: $Z = \dfrac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}$, RR: $|Z| \geq 1.96$

$z = 1.5811$. There is no evidence to suggest the mean is different from 23.625. The assembly line should not be shut down. **(b)** 23.532, 23.718

9.66 **(a)** H_0: $\mu = 15.5$, $H_a: \mu < 15.5$

TS: $Z = \dfrac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}$, RR: $Z \leq -2.3263$

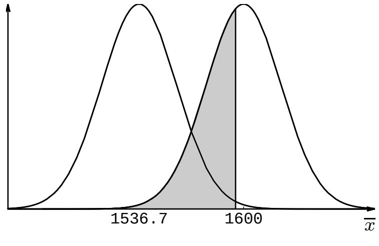
$z = -3.0407 \leq -2.3263$. There is evidence to suggest the mean weight is less than 15.5 ounces. **(b)** The sample size is very large and σ is small.

9.67 **(a)** H_0: $\mu = 1536.7$, $H_a: \mu \neq 1536.7$

TS: $Z = \dfrac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}$, RR: $|Z| \geq 2.5758$

$z = 2.4575$. There is no evidence to suggest the mean ice thickness is different from 1536.7. **(b)** 0.4146

(c) Illustration of part (b):



(d) 0.1061

9.68 **(a)** H_0: $\mu = 714$, $H_a: \mu \neq 714$

TS: $Z = \dfrac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}$, RR: $|Z| \geq 1.96$

$z = -2.4656 \leq -1.96$. There is evidence to suggest the mean monthly usage is different from 714. **(b)** The standard deviation is very large.

9.69 **(a)** H_0: $\mu = 4.0$, $H_a: \mu > 4.0$

TS: $Z = \dfrac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}$, RR: $Z \geq 2.3263$

$z = 0.9882$. There is no evidence to suggest the mean daily temperature is greater than 4.0. **(b)** $z = 1.6941$. Same conclusion.

9.70 H_0: $\mu = 14.0$, $H_a: \mu > 14.0$

TS: $Z = \dfrac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}$, RR: $Z \geq 3.0902$

$z = 0.0354$. There is no evidence to suggest the mean response time has increased.

9.71 **(a)** H_0: $\mu = 12$, $H_a: \mu < 12$

TS: $Z = \dfrac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}$, RR: $Z \leq -1.6449$

$z = -1.9985 \leq -1.6449$. There is evidence to suggest the mean impact velocity is less than 12. **(b)** If $\alpha = 0.01$, then RR: $Z \leq -2.3263$. There is no evidence to suggest the mean impact velocity is less than 12.

9.72 H_0: $\mu = 450$, $H_a: \mu < 450$

TS: $Z = \dfrac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}$, RR: $Z \leq -1.6449$

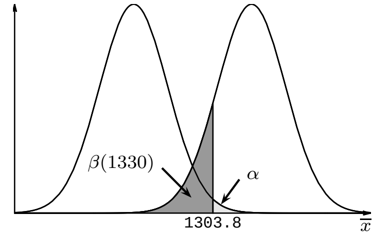
$z = -1.7472 \leq -1.6449$. There is evidence to suggest the mean maximum crush distance is less than 450 mm.

9.73 **(a)** H_0: $\mu = 1250$, $H_a: \mu > 1250$

TS: $Z = \dfrac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}$, RR: $Z \geq 2.3263$

$z = 2.3803 \geq 2.3263$. There is evidence to suggest the mean is greater than 1250. **(b)** 0.1280

(c)



9.74 **(a)** H_0: $\mu = 225$, $\quad H_a : \mu < 225$

TS: $Z = \dfrac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}$, $\quad$ RR: $Z \le -1.6449$

$z = -1.6025$. There is no evidence to suggest the mean is less than 225. **(b)** The sample size is large and the population standard deviation is known.

9.75 H_0: $\mu = 6$, $\quad H_a : \mu < 6$

TS: $Z = \dfrac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}$, $\quad$ RR: $Z \le -2.0537$

$z = 0.3275$. There is no evidence to suggest the mean amount of protein is less than 6 grams.

9.76 H_0: $\mu = 42$, $\quad H_a : \mu \ne 42$

TS: $Z = \dfrac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}$, $\quad$ RR: $|Z| \ge 1.96$

$z = 1.3902$. There is no evidence to suggest the mean is different from 42.

9.77 **(a)** H_0: $\mu = 12$, $\quad H_a : \mu > 12$

TS: $Z = \dfrac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}$, $\quad$ RR: $Z \ge 2.3263$

$z = 1.4599$. There is no evidence to suggest the mean moisture content is greater than 12%. **(b)** 0.9120

9.78 **(a)** 1047.7536, 1052.2464
(b) H_0: $\mu = 1050$, $\quad H_a : \mu \ne 1050$

TS: $Z = \dfrac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}$, $\quad$ RR: $|Z| \ge 2.5758$

$z = -1.1467$ does not lie in the rejection region. $-2.5758 < -1.1467 < 2.5758$. There is no evidence to suggest the mean is different from 1050. Similarly, $\overline{x} = 1049$ does not lie in the rejection region using the distribution of $\overline{X}$. $1047.7536 < 1049 < 1052.2464$.

9.79 **(a)** H_0: $\mu = 775$, $\quad H_a : \mu > 775$

TS: $Z = \dfrac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}$, $\quad$ RR: $Z \ge 2.3263$

$z = 0.0955$. There is no evidence to suggest the mean is greater than 775. **(b)** H_0: $\mu = 475$, $\quad H_a : \mu > 475$

TS: $Z = \dfrac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}$, $\quad$ RR: $Z \ge 2.3263$

$z = 0.9977$. There is no evidence to suggest the mean is greater than 475. The population standard deviation is large and the sample size is small.

Section 9.4

9.80 **(a)** Do not reject. **(b)** Reject. **(c)** Do not reject. **(d)** Do not reject. **(e)** Reject. **(f)** Do not reject.

9.81 **(a)** 0.0307 **(b)** 0.0054 **(c)** 0.1151 **(d)** 0.2843 **(e)** 0.0001 **(f)** 0.8729

9.82 **(a)** 0.0202 **(b)** 0.0764 **(c)** 0.0006 **(d)** 0.2514 **(e)** 0.000002325 **(f)** 0.5987

9.83 **(a)** 0.0767 **(b)** 0.1527 **(c)** 0.0099 **(d)** 0.7114 **(e)** 0.0003 **(f)** 0.3953

9.84 **(a)** 0.0764. Do not reject. **(b)** 0.0202. Reject. **(c)** 0.0801. Reject. **(d)** 0.0009. Reject. **(e)** 0.1230. Do not reject. **(f)** 0.0188. Do not reject.

9.85 **(a)** 0.0059. Reject. **(b)** 0.0823. Do not reject. **(c)** 0.0113. Do not reject. **(d)** 0.5675. Do not reject. **(e)** 0.1031. Do not reject. **(f)** 0.0031. Do not reject.

9.86 **(a)** 0.2000. Do not reject. **(b)** 0.1671. Do not reject. **(c)** 0.0021. Reject. **(d)** 0.0068. Do not reject. **(e)** 0.7288. Do not reject. **(f)** 0.0094. Reject.

9.87 H_0: $\mu = 10$, $\quad H_a : \mu > 10$, $\quad$ TS: $Z = \dfrac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}$

$z = 2.6904$, $p = 0.0036$. There is evidence to suggest the mean is greater than 10.

9.88 H_0: $\mu = 87.6$, $\; H_a : \mu > 87.6$, $\;$ TS: $Z = \dfrac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}$

$z = 2.1719$, $p = 0.0149$. There is evidence to suggest the mean is greater than 87.6.

9.89 H_0: $\mu = 1$, $\quad H_a : \mu \ne 1$, $\quad$ TS: $Z = \dfrac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}$

$z = 1.7678$, $p = 0.0771$. There is no evidence to suggest the mean is different from 1.

9.90 **(a)** H_0: $\mu = 30$, $\quad H_a : \mu > 30$

TS: $Z = \dfrac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}$, $\quad$ RR: $Z \ge 2.3263$

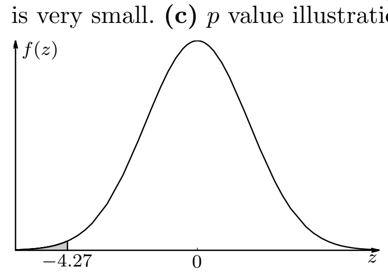
$z = 2.9394$. There is evidence to suggest the mean is greater than 30. **(b)** 0.0016

9.91 H_0: $\mu = 190$, $\; H_a : \mu > 190$, TS: $Z = \dfrac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}$

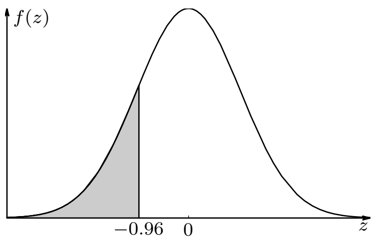
$z = 0.2522$, $p = 0.4005$. There is no evidence to suggest the mean is greater than 190.

9.92 **(a)** H_0: $\mu = 60$, $\; H_a : \mu < 60$, TS: $Z = \dfrac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}$

$z = -4.2693$, $p = 0.00098$. There is evidence to suggest the mean is less than 60. **(b)** Yes. The p value is very small. **(c)** p value illustration:



9.93 **(a)** H_0: $\mu = 1600$, $H_a : \mu < 1600$, TS:
$Z = \dfrac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}$
$z = -0.9565$, $p = 0.1694$. There is no evidence to suggest the mean is less than 1600. **(b)** p value illustration:



9.94 H_0: $\mu = 40$, $H_a : \mu \neq 40$, TS: $Z = \dfrac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}$
$z = 1.2905$, $p = 0.1969$. There is no evidence to suggest the mean is different from 40.

9.95 H_0: $\mu = 5700$, $H_a : \mu > 5700$, TS: $Z = \dfrac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}$
$z = 2.3316$, $p = 0.0099$. There is evidence to suggest the mean is greater than 5700.

9.96 **(a)** H_0: $\mu = 85$, $H_a : \mu < 85$, TS: $Z = \dfrac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}$
$z = -0.1660$, $p = 0.4341$. There is no evidence to suggest the mean is less than 85. **(b)** 0.4341.

9.97 H_0: $\mu = 115$, $H_a : \mu \neq 115$, TS: $Z = \dfrac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}$
$z = -1.0643$, $p = 0.2872$. There is no evidence to suggest the mean is different from 115.

9.98 H_0: $\mu = 80$, $H_a : \mu < 80$, TS: $Z = \dfrac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}$
$z = -2.4007$, $p = 0.0082$. There is evidence to suggest the mean is less than 80, that the manufacturer's claim is false.

Section 9.5

9.99 **(a)** $T = (\overline{X} - \mu_0)/(S/\sqrt{n})$ **(b)** **(i)** $T \geq 3.3649$ **(ii)** $T \geq 2.0739$ **(iii)** $T \geq 1.7459$ **(iv)** $T \geq 1.3125$ **(v)** $T \geq 4.2968$ **(vi)** $T \geq 6.4420$

9.100 **(a)** $T = (\overline{X} - \mu_0)/(S/\sqrt{n})$ **(b)** **(i)** $T \leq -2.6245$ **(ii)** $T \leq -4.5869$ **(iii)** $T \leq -1.7247$ **(iv)** $T \leq -1.3195$ **(v)** $T \leq -7.1732$ **(vi)** $T \leq -4.2340$

9.101 **(a)** $T = (\overline{X} - \mu_0)/(S/\sqrt{n})$ **(b)** **(i)** $|T| \geq 3.1058$ **(ii)** $|T| \geq 1.3304$ **(iii)** $|T| \geq 2.0595$ **(iv)** $|T| \geq 1.7033$ **(v)** $|T| \geq 5.9588$ **(vi)** $|T| \geq 2.3961$

9.102 **(a)** 0.025 **(b)** 0.001 **(c)** 0.01 **(d)** 0.001

9.103 **(a)** 0.10 **(b)** 0.001 **(c)** 0.005 **(d)** 0.01

9.104 **(a)** 0.10 **(b)** 0.01 **(c)** 0.002 **(d)** 0.0002

9.105 **(a)** $0.01 \leq p \leq 0.025$ **(b)** $0.005 \leq p \leq 0.01$ **(c)** $p < 0.0001$ **(d)** $0.05 \leq p \leq 0.10$

9.106 **(a)** $0.025 \leq p \leq 0.05$ **(b)** $p > 0.20$ **(c)** $0.01 \leq p \leq 0.025$ **(d)** $0.0005 \leq p \leq 0.001$

9.107 **(a)** $0.05 \leq p \leq 0.10$ **(b)** $0.001 \leq p \leq 0.005$ **(c)** $p < 0.0001$ **(d)** $0.10 \leq p \leq 0.20$

9.108 **(a)** H_0: $\mu = 1.618$; H_a: $\mu < 1.618$;
TS: $T = (\overline{X} - \mu_0)/(S/\sqrt{n})$; RR: $T \leq -1.7291$
(b) $t = -1.1727$. There is no evidence to suggest the mean is less than 1.618. **(c)** 0.1277

9.109 **(a)** H_0: $\mu = 57.71$; H_a: $\mu > 57.71$;
TS: $T = (\overline{X} - \mu_0)/(S/\sqrt{n})$; RR: $T \geq 2.7638$
(b) $\overline{x} = 59.3082$, $s = 1.6037$, $t = 3.3053 \geq 2.7638$. There is evidence to suggest the mean is greater than 57.71. **(c)** 0.004

9.110 **(a)** H_0: $\mu = 9.96$; H_a: $\mu \neq 9.96$;
TS: $T = (\overline{X} - \mu_0)/(S/\sqrt{n})$; RR: $|T| \geq 3.4210$
(b) $t = -4.0568 \leq -3.4210$. There is evidence to suggest the mean is different from 9.96. **(c)** 0.0004

9.111 **(a)** Should be S, not σ in the denominator. **(b)** Should be $\sqrt{25}$, not $\sqrt{24}$. **(c)** Should be a two-sided rejection region. **(d)** $0.01 \leq p \leq 0.025$

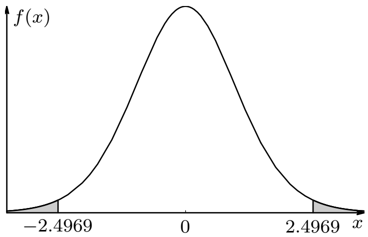
9.112 H_0: $\mu = 871$, $H_a : \mu > 871$,
TS: $T = \dfrac{\overline{X} - \mu_0}{S/\sqrt{n}}$, RR: $T \geq 1.7959$
$t = 0.9793$. There is no evidence to suggest the mean is greater than 871.

9.113 H_0: $\mu = 245$, $H_a : \mu < 245$,
TS: $T = \dfrac{\overline{X} - \mu_0}{S/\sqrt{n}}$, RR: $T \leq -2.1448$
$t = -2.3892 \leq -2.1448$. There is evidence to suggest the mean is less than 245.

9.114 H_0: $\mu = 31.9$, $H_a : \mu < 31.9$,
TS: $T = \dfrac{\overline{X} - \mu_0}{S/\sqrt{n}}$, RR: $T \leq -2.4851$
$t = -2.0842$. There is no evidence to suggest the mean is less than 31.9.

9.115 **(a)** H_0: $\mu = 1381$, $H_a : \mu \neq 1381$,
TS: $T = \dfrac{\overline{X} - \mu_0}{S/\sqrt{n}}$, RR: $|T| \geq 2.1199$
$t = 2.4969 \geq 2.1199$. There is evidence to suggest the mean is different from 1381. **(b)** $0.01 \leq p \leq 0.025$

(c) p value illustration:



9.116 **(a)** H_0: $\mu = 2$, $H_a : \mu \neq 2$,
TS: $T = \dfrac{\overline{X} - \mu_0}{S/\sqrt{n}}$, RR: $|T| \geq 2.8453$
$t = 1.0819$. There is no evidence to suggest the population mean is different from 2. **(b)** $0.2 \leq p \leq 0.4$

9.117 **(a)** H_0: $\mu = 159350$, $H_a : \mu > 159350$,
TS: $T = \dfrac{\overline{X} - \mu_0}{S/\sqrt{n}}$, RR: $T \geq 2.7638$
$t = 1.4855$. There is no evidence to suggest the population mean is greater than 159350.
(b) $0.05 \leq p \leq 0.10$

9.118 **(a)** H_0: $\mu = 15$, $H_a : \mu < 15$,
TS: $T = \dfrac{\overline{X} - \mu_0}{S/\sqrt{n}}$, RR: $T \leq -2.2281$
$t = -0.5749$. There is no evidence to suggest the population mean is less than 15. **(b)** 14.35 is a reasonable observation subject to natural variability.
(c) $p > 0.20$

9.119 H_0: $\mu = 86.99$, $H_a : \mu \neq 86.99$,
TS: $T = \dfrac{\overline{X} - \mu_0}{S/\sqrt{n}}$, RR: $|T| \geq 2.8188$
$t = 3.6917 \geq 2.8188$. There is evidence to suggest the population mean is different from 86.99, that the mean penalty for a stop-sign violation is different from \$86.99.

9.120 H_0: $\mu = 40$, $H_a : \mu > 40$,
TS: $T = \dfrac{\overline{X} - \mu_0}{S/\sqrt{n}}$, RR: $T \geq 5.1106$
$t = 4.8568$. There is no evidence to suggest the population mean is greater than 40. Assumption: the underlying population is normal.

9.121 H_0: $\mu = 23.1$, $H_a : \mu > 23.1$,
TS: $T = \dfrac{\overline{X} - \mu_0}{S/\sqrt{n}}$, RR: $T \geq 2.8965$
$t = 2.1429$. There is no evidence to suggest the population mean is greater than 23.1. If the test is significant, one cannot conclude the ad campaign caused the increase.

9.122 **(a)** H_0: $\mu = 1.37$, $H_a : \mu > 1.37$,
TS: $T = \dfrac{\overline{X} - \mu_0}{S/\sqrt{n}}$, RR: $T \geq 1.7959$
$t = 0.2986$. There is no evidence to suggest the population mean is greater than 1.37. Assumption: the underlying population is normal. **(b)** $p > 0.20$

9.123 **(a)** H_0: $\mu = 1659$, $H_a : \mu < 1659$,
TS: $T = \dfrac{\overline{X} - \mu_0}{S/\sqrt{n}}$, RR: $T \leq -1.7139$
$t = -1.7733 \leq -1.7139$. There is evidence to suggest the population mean is less than 1659. We cannot conclude the heat wave caused this decrease.
(b) $0.025 \leq p \leq 0.05$

9.124 **(a)** H_0: $\mu = 4.75$, $H_a : \mu < 4.75$,
TS: $T = \dfrac{\overline{X} - \mu_0}{S/\sqrt{n}}$, RR: $T \leq -2.4121$
$t = -2.4416 \leq -2.4121$. There is evidence to suggest the population mean is less than 4.75. **(b)** The sample size is large. **(c)** $0.005 \leq p \leq 0.01$

9.125 **(a)** H_0: $\mu = 0$, $H_a : \mu \neq 0$,
TS: $T = \dfrac{\overline{X} - \mu_0}{S/\sqrt{n}}$, RR: $|T| \geq 2.8609$
$t = -0.6902$. There is no evidence to suggest the mean is different from 0. $p > 0.40$. **(b)** There is no evidence to suggest prevailing drought or wet conditions.

9.126 **(a)** H_0: $\mu = 4.0$, $H_a : \mu > 4.0$,
TS: $T = \dfrac{\overline{X} - \mu_0}{S/\sqrt{n}}$, RR: $T \geq 1.7139$
$t = 1.2490$. There is no evidence to suggest the population mean is greater than 4.0.
(b) $0.10 \leq p \leq 0.20$

9.127 H_0: $\mu = 350$, $H_a : \mu \neq 350$,
TS: $T = \dfrac{\overline{X} - \mu_0}{S/\sqrt{n}}$, RR: $|T| \geq 2.4469$
$t = 1.7953$. There is no evidence to suggest the population mean is different from 350.

9.128 **(a)** H_0: $\mu = 1000$, $H_a : \mu > 1000$,
TS: $T = \dfrac{\overline{X} - \mu_0}{S/\sqrt{n}}$, RR: $T \geq 1.7033$
$t = 0.9399$. There is no evidence to suggest the population mean is greater than 1000.
(b) $0.10 \leq p \leq 0.20$

9.129 H_0: $\mu = 7.4$, $H_a : \mu < 7.4$,
TS: $T = \dfrac{\overline{X} - \mu_0}{S/\sqrt{n}}$, RR: $T \leq -1.7709$
$t = 2.0512$. There is no evidence to suggest the population mean has decreased. In fact, there is evidence to suggest it has increased!

9.130 **(a)** H_0: $\mu = 79.52$, $H_a: \mu > 79.52$,

TS: $T = \dfrac{\overline{X} - \mu_0}{S/\sqrt{n}}$, RR: $T \geq 1.7613$

$t = 1.2480$. There is no evidence to suggest the population mean is greater than 79.52. **(b)** $t = 1.4410$. Still no evidence to suggest the population mean is greater than 79.52. **(c)** 30

9.131 **(a)** H_0: $\mu = 25$, $H_a: \mu > 25$,

TS: $T = \dfrac{\overline{X} - \mu_0}{S/\sqrt{n}}$, RR: $T \geq 2.4377$

$t = 2.8889 \geq 2.4377$. There is evidence to suggest the population mean is greater than 25.
(b) $0.001 \leq p \leq 0.005$

9.132 **(a)** H_0: $\mu = 30.50$, $H_a: \mu > 30.50$,

TS: $T = \dfrac{\overline{X} - \mu_0}{S/\sqrt{n}}$, RR: $T \geq 1.7396$

$t = 0.6709$. There is no evidence to suggest the population mean is greater than 30.50. **(b)** $p > 0.20$

9.133 **(a)** H_0: $\mu = 2748$, $H_a: \mu > 2748$,

TS: $T = \dfrac{\overline{X} - \mu_0}{S/\sqrt{n}}$, RR: $T \geq 2.7638$

$t = 1.9885$. There is no evidence to suggest the population mean is greater than 2748.
(b) $0.025 \leq p \leq 0.05$ **(c)** 22

9.134 H_0: $\mu = 3.5$, $H_a: \mu > 3.5$,

TS: $T = \dfrac{\overline{X} - \mu_0}{S/\sqrt{n}}$, RR: $T \geq 1.7959$

$t = 1.6295$. There is no evidence to suggest the population mean is greater than 3.5.

Section 9.6

9.135 **(a)** $np_0 = 82.8 \geq 5$, $n(1 - p_0) = 193.2 \geq 5$. The non-skewness criteria are satisfied.
(b) $np_0 = 694.8 \geq 5$, $n(1 - p_0) = 463.2 \geq 5$. The non-skewness criteria are satisfied. **(c)** $np_0 = 19.4 \geq 5$, $n(1 - p_0) = 625.7 \geq 5$. The non-skewness criteria are satisfied. **(d)** $np_0 = 154.2 \geq 5$, $n(1 - p_0) = 4.8 < 5$. The non-skewness criteria are not satisfied.
(e) $np_0 = 122.4 \geq 5$, $n(1 - p_0) = 199.6 \geq 5$. The non-skewness criteria are satisfied.
(f) $np_0 = 363.3 \geq 5$, $n(1 - p_0) = 79.7 \geq 5$. The non-skewness criteria are satisfied.

9.136

	RR	Value of the TS	Conclusion
(a)	$Z \geq 1.6449$	0.3033	Do not reject.
(b)	$Z \geq 1.2816$	1.4882	Reject.
(c)	$Z \geq 2.3263$	2.3327	Reject.
(d)	$Z \geq 1.9600$	0.6872	Do not reject.
(e)	$Z \geq 2.3263$	0.3307	Do not reject.

9.137

	RR	Value of the TS	Conclusion
(a)	$Z \leq -2.3263$	−0.7090	Do not reject.
(b)	$Z \leq -1.6449$	−1.4596	Do not reject.
(c)	$Z \leq -1.9600$	−2.9056	Reject.
(d)	$Z \leq -3.0902$	−3.3245	Reject.
(e)	$Z \leq -1.6449$	−1.1619	Do not reject.

9.138

	RR	Value of the TS	Conclusion
(a)	$\lvert Z\rvert \geq 2.2414$	−2.0142	Do not reject.
(b)	$\lvert Z\rvert \geq 2.3263$	2.3451	Reject.
(c)	$\lvert Z\rvert \geq 1.9600$	−2.0294	Reject.
(d)	$\lvert Z\rvert \geq 2.8070$	−1.4025	Do not reject.
(e)	$\lvert Z\rvert \geq 2.5758$	2.6455	Reject.

9.139

	Value of the TS	p value	Conclusion
(a)	0.9796	0.1636	Do not reject.
(b)	1.8453	0.0325	Reject.
(c)	1.5216	0.0641	Do not reject.
(d)	2.8587	0.0021	Reject.
(e)	3.2703	0.0005	Reject.

9.140

	Value of the TS	p value	Conclusion
(a)	−2.0285	0.0213	Reject.
(b)	0.0574	0.5229	Do not reject.
(c)	−0.7611	0.2233	Do not reject.
(d)	−2.2166	0.0133	Reject.
(e)	−2.6187	0.0044	Reject.

9.141

	Value of the TS	p value	Conclusion
(a)	−1.5489	0.1214	Do not reject.
(b)	2.4086	0.0160	Reject.
(c)	−3.3621	0.0008	Reject.
(d)	2.7775	0.0055	Reject.
(e)	−2.7110	0.0067	Reject.

9.142 **(a)** 500, 16, 0.02. **(b)** $np_0 = 10 \geq 5$, $n(1 - p_0) = 490 \geq 5$. The large-sample test is appropriate.
(c) H_0: $p = 0.02$, H_a: $p > 0.02$

TS: $Z = \dfrac{\widehat{P} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}$, RR: $Z \geq 1.6449$

$z = 1.9166 \geq 1.6449$. There is evidence to suggest the population proportion is greater than 0.02. **(d)** 0.0320

9.143 **(a)** 60, 15, 0.30. **(b)** $np_0 = 18 \geq 5$, $n(1-p_0) = 42 \geq 5$. The large-sample test is appropriate.
(c) H_0: $p = 0.30$, H_a: $p < 0.30$

$$\text{TS: } Z = \frac{\widehat{P} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}, \quad \text{RR: } Z \leq -1.96$$

$z = -0.8452$. There is no evidence to suggest the population proportion is less than 0.30. **(d)** 0.1990

9.144 **(a)** 225, 189, 0.90. **(b)** $np_0 = 202.5 \geq 5$, $n(1-p_0) = 22.5 \geq 5$. The large-sample test is appropriate.
(c) H_0: $p = 0.90$, H_a: $p \neq 0.90$

$$\text{TS: } Z = \frac{\widehat{P} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}, \quad \text{RR: } |Z| \geq 1.96$$

$z = -3.0 \leq -1.96$. There is evidence to suggest the population proportion is different from 0.90.
(d) 0.0027

9.145 **(a)** 130, 62, 0.52. **(b)** $np_0 = 67.6 \geq 5$, $n(1-p_0) = 62.4 \geq 5$. The large-sample test is appropriate.
H_0: $p = 0.52$, H_a: $p < 0.52$

$$\text{TS: } Z = \frac{\widehat{P} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}, \quad \text{RR: } Z \leq -2.3263$$

$z = -0.9831$. There is no evidence to suggest the population proportion is less than 0.52. **(d)** 0.1628

9.146 H_0: $p = 0.30$, H_a: $p > 0.30$

$$\text{TS: } Z = \frac{\widehat{P} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}, \quad \text{RR: } Z \geq 3.0902$$

$z = 3.7243 \geq 3.0902$. There is evidence to suggest the population proportion is greater than 0.30.

9.147 **(a)** $np_0 = 13.92 \geq 5$, $n(1-p_0) = 1186.08 \geq 5$. The number of successes is very small.
(b) H_0: $p = 0.0116$, H_a: $p < 0.0116$

$$\text{TS: } Z = \frac{\widehat{P} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}, \quad \text{RR: } Z \leq -1.6449$$

$z = -0.7872$. There is no evidence to suggest the population proportion is less than 0.0116.

9.148 **(a)** H_0: $p = 0.95$, H_a: $p < 0.95$

$$\text{TS: } Z = \frac{\widehat{P} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}, \quad \text{RR: } Z \leq -1.6449$$

$z = -2.2711 \leq -1.6449$. There is evidence to suggest the population proportion is less than 0.95. **(b)** 0.0116
(c) No. There is evidence to suggest that less than 95% of all batteries last at least three years.

9.149 H_0: $p = 0.49$, H_a: $p \neq 0.49$

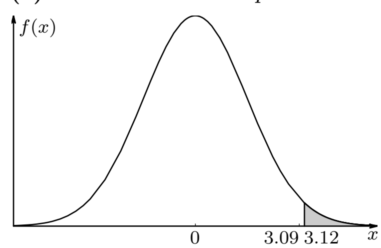
$$\text{TS: } Z = \frac{\widehat{P} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}},$$

$z = -1.1602$, $p = 0.2460$. There is no evidence to suggest the population proportion is different from 0.49.

9.150 **(a)** H_0: $p = 0.45$, H_a: $p > 0.45$

$$\text{TS: } Z = \frac{\widehat{P} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}, \quad \text{RR: } Z \geq 3.0902$$

$z = 3.1156 \geq 3.0902$. There is evidence to suggest the population proportion is greater than 0.45. **(b)** 0.0009
(c) Critical value and p value illustration:



9.151 H_0: $p = 0.795$, H_a: $p < 0.795$

$$\text{TS: } Z = \frac{\widehat{P} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}, \quad \text{RR: } Z \leq -2.3263$$

$z = -1.4095$. There is no evidence to suggest the population proportion is less than 0.795.

9.152 H_0: $p = 0.556$, H_a: $p \neq 0.556$

$$\text{TS: } Z = \frac{\widehat{P} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}, \quad \text{RR: } |Z| \geq 2.5758$$

$z = -1.2472$. There is no evidence to suggest the population proportion is different from 0.556.

9.153 H_0: $p = 0.40$, H_a: $p < 0.40$

$$\text{TS: } Z = \frac{\widehat{P} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}, \quad \text{RR: } Z \leq -2.3263$$

$z = -2.4244 \leq -2.3263$. There is evidence to suggest the population proportion is less than 0.40. The politician should enter the race for mayor.

9.154 H_0: $p = 0.47$, H_a: $p < 0.47$

$$\text{TS: } Z = \frac{\widehat{P} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}, \quad \text{RR: } Z \leq -2.3263$$

$z = -2.7010 \leq -2.3263$. There is evidence to suggest the population proportion is less than 0.47.
$p = 0.0035 \leq 0.01$. There is evidence to suggest the proportion of people who die from heart attacks has decreased.

9.155 H_0: $p = 0.10$, H_a: $p < 0.10$

TS: $Z = \dfrac{\widehat{P} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}$

$z = 0.6667$, $p = 0.7475$. There is no evidence to suggest the population proportion is less than 0.10.

9.156 H_0: $p = 0.18$, H_a: $p < 0.18$

TS: $Z = \dfrac{\widehat{P} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}$, RR: $Z \le -1.6449$

$z = -1.3587$. There is no evidence to suggest the population proportion is less than 0.18.

9.157 H_0: $p = 0.44$, H_a: $p \ne 0.44$

TS: $Z = \dfrac{\widehat{P} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}$, RR: $|Z| \ge 1.96$

$z = -1.8154$. There is no evidence to suggest the population proportion is different from 0.44.

Section 9.7

9.158 **(a)** $X^2 = \dfrac{(n-1)S^2}{\sigma_0^2}$

(b) (i) 19.6751 (ii) 31.5264 (iii) 40.2894 (iv) 37.9159 (v) 20.5150 (vi) 42.5793

9.159 **(a)** $X^2 = \dfrac{(n-1)S^2}{\sigma_0^2}$

(b) (i) 3.9416 (ii) 5.2260 (iii) 12.5622 (iv) 17.2919 (v) 20.0719 (vi) 0.9893

9.160 **(a)** $X^2 = \dfrac{(n-1)S^2}{\sigma_0^2}$ **(b)**

	Rejection region		
(i)	$X^2 \le 23.6543$	or	$X^2 \ge 58.1201$
(ii)	$X^2 \le 13.7867$	or	$X^2 \ge 53.6720$
(iii)	$X^2 \le 5.8957$	or	$X^2 \ge 49.0108$
(iv)	$X^2 \le 5.2293$	or	$X^2 \ge 30.5779$
(v)	$X^2 \le 10.3909$	or	$X^2 \ge 56.8923$
(vi)	$X^2 \le 1.0636$	or	$X^2 \ge 7.7794$

9.161 **(a)** 0.05 **(b)** 0.005 **(c)** 0.005 **(d)** 0.0005

9.162 **(a)** 0.0005 **(b)** 0.01 **(c)** 0.025 **(d)** 0.005

9.163 **(a)** 0.01 **(b)** 0.02 **(c)** 0.001 **(d)** 0.05

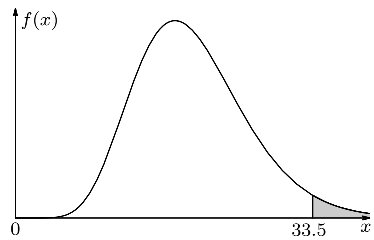
9.164 **(a)** $0.01 \le p \le 0.025$ **(b)** $0.05 \le p \le 0.10$ **(c)** $0.001 \le p \le 0.005$ **(d)** $p \le 0.0001$

9.165 **(a)** $0.0001 \le p \le 0.005$ **(b)** $p \le 0.0001$ **(c)** $0.005 \le p \le 0.01$ **(d)** $0.025 \le p \le 0.05$

9.166 **(a)** $0.02 \le p \le 0.05$ **(b)** $0.0002 \le p \le 0.001$ **(c)** $0.05 \le p \le 0.10$ **(d)** $0.001 \le p \le 0.002$

9.167 **(a)** H_0: $\sigma^2 = 16.7$, H_a: $\sigma^2 > 16.7$
TS: $X^2 = (n-1)S^2/\sigma_0^2$, RR: $X^2 \ge 37.5662$

(b) $\chi^2 = 33.5329$. There is no evidence to suggest the population variance is greater than 16.7.
(c) $0.025 \le p \le 0.05$. p value illustration:



9.168 **(a)** H_0: $\sigma^2 = 36.8$, H_a: $\sigma^2 \ne 36.8$
TS: $X^2 = (n-1)S^2/\sigma_0^2$
RR: $X^2 \le 6.2621$ or $X^2 \ge 27.4884$

(b) $s^2 = 105.863$, $\chi^2 = 43.1508 \ge 27.4884$. There is evidence to suggest the population variance is different from 36.8. **(c)** $0.0002 \le p \le 0.01$

9.169 **(a)** H_0: $\sigma^2 = 75.6$, H_a: $\sigma^2 < 75.6$
TS: $X^2 = (n-1)S^2/\sigma_0^2$, RR: $X^2 \le 17.2616$

(b) $\chi^2 = 25.0198$. There is no evidence to suggest the population variance is less than 75.6.
(c) $0.025 \le p \le 0.05$

9.170 H_0: $\sigma^2 = 0.25$, H_a: $\sigma^2 > 0.25$
TS: $X^2 = (n-1)S^2/\sigma_0^2$, RR: $X^2 \ge 48.6024$

$\chi^2 = 42.3455$. There is no evidence to suggest the population variance is greater than 0.25.

9.171 H_0: $\sigma^2 = 1050$, H_a: $\sigma^2 < 1050$
TS: $X^2 = (n-1)S^2/\sigma_0^2$, RR: $X^2 \le 10.1170$

$\chi^2 = 7.4777 \le 10.1170$. There is evidence to suggest the population variance is less than 1050.

9.172 H_0: $\sigma^2 = 324$, H_a: $\sigma^2 > 324$
TS: $X^2 = (n-1)S^2/\sigma_0^2$, RR: $X^2 \ge 24.7250$

$\chi^2 = 15.7814$. There is no evidence to suggest the population variance is greater than 324. There is no evidence to refute the manufacturer's claim.

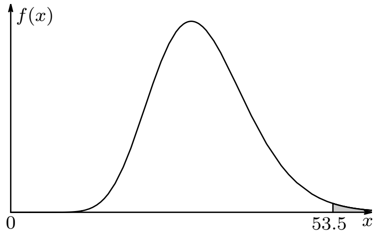
9.173 H_0: $\sigma^2 = 0.09$, H_a: $\sigma^2 > 0.09$
TS: $X^2 = (n-1)S^2/\sigma_0^2$, RR: $X^2 \ge 36.7807$

$\chi^2 = 25.6667$. There is no evidence to suggest the population variance is greater than 0.09.

9.174 **(a)** H_0: $\sigma^2 = 49$, H_a: $\sigma^2 > 49$
TS: $X^2 = (n-1)S^2/\sigma_0^2$, RR: $X^2 \ge 62.4872$

$\chi^2 = 53.5344$. There is no evidence to suggest the population variance is greater than 49.
(b) $0.005 \le p \le 0.01$

p value illustration:



9.175 **(a)** H_0: $\sigma^2 = 0.36$, H_a: $\sigma^2 > 0.36$
TS: $X^2 = (n-1)S^2/\sigma_0^2$, RR: $X^2 \geq 30.1435$

$\chi^2 = 22.1667$. There is no evidence to suggest the population variance is greater than 0.36. **(b)** $p > 0.10$

9.176 **(a)** H_0: $\sigma^2 = 5.07$, H_a: $\sigma^2 \neq 5.07$
TS: $X^2 = (n-1)S^2/\sigma_0^2$

RR: $X^2 \leq 15.6555$ or $X^2 \geq 52.1914$

$\chi^2 = 14.3688 \leq 15.6555$. There is evidence to suggest the population variance has changed.
(b) $0.002 \leq p \leq 0.01$

9.177 H_0: $\sigma^2 = 62.5$, H_a: $\sigma^2 > 62.5$
TS: $X^2 = (n-1)S^2/\sigma_0^2$, RR: $X^2 \geq 21.6660$

$\chi^2 = 10.0944$. There is no evidence to suggest the population variance is greater than 62.5.

9.178 **(a)** H_0: $\sigma^2 = 230$, H_a: $\sigma^2 > 230$
TS: $X^2 = (n-1)S^2/\sigma_0^2$, RR: $X^2 \geq 38.8851$

$\chi^2 = 21.9352$. There is no evidence to suggest the population variance is greater than 230. There is no evidence to suggest an inconsistent signal.
(b) $p > 0.10$

9.179 H_0: $\sigma^2 = 0.04$, H_a: $\sigma^2 > 0.04$
TS: $X^2 = (n-1)S^2/\sigma_0^2$, RR: $X^2 \geq 42.9798$

$\chi^2 = 35.7216$. There is no evidence to suggest the population variance in die weight is greater than 0.04.

9.180 H_0: $\sigma^2 = 40000$, H_a: $\sigma^2 < 40000$
TS: $X^2 = (n-1)S^2/\sigma_0^2$, RR: $X^2 \leq 44.0379$

$\chi^2 = 55.7408$. There is no evidence to suggest the population variance is less than 40000; there is no evidence to suggest the population standard deviation is less than 200.

9.181 **(a)** H_0: $\sigma^2 = 2500$, H_a: $\sigma^2 > 2500$
TS: $X^2 = (n-1)S^2/\sigma_0^2$, RR: $X^2 \geq 62.4281$

$\chi^2 = 50.6222$. There is no evidence to suggest the population variance is greater than the company's desired value, 2500. **(b)** $p > 0.10$.

9.182 H_0: $\sigma^2 = 0.57$, H_a: $\sigma^2 \neq 0.57$
TS: $X^2 = (n-1)S^2/\sigma_0^2$

RR: $X^2 \leq 3.5968$ or $X^2 \geq 44.9232$

$\chi^2 = 3.4477 \leq 3.5968$. There is evidence to suggest the population variance in completion time is different from 0.57.

9.183 H_0: $\sigma^2 = 22.5$, H_a: $\sigma^2 < 22.5$
TS: $X^2 = (n-1)S^2/\sigma_0^2$, RR: $X^2 \leq 23.2686$

$\chi^2 = 24.9600$. There is no evidence to suggest the population variance in ride times is less than 22.5; there is no evidence to suggest the bull riding has become less exciting.

9.184 **(a)** H_0: $\sigma^2 = 7.5625$, H_a: $\sigma^2 > 7.5625$
TS: $X^2 = (n-1)S^2/\sigma_0^2$, RR: $X^2 \geq 32.6706$

$\chi^2 = 40.3239 \geq 32.6706$. There is evidence to suggest the population variance in wingspan is greater than 7.5625. **(b)** $0.005 \leq p \leq 0.01$

9.185 **(a)** H_0: $\sigma^2 = 49$, H_a: $\sigma^2 \neq 49$
TS: $X^2 = (n-1)S^2/\sigma_0^2$

RR: $X^2 \leq 9.5908$ or $X^2 \geq 31.4104$

(b) $s_L^2 = 23.4975$, $s_H^2 = 76.9555$ **(c)** There is no evidence to suggest the population variance in thickness is different from 49. **(d)** $s^2 = 15.6 \leq 23.4975$. There is evidence to suggest the population variance in thickness is different from 49.

Chapter Exercises

9.186 **(a)** H_0: $\mu = 1.6$; H_a: $\mu \neq 1.6$;
TS: $Z = (\overline{x} - \mu_0)/(\sigma/\sqrt{n})$; RR: $|Z| \geq 2.5758$

$z = 1.7265$. There is no evidence to suggest the population mean is different from 1.6; there is no evidence to suggest the machine is malfunctioning.
(b) 0.0843

9.187 H_0: $\mu = 4$; H_a: $\mu \neq 4$;
TS: $Z = (\overline{x} - \mu_0)/(\sigma/\sqrt{n})$; RR: $|Z| \geq 2.5758$

(a) $z = 1.7709$. There is no evidence to suggest the population mean thickness is different from 4. The process should not be stopped.
(b) $z = -2.6563 \leq -2.5758$. There is evidence to suggest the population mean thickness is different from 4. The process should be stopped.

9.188 **(a)** H_0: $\mu = 11$; H_a: $\mu < 11$;
TS: $Z = (\overline{x} - \mu_0)/(\sigma/\sqrt{n})$; RR: $Z \leq -1.6449$

$z = -2.0870 \leq -1.6449$. There is evidence to suggest the population mean take-off run is less than 11.
(b) 0.0184

9.189 **(a)** H_0: $\mu = 23$; H_a: $\mu > 23$;
TS: $Z = (\overline{x} - \mu_0)/(\sigma/\sqrt{n})$; RR: $Z \geq 2.3263$

$z = 2.9773 \geq 2.3263$. There is evidence to suggest the population mean width is greater than 23. **(b)** 0.0015

9.190 **(a)** H_0: $\mu = 1800$; H_a: $\mu > 1800$;
TS: $Z = (\overline{x} - \mu_0)/(\sigma/\sqrt{n})$; RR: $Z \geq 1.6449$

$z = 1.5446$. There is no evidence to suggest the population mean amount of ore extracted each day is greater than 1800. There is no evidence to suggest the new machinery has improved production. **(b)** 0.2800, 0.0193

9.191 **(a)** H_0: $\mu = 650$, $\quad H_\text{a} : \mu \neq 650$,

TS: $T = \dfrac{\overline{X} - \mu_0}{S/\sqrt{n}}$, $\quad$ RR: $|T| \geq 2.1199$

$t = -0.3346$. There is no evidence to suggest the population mean etch rate is different from 650.
(b) The underlying population is normal. **(c)** $p > 0.40$

9.192 H_0: $\mu = 13$, $\quad H_\text{a} : \mu \neq 13$,

TS: $T = \dfrac{\overline{X} - \mu_0}{S/\sqrt{n}}$, $\quad$ RR: $|T| \geq 2.2622$

(a) $t = -0.3623$. There is no evidence to suggest the mean diameter is different from 13. The process should not be stopped. **(b)** $t = 2.8109 \geq 2.2622$. There is evidence to suggest the mean diameter is different from 13. The process should be stopped. **(c)** Larger.

9.193 **(a)** H_0: $\mu = 40$, $\quad H_\text{a} : \mu < 40$,

TS: $T = \dfrac{\overline{X} - \mu_0}{S/\sqrt{n}}$, $\quad$ RR: $T \leq -2.5083$

$t = -1.1733$. There is no evidence to suggest the population mean brightness is less than 40.
(b) $0.10 \leq p \leq 0.20$

9.194 H_0: $\mu = 3$, $\quad H_\text{a} : \mu > 3$,

TS: $T = \dfrac{\overline{X} - \mu_0}{S/\sqrt{n}}$, $\quad$ RR: $T \geq 1.7613$

$t = 1.4660$. There is no evidence to suggest the population mean FEF is greater than 3.

9.195 **(a)** H_0: $\mu = 4500000$, $\quad H_\text{a} : \mu > 4500000$,

TS: $T = \dfrac{\overline{X} - \mu_0}{S/\sqrt{n}}$, $\quad$ RR: $T \geq 2.3060$

$t = 1.0895$. There is no evidence to suggest the population mean amount of oil stored is greater than 4500000. **(b)** $0.10 \leq p \leq 0.20$

9.196 **(a)** H_0: $p = 0.60$, $\quad H_\text{a}$: $p < 0.60$

TS: $Z = \dfrac{\widehat{P} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}$, $\quad$ RR: $Z \leq -2.3263$

$z = -2.7951 \leq -2.3263$. There is evidence to suggest the population proportion of cast-iron pans with harmful bacteria is less than 0.60. **(b)** 0.0026 **(c)** No. The people who brought their pans for testing self-selected.

9.197 **(a)** $p_0 = 0.20$, $n = 1500$, $\widehat{p} = 0.23$.
(b) $np_0 = 300 \geq 5$, $n(1 - p_0) = 1200 \geq 5$.
(c) H_0: $p = 0.20$, $\quad H_\text{a}$: $p > 0.20$

TS: $Z = \dfrac{\widehat{P} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}$, $\quad$ RR: $Z \geq 2.3263$

$z = 2.9047 \geq 2.3263$. There is evidence to suggest the population proportion of companies that require this information is greater than 0.20. **(d)** 0.0018

9.198 **(a)** H_0: $p = 0.75$, $\quad H_\text{a}$: $p < 0.75$

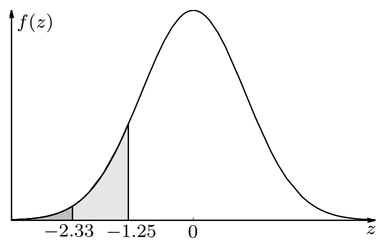
TS: $Z = \dfrac{\widehat{P} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}$, $\quad$ RR: $Z \leq -2.3263$

$z = -2.7325 \leq -2.3263$. There is evidence to suggest the population proportion of residents who favor additional power to tap phones is less than 0.75.
(b) 0.0031

9.199 **(a)** H_0: $p = 0.92$, $\quad H_\text{a}$: $p < 0.92$

TS: $Z = \dfrac{\widehat{P} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}$, $\quad$ RR: $Z \leq -2.3263$

$z = -1.2511$. There is no evidence to suggest the true proportion of assisted-living patients who are satisfied is less than 0.92. **(b)** 0.1055 **(c)** Illustration:



9.200 **(a)** H_0: $p = 0.30$, $\quad H_\text{a}$: $p \neq 0.30$

TS: $Z = \dfrac{\widehat{P} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}$, $\quad$ RR: $|Z| \geq 1.9600$

$z = -0.5623$. There is no evidence to suggest the population proportion of youth gang members has changed. **(b)** 0.5739

9.201 H_0: $p = 0.80$, $\quad H_\text{a}$: $p < 0.80$

TS: $Z = \dfrac{\widehat{P} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}$, $\quad$ RR: $Z \leq -3.0902$

$z = -3.8025 \leq -3.0902$. There is evidence to suggest the population proportion of people who believe in this conspiracy theory has decreased.

9.202 H_0: $p = 0.89$, $\quad H_\text{a}$: $p \neq 0.89$

TS: $Z = \dfrac{\widehat{P} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}$, $\quad$ RR: $|Z| \geq 2.5758$

$z = -0.5038$. There is no evidence to suggest the population proportion of drivers who believe not signaling is an annoying habit is different from 0.89.

9.203 H_0: $\sigma^2 = 0.0015$, $\quad H_\text{a}$: $\sigma^2 > 0.0015$
TS: $\text{X}^2 = (n-1)S^2/\sigma_0^2$, $\quad$ RR: $\text{X}^2 \geq 23.6848$

$\chi^2 = 24.2667 \geq 23.6848$. There is evidence to suggest the population variance in diameter of viruses has increased.

9.204 H_0: $\sigma^2 = 0.50$, H_a: $\sigma^2 < 0.50$
TS: $X^2 = (n-1)S^2/\sigma_0^2$, RR: $X^2 \leq 12.4426$

$\chi^2 = 15.6000$. There is no evidence to suggest the population variance in shrinkage is less than 0.50.

9.205 H_0: $\sigma^2 = 62500^2$, H_a: $\sigma^2 > 62500^2$
TS: $X^2 = (n-1)S^2/\sigma_0^2$, RR: $X^2 \geq 67.9852$

$\chi^2 = 39.2593$. There is no evidence to suggest the population variance in blood platelet count has increased.

9.206 **(a)** H_0: $\sigma^2 = 3.1^2$, H_a: $\sigma^2 < 3.1^2$
TS: $X^2 = (n-1)S^2/\sigma_0^2$, RR: $X^2 \leq 7.2609$

$\chi^2 = 9.3511$. There is no evidence to suggest the population variance in b value has decreased.
(b) $p > 0.10$

9.207 H_0: $\mu = 1.5$, $H_a : \mu > 1.5$,

TS: $T = \dfrac{\overline{X} - \mu_0}{S/\sqrt{n}}$, RR: $T \geq 2.5083$

$t = 3.3344 \geq 2.5083$. There is evidence to suggest the population mean serving size is greater than 1.5.

Exercises′

9.208 **(a)** H_0: $p = 0.22$, H_a: $p < 0.22$

TS: $Z = \dfrac{\widehat{P} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}$, RR: $Z \leq -2.3263$

$z = -2.6718 \leq -2.3263$. There is evidence to suggest the population proportion of adults who have not filled a prescription is less than 0.22. **(b)** 0.2342
(c) 0.1590 **(d)** 758

9.209 **(a)** H_0: $p = 0.63$, H_a: $p < 0.63$
TS: X = the number of successes in n trials
RR: $X \leq 10$ **(b)** $x = 12$. There is no evidence to suggest the population proportion of adults who do not want to live to be 100 is less than 0.63. **(c)** 0.0907

9.210 **(a)** H_0: $\lambda = 4$, H_a: $\lambda < 4$
TS: X = the number of people locked out of their rooms. RR: $X \leq 0$ ($\alpha \approx 0.0183$) **(b)** $x = 2$. There is no evidence to suggest the mean number of people locked out of their rooms per day is less than 4. **(c)** 0.2381

9.211 **(a)** H_0: $\lambda = 20$, H_a: $\lambda > 20$
TS: $Z = (X - \lambda_0)/\sqrt{\lambda_0}$, RR: $Z \geq 2.3263$
(b) $z = 1.5652$. There is no evidence to suggest the population mean number of dog bites in Seattle per fiscal year is greater than 20. **(c)** 0.0779

9.212 **(a)** H_0: $\sigma^2 = 1.56$, H_a: $\sigma^2 \neq 1.56$
TS: $Z = \frac{S^2 - \sigma_0^2}{\sqrt{2}\sigma_0^2/\sqrt{n-1}}$, RR: $|Z| \geq 1.96$
(b) $z = 1.9888 \geq 1.96$. There is evidence to suggest the population variance in exchange rate is different from 1.56. **(c)** 0.0467

(d) H_0: $\sigma^2 = 1.56$, H_a: $\sigma^2 \neq 1.56$
TS: $X^2 = (n-1)S^2/\sigma_0^2$
RR: $X^2 \leq 29.9562$ or $X^2 \geq 67.8206$

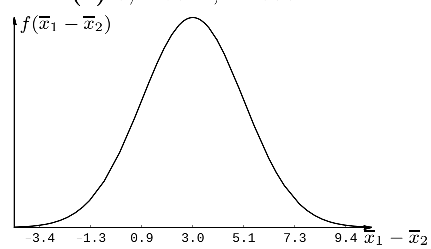
$\chi^2 = 66.2821$. There is no evidence to suggest the population variance in exchange rate is different from 1.56. $p = 0.0666$. Note: The conclusion and p value are different.

Chapter 10

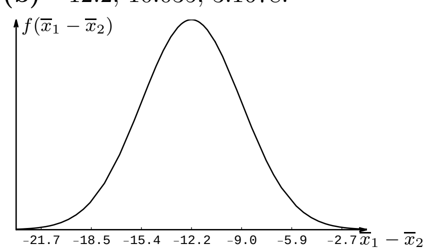
Section 10.1

10.1
(a) $\mu_1 - \mu_2 = 0$ **(b)** $\mu_1 - \mu_2 < 0$ **(c)** $\mu_1 - \mu_1 \neq 7$
(d) $\mu_1 - \mu_2 > -4$ **(e)** $\mu_1 - \mu_2 \neq 0$ **(f)** $\mu_1 - \mu_2 = 10$

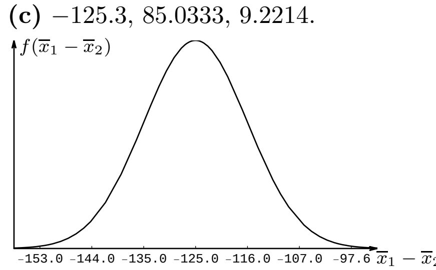
10.2 **(a)** 3, 4.5524, 2.1336.



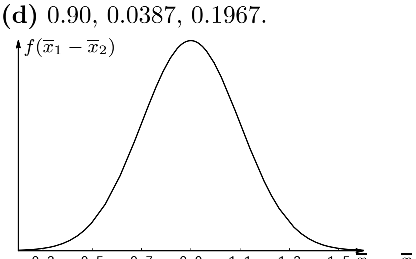
(b) −12.2, 10.035, 3.1678.



(c) −125.3, 85.0333, 9.2214.

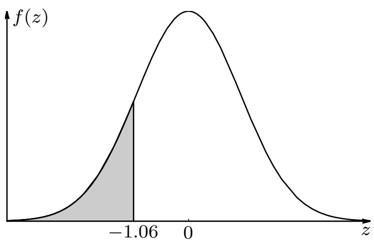


(d) 0.90, 0.0387, 0.1967.



10.3 **(a)** H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 > 0$
TS: $Z = \frac{(\overline{X}_1 - \overline{X}_2) - 0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$, RR: $Z \geq 1.6449$
(b) $z = 2.0951 \geq 1.6449$. There is evidence to suggest population mean 1 is greater than population mean 2. **(c)** 0.0181

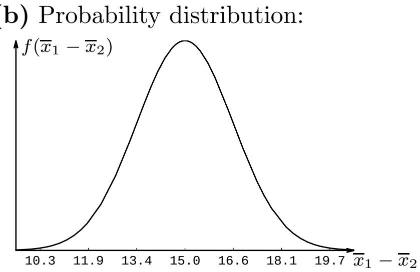
10.4 **(a)** H_0: $\mu_1 - \mu_2 = 2$, H_a: $\mu_1 - \mu_2 < 2$
TS: $Z = \frac{(\overline{X}_1 - \overline{X}_2) - 2}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$, RR: $Z \leq -2.3263$
(b) $z = -1.0566$. There is no evidence to suggest population mean 1 is less than population mean 2 plus 2. **(c)** $p = 0.1453$. p value illustration:



10.5 **(a)** H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 \neq 0$
TS: $Z = \frac{(\overline{X}_1 - \overline{X}_2) - 0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$, RR: $|Z| \geq 3.2905$
(b) $z = -1.9379$. There is no evidence to suggest population mean 1 is different from population mean 2. **(c)** No. Both sample sizes are large.

10.6 **(a)** $(-11.1298, 2.4492)$ **(b)** No, 0 is in the CI.

10.7 **(a)** $\overline{X}_1 - \overline{X}_2$ is normal with mean 15, variance 2.4286, and standard deviation 1.5584.
(b) Probability distribution:



(c) 0.0997 **(d)** 0.2063 **(e)** 0.2605

10.8 **(a)** H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 > 0$
TS: $Z = \frac{(\overline{X}_1 - \overline{X}_2) - 0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$, RR: $Z \geq 1.6449$
$z = 0.3611$. There is no evidence to suggest the mean rotation speed for the Sonicare Elite is greater than the mean rotation speed for the Oral-B. **(b)** 0.3590

10.9 H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 \neq 0$
TS: $Z = \frac{(\overline{X}_1 - \overline{X}_2) - 0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$, RR: $|Z| \geq 2.5758$
$z = -3.0814 \leq -2.5758$. There is evidence to suggest the mean Nordstrom gift-certificate value is different from the mean Macy's gift-certificate value.

10.10 H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 < 0$
TS: $Z = \frac{(\overline{X}_1 - \overline{X}_2) - 0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$, RR: $Z \leq -1.6449$
$z = -1.6410$. There is no evidence to suggest the mean noise level for the Hotpoint dishwasher is less than the mean noise level for the Maytag.

10.11 **(a)** $(-1.6135, 0.4735)$ **(b)** There is no evidence to suggest the mean power-output ratings for the two brands differ. 0 is in the CI.

10.12 **(a)** H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 \neq 0$
TS: $Z = \frac{(\overline{X}_1 - \overline{X}_2) - 0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$, RR: $|Z| \geq 2.5758$
$z = -1.2536$. There is no evidence to suggest the population mean magnesium in each serving of baked beans and potatoes is different. **(b)** $z = -1.8214$. Still no evidence to refute the claim. **(c)** $n_1 = n_2 = 76$

10.13 H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 \neq 0$
TS: $Z = \frac{(\overline{X}_1 - \overline{X}_2) - 0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$, RR: $|Z| \geq 2.5758$
$z = 3.6456 \geq 2.5758$. There is evidence to suggest the mean taxi ride time is different in San Diego and Phoenix.

10.14 **(a)** H_0: $\mu_1 - \mu_2 = 5$, H_a: $\mu_1 - \mu_2 < 5$
TS: $Z = \frac{(\overline{X}_1 - \overline{X}_2) - 5}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$, RR: $Z \leq -2.3263$
$z = -0.7546$. There is no evidence to refute the claim; there is no evidence to suggest the difference in mean weights is less than 5 pounds. **(b)** 0.2252 **(c)** No. Both sample sizes are large.

10.15 H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 \neq 0$
TS: $Z = \frac{(\overline{X}_1 - \overline{X}_2) - 0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$, RR: $|Z| \geq 2.5758$
$z = 0.4513$. There is no evidence to suggest the mean amount of protein is different in the two products.

10.16 **(a)** $(3.4032, 7.1968)$ **(b)** Yes. 0 is not in the CI, and the CI is entirely above 0.

10.17 **(a)** H_0: $\mu = 7.4$, H_a: $\mu \neq 7.4$
TS: $Z = \frac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}$, RR: $|Z| \geq 1.96$
$z = -0.1501$. There is no evidence to suggest the mean output of elements from The Repair Clinic is different from 7.4.

(b) H_0: $\mu = 7.4$, H_a: $\mu \neq 7.4$

TS: $Z = \frac{\overline{X}-\mu_0}{\sigma/\sqrt{n}}$, RR: $|Z| \geq 1.96$

$z = -0.4502$. There is no evidence to suggest the mean output of elements from The Parts Pros is different from 7.4.

(c) H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 \neq 0$

TS: $Z = \frac{(\overline{X}_1-\overline{X}_2)-0}{\sqrt{\frac{\sigma_1^2}{n_1}+\frac{\sigma_2^2}{n_2}}}$, RR: $|Z| \geq 1.96$

$z = 0.1627$. There is no evidence to suggest that the two population means are different. **(d)** The Repair Clinic.

10.18 H_0: $\mu_1 - \mu_2 = 3$, H_a: $\mu_1 - \mu_2 > 3$

TS: $Z = \frac{(\overline{X}_1-\overline{X}_2)-3}{\sqrt{\frac{\sigma_1^2}{n_1}+\frac{\sigma_2^2}{n_2}}}$, RR: $Z \geq 1.6449$

$z = 0.1270$. There is no evidence to suggest the difference in mean tire pressure is greater than 3 psi.

10.19 **(a)** H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 > 0$

TS: $Z = \frac{(\overline{X}_1-\overline{X}_2)-0}{\sqrt{\frac{\sigma_1^2}{n_1}+\frac{\sigma_2^2}{n_2}}}$, RR: $Z \geq 2.3263$

$z = 3.1283 \geq 2.3263$. There is evidence to suggest the population mean standby time for the Motorola phone is greater than the population mean standby time for the Uniden phone. **(b)** 0.000879

10.20 H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 > 0$

TS: $Z = \frac{(\overline{X}_1-\overline{X}_2)-0}{\sqrt{\frac{\sigma_1^2}{n_1}+\frac{\sigma_2^2}{n_2}}}$, RR: $Z \geq 1.6449$

$z = 1.2130$. There is no evidence to suggest the mean time to induction for intravenous administration is less than the mean time to induction for inhalation administration.

10.21 **(a)** H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 < 0$

TS: $Z = \frac{(\overline{X}_1-\overline{X}_2)-0}{\sqrt{\frac{\sigma_1^2}{n_1}+\frac{\sigma_2^2}{n_2}}}$, RR: $Z \leq -2.3263$

$z = -1.4998$. There is no evidence to suggest the mean hourly wage for a plumber in Utica is less than the mean hourly wage for a plumber in Atlanta. **(b)** 0.0668 **(c)** Large population variances.

Section 10.2

10.22 **(a)** RR: $T \leq -1.7011$, $t = -0.1181$. There is no evidence to suggest μ_1 is less than μ_2. **(b)** $p > 0.20$

10.23 **(a)** RR: $T \geq 2.5395$, $t = 2.2793$. There is no evidence to suggest μ_1 is greater than μ_2. **(b)** 0.0172

10.24 **(a)** RR: $|T| \geq 2.0484$, $t = 3.0096 \geq 2.0484$. There is evidence to suggest the two population means are different. **(b)** $0.001 \leq p \leq 0.01$

10.25 **(a)** $(-5.7176, 4.6376)$ **(b)** There is no evidence to suggest the population means are different. 0 is in the CI.

10.26 **(a)** 24 **(b)** 15 **(c)** 33 **(d)** 62

10.27 **(a)** RR: $T' \geq 1.7613$, $t' = 2.2214 \geq 1.7613$. There is evidence to suggest μ_1 is greater than μ_2. **(b)** $0.01 \leq p \leq 0.025$

10.28 **(a)** RR: $|T| \geq 2.0796$, $t = 1.8502$. There is no evidence to suggest the two population means are different. **(b)** RR: $|T'| \geq 2.1009$, $t' = 2.6994 \geq 2.1009$. There is evidence to suggest the two population means are different. **(c)** Population variances are assumed unequal. The sample standard deviations suggest unequal variances.

10.29 **(a)** $(-24.1659, 1.1659)$ **(b)** There is no evidence to suggest the population means are different. 0 is in the CI.

10.30 **(a)** H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 \neq 0$

TS: $T = \frac{(\overline{X}_1-\overline{X}_2)-0}{\sqrt{S_p^2\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}}$, RR: $|T| \geq 2.0687$

$t = -0.9209$. There is no evidence to suggest the population mean deviations from perfect flatness are different. **(b)** $0.20 \leq p \leq 0.40$

10.31 **(a)** H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 > 0$

TS: $T = \frac{(\overline{X}_1-\overline{X}_2)-0}{\sqrt{S_p^2\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}}$, RR: $T \geq 1.7341$

$t = 2.0954 \geq 1.7341$. There is evidence to suggest the population mean weight of a new-process key is less than the population mean weight of an old-process key. **(b)** $0.025 \leq p \leq 0.05$

10.32 H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 < 0$

TS: $T = \frac{(\overline{X}_1-\overline{X}_2)-0}{\sqrt{S_p^2\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}}$, RR: $T \leq -1.7011$

$t = -2.4051 \leq -1.7011$. There is evidence to suggest the mean file size for rap is less than the mean file size for jazz.

10.33 **(a)** H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 \neq 0$

TS: $T = \frac{(\overline{X}_1-\overline{X}_2)-0}{\sqrt{S_p^2\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}}$, RR: $|T| \geq 2.8982$

$t = -3.2218 \leq -2.8982$. There is evidence to suggest the population mean shading coefficients are different. **(b)** $(-0.2659, -0.0141)$ **(c)** Using the CI, there is evidence to suggest the population mean shading coefficients are different. 0 is not in the CI. This conclusion is the same as in part (a).

10.34 H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 \neq 0$

TS: $T = \frac{(\overline{X}_1-\overline{X}_2)-0}{\sqrt{S_p^2\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}}$, RR: $|T| \geq 2.0129$

$t = 2.1753 \geq 2.0129$. There is evidence to suggest the population mean elevator speeds are different.

10.35 **(a)** H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 \neq 0$

TS: $T = \frac{(\overline{X}_1 - \overline{X}_2) - 0}{\sqrt{S_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$, RR: $|T| \geq 2.6259$

$t = -3.0863 \leq -2.6259$. There is evidence to suggest the mean sagittal diameter of women's biceps tendons is different from that of men's biceps tendons.

(b) $(-0.4928, -0.1072)$

10.36 **(a)** H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 < 0$

TS: $T = \frac{(\overline{X}_1 - \overline{X}_2) - 0}{\sqrt{S_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$, RR: $T \leq -1.6973$

$t = -2.2393 \leq -1.6973$. There is evidence to suggest the population mean depth for Line 1 is less than the population mean depth for Line 2.

(b) $0.01 \leq p \leq 0.025$

10.37 **(a)** H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 < 0$

TS: $T = \frac{(\overline{X}_1 - \overline{X}_2) - 0}{\sqrt{S_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$, RR: $T \leq -2.4121$

$t = -3.3073 \leq -2.4121$. There is evidence to suggest the mean width of a \$20 bill is greater than the mean width of a \$1 bill.

(b) H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 < 0$

TS: $T' = \frac{(\overline{X}_1 - \overline{X}_2) - 0}{\sqrt{\left(\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}\right)}}$, RR: $T' \leq -2.4314$

$t' = -3.28 \leq -2.4314$. There is evidence to suggest the mean width of a \$20 bill is greater than the mean width of a \$1 bill. **(c)** The sample means are relatively close, the sample variances are relatively close, and the sample sizes are relatively large.

10.38 H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 > 0$

TS: $T = \frac{(\overline{X}_1 - \overline{X}_2) - 0}{\sqrt{S_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$, RR: $T \geq 3.2514$

$t = 4.4422 \geq 3.2514$. There is evidence to suggest the mean amount men intend to spend is greater than the mean amount women intend to spend.

10.39 **(a)** H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 > 0$

TS: $T = \frac{(\overline{X}_1 - \overline{X}_2) - 0}{\sqrt{S_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$, RR: $T \geq 2.5524$

$t = 43.1349 \geq 2.5524$. There is evidence to suggest the population mean Halogen cure depth is greater than the population mean LuxOMax cure depth.

(b) $(1.3532, 1.5468)$

10.40 **(a)**

Country	Sample size	Sample mean	Sample std. dev.
US	20	43.7920	7.3591
Canada	20	32.8255	5.0226

The assumption of equal variances is reasonable. The variances are relatively close, and the test is robust to departures from this assumption.

(b) H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 > 0$

TS: $T = \frac{(\overline{X}_1 - \overline{X}_2) - 0}{\sqrt{S_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$, RR: $T \geq 2.4286$

$t = 5.5045 \geq 2.4286$. There is evidence to suggest the population mean price for Prozac in the United States is greater than the population mean price for Prozac in Canada. **(b)** $p < 0.0001$.

10.41 **(a)** H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 > 0$

TS: $T' = \frac{(\overline{X}_1 - \overline{X}_2) - 0}{\sqrt{\left(\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}\right)}}$, RR: $T' \geq 2.4922$

$t' = 3.5202 \geq 2.4922$. There is evidence to suggest the population mean amount of coating for Fero is greater than the population mean amount of coating for Cintex. **(b)** $(13.5281, 51.8719)$

10.42 **(a)** H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 \neq 0$

TS: $T' = \frac{(\overline{X}_1 - \overline{X}_2) - 0}{\sqrt{\left(\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}\right)}}$, RR: $|T'| \geq 1.9996$

$t' = -0.2524$. There is no evidence to suggest the mean pressure required to open each valve is different. **(b)** $(-1.784, 1.3842)$. This CI is consistent with part (a); 0 is not in the CI.

10.43 H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 \neq 0$

TS: $T' = \frac{(\overline{X}_1 - \overline{X}_2) - 0}{\sqrt{\left(\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}\right)}}$, RR: $|T'| \geq 4.5869$

$t' = -1.5909$. There is no evidence to suggest the population mean curve in sticks is different.

10.44 H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 > 0$

TS: $T' = \frac{(\overline{X}_1 - \overline{X}_2) - 0}{\sqrt{\left(\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}\right)}}$, RR: $T' \geq 2.4851$

$t' = 2.9891 \geq 2.4851$. There is evidence to suggest the mean thickness of Aries wallpaper is greater than the mean thickness of all other wallpapers.

10.45 **(a)** H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 < 0$

TS: $T = \frac{(\overline{X}_1 - \overline{X}_2) - 0}{\sqrt{S_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$, RR: $T \leq -2.5280$

$t = -3.2199 \leq -2.5280$. There is evidence to suggest the population mean lifetime of the new fuel rod is greater than the population mean lifetime of the old fuel rod. **(b)** $(-8.740, -0.5398)$. This CI supports part (a); 0 is not included in the CI.

10.46 H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 \neq 0$

TS: $T' = \frac{(\overline{X}_1 - \overline{X}_2) - 0}{\sqrt{\left(\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}\right)}}$, RR: $|T'| \geq 2.2281$

$t' = 0.1139$. There is no evidence to suggest the population means are different.

10.47 H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 \neq 0$

TS: $T = \frac{(\overline{X}_1 - \overline{X}_2) - 0}{\sqrt{S_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$, RR: $|T| \geq 2.7500$

$t = 0.3467$. There is no evidence to suggest the population mean amount spent on gift cards per consumer is different on the East Coast and the West Coast.

10.48 **(a)** H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 \neq 0$

TS: $T = \frac{(\overline{X}_1 - \overline{X}_2) - 0}{\sqrt{S_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$, RR: $|T| \geq 2.0595$

$t = 1.4981$. There is no evidence to suggest the population mean age of homes is different in the two subregions. **(a)** $0.10 \leq p \leq 0.20$

10.49 H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 \neq 0$

TS: $T = \frac{(\overline{X}_1 - \overline{X}_2) - 0}{\sqrt{S_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$, RR: $|T| \geq 2.0244$

$t = 1.0183$. There is no evidence to suggest the population mean number of days in the hospital is different for Type A toxin and Type B toxin.

Section 10.3

10.50 **(a)** Paired; elementary classroom. **(b)** Independent; homes in the Northeast, homes in the South. **(c)** Paired; routes. **(d)** Paired; policy holders. **(e)** Independent; home sites in Kansas, home sites in upstate New York.

10.51 **(a)** Paired; patients (arms). **(b)** Paired; lathes. **(c)** Independent; 20-year-old males, 70-year-old males. **(d)** Paired; files. **(e)** Independent; frequent flyers on United, frequent flyers on Delta.

10.52 H_0: $\mu_D = 0$, H_a: $\mu_D > 0$

TS: $T = \frac{\overline{D} - \Delta_0}{S_D/\sqrt{n}}$, RR: $T \geq 1.7459$

$t = 1.9270 \geq 1.7459$. There is evidence to suggest population mean 1 is greater than population mean 2.

10.53 **(a)** H_0: $\mu_D = 0$, H_a: $\mu_D < 0$

TS: $T = \frac{\overline{D} - \Delta_0}{S_D/\sqrt{n}}$, RR: $T \leq -3.7469$

$t = -1.0551$. There is no evidence to suggest the population mean before treatment is less than the population mean after treatment. **(b)** $0.10 \leq p \leq 0.20$

10.54 **(a)** H_0: $\mu_D = 0$, H_a: $\mu_D \neq 0$

TS: $T = \frac{\overline{D} - \Delta_0}{S_D/\sqrt{n}}$, RR: $|T| \geq 2.8609$

$t = 3.1458 \geq 2.8609$. There is evidence to suggest the Natural population mean is different from the Coated population mean. **(b)** $0.002 \leq p \leq 0.10$

10.55 **(a)** Programmer. **(b)** H_0: $\mu_D = 0$, H_a: $\mu_D < 0$

TS: $T = \frac{\overline{D} - \Delta_0}{S_D/\sqrt{n}}$, RR: $T \leq -3.5518$

$t = -3.8636 \leq -3.5518$. There is evidence to suggest the population mean runtime for Java programs is greater than the population mean runtime for `C++` programs. **(c)** $0.0001 \leq p \leq 0.0005$

10.56 **(a)** Handgun. **(b)** H_0: $\mu_D = 0$, H_a: $\mu_D < 0$

TS: $T = \frac{\overline{D} - \Delta_0}{S_D/\sqrt{n}}$, RR: $T \leq -3.3649$

$t = -0.4966$. There is no evidence to suggest the population mean muzzle velocity of a clean gun is greater than the population mean muzzle velocity of a dirty gun. **(c)** $p > 0.20$

10.57 **(a)** Patient. **(b)** H_0: $\mu_D = 0$, H_a: $\mu_D > 0$

TS: $T = \frac{\overline{D} - \Delta_0}{S_D/\sqrt{n}}$, RR: $T \geq 1.8331$

$t = 3.3746 \geq 1.8331$. There is evidence to suggest the population mean temperature before the drug is greater than the population mean temperature after the drug. **(c)** $0.001 \leq p \leq 0.005$ **(d)** Nine of the 10 differences are positive.

10.58 **(a)** $(-0.3584, 5.9584)$ **(b)** No, 0 is included in the CI.

10.59 H_0: $\mu_D = 0$, H_a: $\mu_D > 0$

TS: $T = \frac{\overline{D} - \Delta_0}{S_D/\sqrt{n}}$, RR: $T \geq 1.6991$

$t = 1.5493$. There is no evidence to suggest the population mean concentration of particulate matter before filtration is greater than the population mean concentration of particulate matter after filtration.

10.60 **(a)** H_0: $\mu_D = 0$, H_a: $\mu_D > 0$

TS: $T = \frac{\overline{D} - \Delta_0}{S_D/\sqrt{n}}$, RR: $T \geq 4.0493$

$t = 5.8213 \geq 4.0493$. There is evidence to suggest the population mean autofocus shutter lag is greater than the population mean prefocus shutter lag.
(b) $p < 0.0001$

10.61 H_0: $\mu_D = 0$, H_a: $\mu_D > 0$

TS: $T = \frac{\overline{D} - \Delta_0}{S_D/\sqrt{n}}$, RR: $T \geq 2.1604$

$t = 0.3132$. There is no evidence to suggest the population mean ammonia-ion concentration before treatment is greater than the population mean ammonia-ion concentration after treatment.

10.62 **(a)** H_0: $\mu_D = 0$, H_a: $\mu_D > 0$

TS: $T = \frac{\overline{D} - \Delta_0}{S_D/\sqrt{n}}$, RR: $T \geq 2.0150$

$t = 2.4360 \geq 2.0150$. There is evidence to suggest the population mean cloud point before the additive is greater than the population mean cloud point after the additive. **(b)** H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 > 0$

TS: $T' = \frac{(\overline{X}_1 - \overline{X}_2) - 0}{\sqrt{\left(\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}\right)}}$, RR: $T' \geq 1.8595$

$t' = 1.5211$. There is no evidence to suggest the population mean cloud point before the additive is greater than the population mean cloud point after the additive. **(c)** The conclusions are different. The test statistics have the same numerator, but different denominators.

10.63 H_0: $\mu_D = 0$, H_a: $\mu_D > 0$

TS: $T = \frac{\overline{D}-\Delta_0}{S_D/\sqrt{n}}$, RR: $T \geq 1.8331$

$t = 0.5689$. There is no evidence to suggest the population mean salt content before potatoes is greater than the population mean salt content after potatoes.

10.64 **(a)** Three-dimensional objects.
(b) H_0: $\mu_D = 0$, H_a: $\mu_D \neq 0$

TS: $T = \frac{\overline{D}-\Delta_0}{S_D/\sqrt{n}}$, RR: $|T| \geq 2.8982$

$t = -0.3416$. There is no evidence to suggest the population mean time to render for ATI is different from the population mean time to render for NVIDIA.

10.65 **(a)** H_0: $\mu_D = 0$, H_a: $\mu_D > 0$

TS: $T = \frac{\overline{D}-\Delta_0}{S_D/\sqrt{n}}$, RR: $T \geq 1.8946$

$t = 0.4740$. There is no evidence to suggest the population mean electromagnetic emission from the old antenna is greater than the population mean electromagnetic emission from the new antenna.
(b) $p > 0.20$

10.66 H_0: $\mu_D = 0$, H_a: $\mu_D > 0$

TS: $T = \frac{\overline{D}-\Delta_0}{S_D/\sqrt{n}}$, RR: $T \geq 3.3962$

$t = 5.4503 \geq 3.3962$. There is evidence to suggest the population mean porosity before treatment is greater than the population mean porosity after treatment.

10.67 **(a)** Force. **(b)** H_0: $\mu_D = 0$, H_a: $\mu_D < 0$

TS: $T = \frac{\overline{D}-\Delta_0}{S_D/\sqrt{n}}$, RR: $T \leq -5.6938$

$t = -5.7564 \leq -5.6938$. There is evidence to suggest the old-formula population mean resilience is less than the new-formula population mean resilience. **(c)** All differences are negative.

10.68 **(a)** Exam score. **(b)** H_0: $\mu_D = 0$, H_a: $\mu_D \neq 0$

TS: $T = \frac{\overline{D}-\Delta_0}{S_D/\sqrt{n}}$, RR: $|T| \geq 2.3646$

$t = 1.7154$. There is no evidence to suggest the written-manual population mean assembly time is different from the interactive-video population mean assembly time.

10.69 **(a)** H_0: $\mu_D = 0$, H_a: $\mu_D < 0$

TS: $T = \frac{\overline{D}-\Delta_0}{S_D/\sqrt{n}}$, RR: $T \leq -3.4210$

$t = -3.4924 \leq -3.4210$. There is evidence to suggest the electric-grill population mean fat content is less than the frying-pan population mean fat content.
(b) $0.0005 \leq p \leq 0.0001$

Section 10.4

10.70

	n_1p_1	$n_1(1-p_1)$	n_2p_2	$n_2(1-p_2)$	Appropriate
(a)	175	128	250	213	Yes
(b)	140	420	125	405	Yes
(c)	155	5	170	15	Yes
(d)	700	310	950	327	Yes
(e)	319	523	280	475	Yes
(f)	237	4138	245	4760	Yes

10.71

	Mean	Variance	Standard deviation	Probability
(a)	−0.020	0.000579	0.0241	0.0034
(b)	0.040	0.001751	0.0418	0.0280
(c)	0.010	0.001557	0.0395	0.7804
(d)	−0.070	0.000858	0.0293	0.8472
(e)	−0.120	0.000275	0.0166	0.9999
(f)	0.041	0.000914	0.0302	0.9527

10.72 **(a)** People in California, people in Tennessee. H_0: $p_1 - p_2 = 0$, H_a: $p_1 - p_2 \neq 0$ **(b)** Men who tried to talk their way out of a traffic ticket, women who tried to talk their way out of a traffic ticket.
H_0: $p_1 - p_2 = 0$, H_a: $p_1 - p_2 < 0$ **(c)** Teens from school district 1, teens from school district 2. H_0: $p_1 - p_2 = 0$, H_a: $p_1 - p_2 \neq 0$ **(d)** High-income Americans who received an income-tax refund, low-income Americans who received an income-tax refund.
H_0: $p_1 - p_2 = 0.10$, H_a: $p_1 - p_2 > 0.10$

10.73 **(a)** $z = 1.1137$, $p = 0.1327$. Do not reject H_0.
(b) $z = -1.8938$, $p = 0.0291$, Do not reject H_0.
(c) $z = -2.2705$, $p = 0.0232$, Reject H_0.
(d) $z = 0.5012$, $p = 0.6163$, Do not reject H_0.

10.74 **(a)** $z = -2.1953$, $p = 0.0141$, Do not reject H_0.
(b) $z = 1.1585$, $p = 0.1233$, Do not reject H_0.
(c) $z = -2.3334$, $p = -.0196$, Do not reject H_0.
(d) $z = -2.8902$, $p = 0.0039$, Do not reject H_0.

10.75 **(a)** $(-0.0972, 0.0340)$ **(b)** $(-0.0710, -0.0052)$
(c) $(-0.1376, 0.1289)$ **(d)** $(0.0168, 0.0598)$

10.76 H_0: $p_1 - p_2 = 0$, H_a: $p_1 - p_2 \neq 0$

TS: $Z = \frac{\widehat{P}_1-\widehat{P}_2}{\sqrt{\widehat{P}_c(1-\widehat{P}_c)\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}}$, RR: $|Z| \geq 1.9600$

$z = 1.4761$. There is no evidence to suggest the population proportion of men who leave their car unlocked is different from the population proportion of women who leave their car unlocked.

10.77 H_0: $p_1 - p_2 = 0$, H_a: $p_1 - p_2 \neq 0$

TS: $Z = \frac{\widehat{P}_1-\widehat{P}_2}{\sqrt{\widehat{P}_c(1-\widehat{P}_c)\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}}$, RR: $|Z| \geq 1.9600$

$z = -1.4878$. There is no evidence to suggest the population proportion of registered voters intending to participate in the primary elections is different in New Hampshire and New York.

10.78 H_0: $p_1 - p_2 = 0$, H_a: $p_1 - p_2 < 0$

TS: $Z = \frac{\widehat{P}_1 - \widehat{P}_2}{\sqrt{\widehat{P}_c(1-\widehat{P}_c)\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}}$, RR: $Z \le -2.3263$

$z = -2.1487$. There is no evidence to suggest the population proportion of young women living at home is less than the population proportion of young men living at home.

10.79 **(a)** H_0: $p_1 - p_2 = 0$, H_a: $p_1 - p_2 > 0$

TS: $Z = \frac{\widehat{P}_1 - \widehat{P}_2}{\sqrt{\widehat{P}_c(1-\widehat{P}_c)\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}}$, RR: $Z \ge 3.0902$

$z = 3.2086 \ge 3.0902$. There is evidence to suggest the population proportion of 18–29-year-olds who believe movies are getting better is greater than the population proportion of 30–49-year-olds who believe movies are getting better.

10.80 H_0: $p_1 - p_2 = 0$, H_a: $p_1 - p_2 < 0$

TS: $Z = \frac{\widehat{P}_1 - \widehat{P}_2}{\sqrt{\widehat{P}_c(1-\widehat{P}_c)\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}}$, RR: $Z \le -2.5758$

$z = -3.9873 \le -2.5758$. There is evidence to suggest the population proportion of women who take a multivitamin is greater than the population proportion of men who take a multivitamin.

10.81 **(a)** H_0: $p_1 - p_2 = 0$, H_a: $p_1 - p_2 < 0$

TS: $Z = \frac{\widehat{P}_1 - \widehat{P}_2}{\sqrt{\widehat{P}_c(1-\widehat{P}_c)\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}}$, RR: $Z \le -1.6449$

$z = -2.8150 \le -1.6449$. There is evidence to suggest the population proportion of men who are angry about the price of gas is less than the population proportion of women who are angry about the price of gas. $p = 0.0024$.

(b) H_0: $p_1 - p_2 = 0$, H_a: $p_1 - p_2 > 0$

TS: $Z = \frac{\widehat{P}_1 - \widehat{P}_2}{\sqrt{\widehat{P}_c(1-\widehat{P}_c)\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}}$, RR: $Z \ge 2.3263$

$z = 4.1027 \ge 2.3263$. There is evidence to suggest the population proportion of Democrats who are angry about the price of gas is greater than the population proportion of Republicans who are angry about the price of gas. $p = 0.0000204$.

(c) H_0: $p_1 - p_2 = 0$, H_a: $p_1 - p_2 \ne 0$

TS: $Z = \frac{\widehat{P}_1 - \widehat{P}_2}{\sqrt{\widehat{P}_c(1-\widehat{P}_c)\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}}$, RR: $|Z| \ge 2.8070$

$z = -1.0063$. There is no evidence to suggest the population proportion of sedan owners who are angry about the price of gas is different from the population proportion of SUV owners who are angry about the price of gas. $p = 0.3143$.

10.82 **(a)** $n_1\widehat{p}_1 = 530 \ge 5$, $n_1(1-\widehat{p}_1) = 525 \ge 5$, $n_2\widehat{p}_2 = 825 \ge 5$, $n_2(1-\widehat{p}_2) = 838 \ge 5$

(b) H_0: $p_1 - p_2 = 0$, H_a: $p_1 - p_2 > 0$

TS: $Z = \frac{\widehat{P}_1 - \widehat{P}_2}{\sqrt{\widehat{P}_c(1-\widehat{P}_c)\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}}$, RR: $Z \ge 2.3263$

$z = 0.3190$. There is no evidence to suggest the population proportion of carpoolers crossing the George Washington Bridge is greater than the population proportion of carpoolers using the Lincoln Tunnel. **(c)** 0.3749

10.83 **(a)** $\widehat{p}_1 = 0.0746$, $\widehat{p}_2 = 0.0614$

(b) $n_1\widehat{p}_1 = 10 \ge 5$, $n_1(1-\widehat{p}_1) = 124 \ge 5$, $n_2\widehat{p}_2 = 7 \ge 5$, $n_2(1-\widehat{p}_2) = 107 \ge 5$

(c) $(-0.0494, 0.0758)$ **(d)** No, 0 is included in the CI.

10.84 H_0: $p_1 - p_2 = 0$, H_a: $p_1 - p_2 > 0$

TS: $Z = \frac{\widehat{P}_1 - \widehat{P}_2}{\sqrt{\widehat{P}_c(1-\widehat{P}_c)\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}}$, RR: $Z \ge 1.6449$

$z = 4.3512 \ge 1.6449$. There is evidence to suggest the population proportion of Fox News Channel viewers who are Republican is greater than the population proportion of CNN viewers who are Republican.

10.85 **(a)** $\widehat{p}_1 = 0.2784$, $\widehat{p}_2 = 0.2321$

(b) H_0: $p_1 - p_2 = 0$, H_a: $p_1 - p_2 \ne 0$

TS: $Z = \frac{\widehat{P}_1 - \widehat{P}_2}{\sqrt{\widehat{P}_c(1-\widehat{P}_c)\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}}$, RR: $|Z| \ge 2.5758$

$z = 1.1773$. There is no evidence to suggest the population proportion of people who experience relief due to the antihistamine is different from the population proportion of people who experience relief from butterbur extract.

10.86 H_0: $p_1 - p_2 = 0$, H_a: $p_1 - p_2 < 0$

TS: $Z = \frac{\widehat{P}_1 - \widehat{P}_2}{\sqrt{\widehat{P}_c(1-\widehat{P}_c)\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}}$, RR: $Z \le -3.0902$

$z = -1.8530$. There is no evidence to suggest the population proportion of adults who consider themselves physically inactive is greater in West Virginia than in Arizona. $p = 0.0319$.

10.87 **(a)** $\widehat{p}_1 = 0.0755$, $\widehat{p}_2 = 0.0992$ **(b)** $n_1\widehat{p}_1 = 8 \ge 5$, $n_1(1-\widehat{p}_1) = 108 \ge 5$, $n_2\widehat{p}_2 = 12 \ge 5$, $n_2(1-\widehat{p}_2) = 109 \ge 5$

(c) H_0: $p_1 - p_2 = 0$, H_a: $p_1 - p_2 \ne 0$

TS: $Z = \frac{\widehat{P}_1 - \widehat{P}_2}{\sqrt{\widehat{P}_c(1-\widehat{P}_c)\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}}$, RR: $|Z| \ge 1.9600$

$z = -0.6286$. There is no evidence to suggest the population proportion of defective lenses is different for Process A and Process B.

10.88 H_0: $p_1 - p_2 = 0.10$, H_a: $p_1 - p_2 > 0.10$

TS: $Z = \dfrac{(\widehat{P}_1 - \widehat{P}_2) - \Delta_0}{\sqrt{\frac{\widehat{P}_1(1-\widehat{P}_1)}{n_1} + \frac{\widehat{P}_2(1-\widehat{P}_2)}{n_2}}}$ RR: $Z \geq 2.3263$

$z = 0.8038$. There is no evidence to suggest the population proportion of homeowners planning a landscaping project is more than 0.10 greater than the population proportion of condominium owners planning a landscaping project.

10.89 H_0: $p_1 - p_2 = 0$, H_a: $p_1 - p_2 > 0$

TS: $Z = \dfrac{\widehat{P}_1 - \widehat{P}_2}{\sqrt{\widehat{P}_c(1-\widehat{P}_c)\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$, RR: $Z \geq 2.3263$

$z = 2.4303 \geq 2.3263$. There is evidence to suggest the population proportion of rural schoolchildren who know "Over the Rainbow" is greater than the population proportion of city schoolchildren.

10.90 H_0: $p_1 - p_2 = 0$, H_a: $p_1 - p_2 \neq 0$

TS: $Z = \dfrac{\widehat{P}_1 - \widehat{P}_2}{\sqrt{\widehat{P}_c(1-\widehat{P}_c)\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$, RR: $|Z| \geq 1.9600$

$z = -0.0663$. There is no evidence to suggest the population proportion of veterans living in Colorado Springs and Jacksonville is different.

10.91 H_0: $p_1 - p_2 = 0$, H_a: $p_1 - p_2 > 0$

TS: $Z = \dfrac{\widehat{P}_1 - \widehat{P}_2}{\sqrt{\widehat{P}_c(1-\widehat{P}_c)\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$, RR: $Z \geq 2.3263$

$z = 0.8912$. There is no evidence to suggest the population proportion of military couples who divorce is greater for those in the Reserve than in the Guard.

Section 10.5

10.92 **(a)** 2.54 **(b)** 1.92 **(c)** 3.94 **(d)** 2.73 **(e)** 0.43 **(f)** 0.36 **(g)** 0.37 **(h)** 0.12

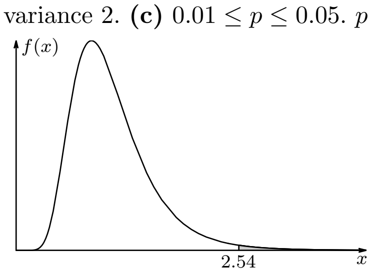
10.93 **(a)** 2.20 **(b)** 3.15 **(c)** 3.58 **(d)** 4.99 **(e)** 0.23 **(f)** 0.12 **(g)** 0.42 **(h)** 0.25

10.94 **(a)** $p > 0.05$ **(b)** $0.01 \leq p \leq 0.05$ **(c)** $0.001 \leq p \leq 0.01$ **(d)** $p < 0.001$

10.95 **(a)** H_0: $\sigma_1^2 = \sigma_2^2$, H_a: $\sigma_1^2 > \sigma_2^2$

TS: $F = S_1^2/S_2^2$, RR: $F \geq 1.94$

(b) $f = 2.5448 \geq 1.94$. There is evidence to suggest population variance 1 is greater than population variance 2. **(c)** $0.01 \leq p \leq 0.05$. p value illustration:



10.96 **(a)** H_0: $\sigma_1^2 = \sigma_2^2$, H_a: $\sigma_1^2 < \sigma_2^2$

TS: $F = S_1^2/S_2^2$, RR: $F \leq 0.45$

(b) $f = 0.1733 \leq 0.45$. There is evidence to suggest the population 1 variance is less than the population 2 variance. **(c)** $p < 0.001$

10.97 **(a)** H_0: $\sigma_1^2 = \sigma_2^2$, H_a: $\sigma_1^2 \neq \sigma_2^2$

TS: $F = S_1^2/S_2^2$, RR: $F \leq 0.17$ or $F \geq 4.54$

(b) $f = 4.8259 \geq 4.54$. There is evidence to suggest population variance 1 is different from population variance 2. **(c)** $0.001 \leq p \leq 0.01$

10.98 Using Equation 10.14: **(a)** 3.18, 0.31 **(b)** 2.55, 0.36 **(c)** 8.10, 0.16 **(d)** 3.07, 0.35

10.99 **(a)** $(0.3254, 3.5608)$ **(b)** $(0.4712, 5.8451)$ **(c)** $(0.2703, 2.3458)$ **(d)** $(0.2843, 2.5079)$

10.100 **(a)** 2.28 **(b)** 0.36 **(c)** 2.66 **(d)** 2.57 **(e)** 0.16 **(f)** 1.76

10.101 H_0: $\sigma_1^2 = \sigma_2^2$, H_a: $\sigma_1^2 > \sigma_2^2$

TS: $F = S_1^2/S_2^2$, RR: $F \geq 2.39$

$f = 4.6944 \geq 2.39$. There is evidence to suggest the population variance in aerosol light absorption coefficient is greater in Africa than in South America.

10.102 H_0: $\sigma_1^2 = \sigma_2^2$, H_a: $\sigma_1^2 \neq \sigma_2^2$

TS: $F = S_1^2/S_2^2$, RR: $F \leq 0.23$ or $F \geq 4.43$

$f = 1.3037$. There is no evidence to suggest the population variance in gross ticket sales per film is different for the two studios.

10.103 H_0: $\sigma_1^2 = \sigma_2^2$, H_a: $\sigma_1^2 > \sigma_2^2$

TS: $F = S_1^2/S_2^2$, RR: $F \geq 3.52$

$f = 4.6786 \geq 3.52$. There is evidence to suggest the population variance in the weight of frozen turkeys from North Carolina is greater than the population variance in the weight of frozen turkeys from Minnesota.

10.104 **(a)** H_0: $\sigma_1^2 = \sigma_2^2$, H_a: $\sigma_1^2 \neq \sigma_2^2$

TS: $F = S_1^2/S_2^2$, RR: $F \leq 0.49$ or $F \geq 1.93$

$f = 0.6843$. There is no evidence to suggest a difference in variability of salt content between the two wells. **(b)** $p > 0.10$. $p = 0.3797$.

10.105 H_0: $\sigma_1^2 = \sigma_2^2$, H_a: $\sigma_1^2 < \sigma_2^2$

TS: $F = S_1^2/S_2^2$, RR: $F \leq 0.54$

$f = 0.4710 \leq 0.54$. There is evidence to suggest the population variance in shot distance in 1975 is less than the population variance in shot distance in 2002. With the chance to make three points, a basketball player is tempted to shoot from almost anywhere on the court. Therefore, greater variability in shot distance.

10.106 **(a)** H_0: $\sigma_1^2 = \sigma_2^2$, H_a: $\sigma_1^2 > \sigma_2^2$
TS: $F = S_1^2/S_2^2$, RR: $F \geq 2.6041$
$f = 2.8281 \geq 2.6041$. There is evidence to suggest the population variance in winning times for an ordinary race is greater than the population variance in winning times for a stakes race. **(b)** $(1.1014, 7.4689)$

10.107 **(a)** 3.5257, 0.2729 **(b)** $(0.2343, 3.0270)$

10.108 H_0: $\sigma_1^2 = \sigma_2^2$, H_a: $\sigma_1^2 \neq \sigma_2^2$
TS: $F = S_1^2/S_2^2$, RR: $F \leq 0.37$ or $F \geq 2.67$
$f = 0.5552$. There is no evidence to suggest the population variance in flight-delay times for Delta is different from the population variance in flight-delay times for United. **(b)** No. The distributions are probably skewed right.

10.109 H_0: $\sigma_1^2 = \sigma_2^2$, H_a: $\sigma_1^2 \neq \sigma_2^2$
TS: $F = S_1^2/S_2^2$
$f = 2.4063$, $p = 0.2757$. There is no evidence to suggest the population variance in mast-pole diameter in Machine A is different from the population variance in mast-pole diameter in Machine B.

10.110 H_0: $\sigma_1^2 = \sigma_2^2$, H_a: $\sigma_1^2 > \sigma_2^2$
TS: $F = S_1^2/S_2^2$, RR: $F \geq 2.85$
$f = 2.25$. There is no evidence to suggest the population variance in nitrate concentration in Region I is greater than the population variance in nitrate concentration in Region II.

10.111 H_0: $\sigma_1^2 = \sigma_2^2$, H_a: $\sigma_1^2 < \sigma_2^2$
TS: $F = S_1^2/S_2^2$, RR: $F \leq 0.22$
$f = 0.3031$. There is no evidence to suggest the population variance in tuition at public colleges is less than the population variance in tuition at private schools.

10.112 **(a)** H_0: $\sigma_1^2 = \sigma_2^2$, H_a: $\sigma_1^2 \neq \sigma_2^2$
TS: $F = S_1^2/S_2^2$, RR: $F \leq 0.42$ or $F \geq 2.54$
$f = 0.5492$. There is no evidence to suggest the population variance in circulation for the Sun-Times is different from the population variance in circulation for the Globe. **(b)** No. The circulation distribution could be skewed right.

10.113 **(a)** H_0: $\sigma_1^2 = \sigma_2^2$, H_a: $\sigma_1^2 \neq \sigma_2^2$
TS: $F = S_1^2/S_2^2$, RR: $F \leq 0.31$ or $F \geq 3.53$
$f = 2.7128$. There is no evidence to suggest the population variance in saccharin amount for Fishing Creek is different from the population variance in saccharin amount for Honest Tea. **(b)** $0.02 \leq p \leq 0.10$

Chapter Exercises

10.114 H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 \neq 0$
TS: $Z = \frac{(\overline{X}_1 - \overline{X}_2) - 0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$, RR: $|Z| \geq 2.5758$
$z = -2.7903 \leq -2.5758$. There is evidence to suggest the population mean amount of corrosive material carried by trucks in North Carolina is different from the population meant amount of corrosive material carried by trucks in Virginia.

10.115 H_0: $p_1 - p_2 = 0$, H_a: $p_1 - p_2 \neq 0$
TS: $Z = \frac{\widehat{P}_1 - \widehat{P}_2}{\sqrt{\widehat{P}_c(1-\widehat{P}_c)\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$, RR: $|Z| \geq 1.96$
$z = 1.7196$. There is no evidence to suggest the population proportion of adults aged 25–34 who watched the ads is different from the population proportion of adults aged 35–53 who watched the ads.

10.116 **(a)** $\widehat{p}_1 = 0.6158$, $\widehat{p}_2 = 0.6318$.
$n_1\widehat{p}_1 = 335 \geq 5$, $n_1(1-\widehat{p}_1) = 209 \geq 5$, $n_2\widehat{p}_2 = 381 \geq 5$, $n_2(1-\widehat{p}_2) = 222 \geq 5$ **(b)** H_0: $p_1 - p_2 = 0$, H_a: $p_1 - p_2 \neq 0$
TS: $Z = \frac{\widehat{P}_1 - \widehat{P}_2}{\sqrt{\widehat{P}_c(1-\widehat{P}_c)\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$, RR: $|Z| \geq 2.5758$
$z = -0.5598$. There is no evidence to suggest the two population proportions are different. **(c)** 0.5756

10.117 **(a)** H_0: $\sigma_1^2 = \sigma_2^2$, H_a: $\sigma_1^2 \neq \sigma_2^2$
TS: $F = S_1^2/S_2^2$, RR: $F \leq 0.29$ or $F \geq 3.78$
$f = 0.1038 \leq 0.29$. There is evidence to suggest the two population variances are different.
(b) H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 < 0$
TS: $T' = \frac{(\overline{X}_1 - \overline{X}_2) - 0}{\sqrt{\left(\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}\right)}}$, RR: $T' \leq -1.7531$
$t' = -1.8697 \leq -1.7531$. There is evidence to suggest the population mean time to complete form 1040 for the lower income level is less than the population mean time to complete form 1040 for the higher income level. $0.025 \leq p \leq 0.05$

10.118 H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 \neq 0$
TS: $T = \frac{(\overline{X}_1 - \overline{X}_2) - 0}{\sqrt{S_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$, RR: $|T| \geq 2.7045$
$t = -1.3083$. There is no evidence to suggest the mean amount of sap from trees in Vermont is different from the mean amount of sap from trees in New York.

10.119 **(a)** H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 \neq 0$
TS: $T = \frac{(\overline{X}_1 - \overline{X}_2) - 0}{\sqrt{S_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$, RR: $|T| \geq 2.6778$
$t = -8.6946 \leq -2.6778$. There is evidence to suggest the population mean number of yearly pro bono hours is different at these two law firms.
(b) $(-7.5863, -4.0137)$ **(c)** Yes, 0 is not in the CI.

10.120 **(a)** H_0: $p_1 - p_2 = 0$, H_a: $p_1 - p_2 > 0$

TS: $Z = \dfrac{\widehat{P}_1 - \widehat{P}_2}{\sqrt{\widehat{P}_c(1-\widehat{P}_c)\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}}$, RR: $Z \geq 2.3263$

$z = 1.0728$. There is no evidence to suggest the population proportion of residents in Ohio who recycle newspapers is greater than the population proportion of residents in Florida. **(b)** 0.1417

10.121 **(a)** Archer. **(b)** H_0: $\mu_D = 0$, H_a: $\mu_D < 0$

TS: $T = \frac{\overline{D}-\Delta_0}{S_D/\sqrt{n}}$, RR: $T \leq -1.7959$

$t = -1.1829$. There is no evidence to suggest the population mean speed of a carbon arrow is less than the population mean speed of an aluminum arrow. **(c)** $0.10 \leq p \leq 0.20$

10.122 H_0: $\sigma_1^2 = \sigma_2^2$, H_a: $\sigma_1^2 > \sigma_2^2$

TS: $F = S_1^2/S_2^2$, RR: $F \geq 5.20$

$f = 7.84 \geq 5.20$. There is evidence to suggest the population variance in aluminum fuselage thickness is greater than the population variance in carbon-fiber fuselage thickness.

10.123 H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 < 0$

TS: $T = \dfrac{(\overline{X}_1-\overline{X}_2)-0}{\sqrt{S_p^2\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}}$, RR: $T \leq -2.6682$

$t = -3.5445 \leq -2.6682$. There is evidence to suggest the population mean amount of iron in white bread is less than the population mean amount of iron in wholewheat bread.

10.124 **(a)** $\widehat{p}_1 = 0.3793$, $\widehat{p}_2 = 0.2876$. $n_1\widehat{p}_1 = 132 \geq 5$, $n_1(1-\widehat{p}_1) = 216 \geq 5$, $n_2\widehat{p}_2 = 65 \geq 5$, $n_2(1-\widehat{p}_2) = 161 \geq 5$ **(b)** $(0.0137, 0.1697)$ **(c)** There is evidence to suggest the population proportion of online investors is different for these two portfolio classifications. 0 is not in the CI.

10.125 H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 < 0$

TS: $T' = \dfrac{(\overline{X}_1-\overline{X}_2)-0}{\sqrt{\left(\frac{S_1^2}{n_1}+\frac{S_2^2}{n_2}\right)}}$, RR: $T' \leq -70.7001$

$t' = -0.3347$. There is no evidence to suggest the population mean PCB level in wild char is less than the population mean PCB level in wild salmon.

10.126 H_0: $\mu_D = 0$, H_a: $\mu_D \neq 0$

TS: $T = \frac{\overline{D}-\Delta_0}{S_D/\sqrt{n}}$, RR: $|T| \geq 2.0930$

$t = 0.4957$. There is no evidence to suggest the population mean moisture content of bulk grain measured by chemical reaction and by distillation is different.

10.127 H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 > 0$

TS: $T = \dfrac{(\overline{X}_1-\overline{X}_2)-0}{\sqrt{S_p^2\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}}$, RR: $T \geq 3.5518$

$t = 2.2317$. There is no evidence to suggest the population mean Rolling Stones concert ticket price is greater than the population mean Coldplay concert ticket price.

10.128 Race versus Age: $t = -2.0685$, $p = 0.0479$. Reject H_0. Race versus Disability: $t = -0.7547$, $p = 0.4565$. Do not reject H_0. Age versus Disability: $t = 1.3559$, $p = 0.1856$. Do not reject H_0.

10.129 H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 < 0$

TS: $T' = \dfrac{(\overline{X}_1-\overline{X}_2)-0}{\sqrt{\left(\frac{S_1^2}{n_1}+\frac{S_2^2}{n_2}\right)}}$, RR: $T' \leq -1.7959$

$t' = -1.6551$. There is no evidence to suggest the population mean gold value at the El Aguila mine is less than the population mean gold value at the Dolaucothi mine. **(b)** The sample standard deviation, s_2 is very large.

10.130 **(a)** $\widehat{p}_1 = 0.1143$, $\widehat{p}_2 = 0.0952$. $n_1\widehat{p}_1 = 16 \geq 5$, $n_1(1-\widehat{p}_1) = 124 \geq 5$, $n_2\widehat{p}_2 = 12 \geq 5$, $n_2(1-\widehat{p}_2) = 114 \geq 5$ **(b)** H_0: $p_1 - p_2 = 0$, H_a: $p_1 - p_2 \neq 0$

TS: $Z = \dfrac{\widehat{P}_1 - \widehat{P}_2}{\sqrt{\widehat{P}_c(1-\widehat{P}_c)\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}}$, RR: $|Z| \geq 2.5758$

$z = 0.5054$. There is no evidence to suggest the population proportion of stations in non-compliance with the law is different near LA and near San Francisco.

10.131 H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 \neq 0$

TS: $T = \dfrac{(\overline{X}_1-\overline{X}_2)-0}{\sqrt{S_p^2\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}}$, RR: $|T| \geq -2.0010$

$t = -2.6898 \leq -2.0010$. There is evidence to suggest the population mean fine particulate measure is different in these two areas.

Exercises′

10.132 **(a)** $n_1 = n_2 = n = \frac{(z_{\alpha/2})^2(\sigma_1^2+\sigma_2^2)}{B^2}$ **(b)** 39 **(c)** $(3.7224, 13.678)$, $B = 4.9778 \leq 5$

10.133 **(a)** H_0: $\sigma_1^2 = \sigma_2^2$, H_a: $\sigma_1^2 \neq \sigma_2^2$

TS: $Z = \dfrac{(S_1^2/S_2^2)-[(n_2-1)/(n_2-3)]}{\sqrt{\frac{2(n_2-1)^2(n_1+n_2-4)}{(n_1-1)(n_2-3)^2(n_2-5)}}}$, RR: $|Z| \geq 1.9600$

$z = 1.7059$. There is no evidence to suggest the two population variances are different.

(b) H_0: $\sigma_1^2 = \sigma_2^2$, H_a: $\sigma_1^2 \neq \sigma_2^2$

TS: $F = S_1^2/S_2^2$, RR: $F \leq 0.48$ or $F \geq 2.07$

$f = 1.7763$. There is no evidence to suggest the two population variances are different. Same conclusion as in (a).

Chapter 11

Section 11.1

11.1 **(a)** 9, 7, 6, 22 **(b)** 260, 229, 195, 684 **(c)** 21602

11.2 **(a)** 10, 9, 10, 10, 8, 10, 57 **(b)** 51.3, 37.7, 49.1, 50.7, 44.0, 46.9, 279.7 **(c)** 1481.97

11.3 **(a)** 775, 745, 768, 753, 3041 **(b)** 465193 **(c)** 2808.95, 112.55, 2696.40 **(d)** 37.5167, 168.525 **(e)** 0.2226

11.4 **(a)** 2456.4790, 122.3315, 2334.1475 **(b)** 30.5829, 66.6899 **(c)** 0.4586 **(d)** No. The p value is 0.7655.

11.5
ANOVA summary table

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Factor	584.1	4	145.0250	0.57	0.6857
Error	12,062.1	47	256.6404		
Total	12,646.2	51			

11.6
ANOVA summary table

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Factor	13.566	3	4.522	4.58	0.0059
Error	61.256	62	0.988		
Total	74.822	65			

(a) H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4$, H_a: $\mu_i \neq \mu_j$ for some $i \neq j$ **(b)** $F \geq 4.11$ **(c)** $f = 4.58 \geq 4.11$. There is evidence to suggest at least two population means are different.

11.7 **(a)** H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4$, H_a: $\mu_i \neq \mu_j$ for some $i \neq j$, TS: $F = \text{MSA/MSE}$, RR: $F \geq 3.10$ **(b)**

ANOVA summary table

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Factor	32705.13	3	10901.71	10.60	0.0002
Error	20576.83	20	1028.84		
Total	53281.96	23			

(c) $f = 10.60 \geq 3.10$. There is evidence to suggest at least two of the population means are different.

11.8 **(a)** H_0: $\mu_1 = \mu_2 = \mu_3$, H_a: $\mu_i \neq \mu_j$ for some $i \neq j$, TS: $F = \text{MSA/MSE}$, RR: $F \geq 5.85$
$f = 9.97 \geq 5.85$. There is evidence to suggest at least two of the population mean weights are different.
(b) 8.16, 7.98, 6.05. $\mu_1 \neq \mu_3$, $\mu_2 \neq \mu_3$.

11.9 H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5$, H_a: $\mu_i \neq \mu_j$ for some $i \neq j$, TS: $F = \text{MSA/MSE}$, RR: $F \geq 2.48$
$f = 7.35 \geq 2.48$. There is evidence to suggest at least two population mean times are different.

11.10 H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4$, H_a: $\mu_i \neq \mu_j$ for some $i \neq j$, TS: $F = \text{MSA/MSE}$, RR: $F \geq 4.48$
$f = 11.16 \geq 4.48$. There is evidence to suggest at least two of the population mean tensions are different.

11.11 H_0: $\mu_1 = \mu_2 = \mu_3$, H_a: $\mu_i \neq \mu_j$ for some $i \neq j$, TS: $F = \text{MSA/MSE}$, RR: $F \geq 5.19$
$f = 6.35 \geq 5.19$. There is evidence to suggest at least two of the population mean weights are different.

11.12 **(a)** H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4$, H_a: $\mu_i \neq \mu_j$ for some $i \neq j$, TS: $F = \text{MSA/MSE}$, RR: $F \geq 3.01$
$f = 3.40 \geq 3.01$. There is evidence to suggest at least two of the population mean pressures are different.
(b) Holder. This broom has the highest mean pressure.

11.13 H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4$, H_a: $\mu_i \neq \mu_j$ for some $i \neq j$, TS: $F = \text{MSA/MSE}$, RR: $F \geq 2.83$
$f = 8.90 \geq 2.83$. There is evidence to suggest at least two population means are different.

11.14 **(a)** 792.98, 532.89, 1325.87 **(b)**
ANOVA summary table

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Factor	792.98	2	396.49	36.46	< 0.0001
Error	532.89	49	10.88		
Total	1325.87	51			

There is evidence to suggest at least two of the population mean waiting times are different.

11.15 H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4$, H_a: $\mu_i \neq \mu_j$ for some $i \neq j$, TS: $F = \text{MSA/MSE}$, RR: $F \geq 4.13$
$f = 6.82 \geq 4.13$. There is evidence to suggest at least two of the population means are different.

11.16 H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4$, H_a: $\mu_i \neq \mu_j$ for some $i \neq j$, TS: $F = \text{MSA/MSE}$, RR: $F \geq 4.57$
$f = 0.45$. There is no evidence to suggest at least two of the population mean levels of sorbitol are different.

11.17 **(a)** H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5$, H_a: $\mu_i \neq \mu_j$ for some $i \neq j$, TS: $F = \text{MSA/MSE}$, RR: $F \geq 5.36$
$f = 21.58 \geq 5.36$. There is evidence to suggest at least two population mean weights are different. **(b)** Weis. These bags have the largest sample mean.

11.18 H_0: $\mu_1 = \mu_2 = \mu_3$, H_a: $\mu_i \neq \mu_j$ for some $i \neq j$, TS: $F = \text{MSA/MSE}$, RR: $F \geq 3.16$
$f = 6.24 \geq 3.16$. There is evidence to suggest at least two population mean numbers of plants per seized plot are different.

11.19 H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4$, H_a: $\mu_i \neq \mu_j$ for some $i \neq j$, TS: $F = \text{MSA}/\text{MSE}$, RR: $F \geq 4.17$
ANOVA summary table

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Factor	1034.56	3	344.85	19.13	< 0.0001
Error	955.49	53	18.03		
Total	1990.05	56			

$f = 19.13 \geq 4.17$. There is evidence to suggest at least two population means are different.

11.20 H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4$, H_a: $\mu_i \neq \mu_j$ for some $i \neq j$, TS: $F = \text{MSA}/\text{MSE}$, RR: $F \geq 3.10$
$f = 0.81$. There is no evidence to suggest at least two population mean thaw depths are different.

11.21 H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4$, H_a: $\mu_i \neq \mu_j$ for some $i \neq j$, TS: $F = \text{MSA}/\text{MSE}$, RR: $F \geq 6.74$
$f = 43.09 \geq 6.74$. There is evidence to suggest at least two population mean hourly wages are different.

11.22 H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4$, H_a: $\mu_i \neq \mu_j$ for some $i \neq j$, TS: $F = \text{MSA}/\text{MSE}$, RR: $F \geq 2.72$
$f = 1.00$. There is no evidence to suggest at least two population mean numbers of unhealthy days per 30-day period are different.

11.23 H_0: $\mu_1 = \mu_2 = \mu_3$, H_a: $\mu_i \neq \mu_j$ for some $i \neq j$, TS: $F = \text{MSA}/\text{MSE}$, RR: $F \geq 5.00$
$f = 16.99 \geq 5.00$. There is evidence to suggest at least two of the population mean nitrogen discharge concentrations are different.

Section 11.2

11.24 **(a)** 3, 2.5525 **(b)** 3, 3.1218 **(c)** 6, 3.4786 **(d)** 10, 2.6778 **(e)** 15, 3.2584

11.25 **(a)** 3.609 **(b)** 3.791 **(c)** 4.634 **(d)** 4.863 **(e)** 6.469

11.26

(a)

$\overline{x}_{2.}$	$\overline{x}_{3.}$	$\overline{x}_{1.}$
46.9	50.4	52.8

(b)

$\overline{x}_{1.}$	$\overline{x}_{3.}$	$\overline{x}_{2.}$
4.82	7.03	8.23

(c)

$\overline{x}_{1.}$	$\overline{x}_{4.}$	$\overline{x}_{3.}$	$\overline{x}_{2.}$
16.08	16.33	18.53	22.71

(d)

$\overline{x}_{3.}$	$\overline{x}_{2.}$	$\overline{x}_{1.}$	$\overline{x}_{4.}$
165.4	168.6	201.7	219.7

11.27

(a)

$\overline{x}_{1.}$	$\overline{x}_{2.}$	$\overline{x}_{3.}$	$\overline{x}_{4.}$
−33.44	−14.83	0.48	4.30

(b)

$\overline{x}_{3.}$	$\overline{x}_{2.}$	$\overline{x}_{4.}$	$\overline{x}_{1.}$
1.30	1.41	1.50	1.62

(c)

$\overline{x}_{4.}$	$\overline{x}_{2.}$	$\overline{x}_{3.}$	$\overline{x}_{1.}$	$\overline{x}_{5.}$
51.92	54.21	60.80	64.35	64.85

11.28 **(a)** $\mu_3 \neq \mu_1$, $\mu_3 \neq \mu_2$, $\mu_3 \neq \mu_4$ **(b)** $\mu_1 \neq \mu_2$, $\mu_1 \neq \mu_3$, $\mu_1 \neq \mu_4$, $\mu_2 \neq \mu_4$, $\mu_3 \neq \mu_4$ **(c)** $\mu_1 \neq \mu_3$, $\mu_1 \neq \mu_4$, $\mu_2 \neq \mu_3$, $\mu_2 \neq \mu_4$ **(d)** $\mu_2 \neq \mu_3$, $\mu_2 \neq \mu_5$, $\mu_2 \neq \mu_1$, $\mu_2 \neq \mu_4$, $\mu_3 \neq \mu_4$, $\mu_5 \neq \mu_4$

11.29

Difference	Bonferroni CI	Significantly different
$\mu_1 - \mu_2$	(−7.62, 3.64)	No
$\mu_1 - \mu_3$	(−2.54, 9.72)	No
$\mu_1 - \mu_4$	(−11.80, −0.54)	Yes
$\mu_2 - \mu_3$	(−0.55, 10.71)	No
$\mu_2 - \mu_4$	(−9.81, 1.45)	No
$\mu_3 - \mu_4$	(−14.89, −3.63)	Yes

11.30

Difference	Tukey CI	Significantly different
$\mu_1 - \mu_2$	(−55.68, 107.88)	No
$\mu_1 - \mu_3$	(−300.88, −142.92)	Yes
$\mu_1 - \mu_4$	(−220.47, −22.13)	Yes
$\mu_2 - \mu_3$	(−324.45, −171.55)	Yes
$\mu_2 - \mu_4$	(−244.57, −50.23)	Yes
$\mu_3 - \mu_4$	(5.78, 195.42)	Yes

11.31

Difference	Bonferroni CI	Significantly different
$\mu_1 - \mu_2$	(−0.30, 0.16)	No
$\mu_1 - \mu_3$	(−1.43, −0.97)	Yes
$\mu_2 - \mu_3$	(−1.37, −0.89)	Yes

11.32

Difference	Tukey CI	Significantly different
$\mu_1 - \mu_2$	(−5.62, 3.22)	No
$\mu_1 - \mu_3$	(−6.42, 2.42)	No
$\mu_2 - \mu_3$	(−5.22, 3.62)	No

11.33 **(a)** $0.001 \leq p \leq 0.01$. There is evidence to suggest at least two population means are different.

(b)

Difference	Bonferroni CI	Significantly different
$\mu_1 - \mu_2$	$(-10.21,\ 0.81)$	No
$\mu_1 - \mu_3$	$(-5.71,\ 5.31)$	No
$\mu_1 - \mu_4$	$(-10.91,\ 0.11)$	No
$\mu_2 - \mu_3$	$(-1.01,\ 10.01)$	No
$\mu_2 - \mu_4$	$(-6.21,\ 4.81)$	No
$\mu_3 - \mu_4$	$(-10.71,\ 0.31)$	No

11.34 (a) H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4$, H_a: $\mu_i \neq \mu_j$ for some $i \neq j$, TS: $F = \text{MSA/MSE}$, RR: $F \geq 4.17$
$f = 4.70 \geq 4.17$. There is no evidence to suggest at least two population mean security guard to inmate ratios are different.

(b)

Difference	Tukey CI	Significantly different
$\mu_1 - \mu_2$	$(-0.05,\ 0.52)$	No
$\mu_1 - \mu_3$	$(-0.41,\ 0.15)$	No
$\mu_1 - \mu_4$	$(-0.17,\ 0.38)$	No
$\mu_2 - \mu_3$	$(-0.63, -0.10)$	Yes
$\mu_2 - \mu_4$	$(-0.39,\ 0.13)$	No
$\mu_3 - \mu_4$	$(-0.02,\ 0.49)$	No

11.35 (a) $p < 0.0001$

(b)

Difference	Bonferroni CI	Significantly different
$\mu_1 - \mu_2$	$(0.87,\ 1.25)$	Yes
$\mu_1 - \mu_3$	$(0.56,\ 0.95)$	Yes
$\mu_1 - \mu_4$	$(0.20,\ 0.59)$	Yes
$\mu_2 - \mu_3$	$(-0.49, -0.12)$	No
$\mu_2 - \mu_4$	$(-0.85, -0.48)$	No
$\mu_3 - \mu_4$	$(-0.55, -0.17)$	No

$\overline{x}_{2.}$	$\overline{x}_{3.}$	$\overline{x}_{4.}$	$\overline{x}_{1.}$
0.2567	0.5601	0.9206	1.3164

11.36

Difference	Bonferroni CI	Significantly different
$\mu_1 - \mu_2$	$(-18.74, -2.52)$	Yes
$\mu_1 - \mu_3$	$(-10.21,\ 6.47)$	No
$\mu_1 - \mu_4$	$(-13.88,\ 2.48)$	No
$\mu_1 - \mu_5$	$(-10.89,\ 5.33)$	No
$\mu_2 - \mu_3$	$(0.95,\ 16.57)$	Yes
$\mu_2 - \mu_4$	$(-2.71,\ 12.57)$	No
$\mu_2 - \mu_5$	$(0.29,\ 15.41)$	Yes
$\mu_3 - \mu_4$	$(-11.71,\ 4.05)$	No
$\mu_3 - \mu_5$	$(-8.72,\ 6.90)$	No
$\mu_4 - \mu_5$	$(-4.72,\ 10.56)$	No

$\overline{x}_{1.}$	$\overline{x}_{3.}$	$\overline{x}_{5.}$	$\overline{x}_{4.}$	$\overline{x}_{1.}$
17.27	19.14	20.05	22.97	27.90

11.37 (a) H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4$, H_a: $\mu_i \neq \mu_j$ for some $i \neq j$, TS: $F = \text{MSA/MSE}$, RR: $F \geq 3.10$
$f = 10.03 \geq 3.10$. There is evidence to suggest at least two population means are different.

(b)

Difference	Bonferroni CI	Significantly different
$\mu_1 - \mu_2$	$(-15.05,\ 0.31)$	No
$\mu_1 - \mu_3$	$(-6.53,\ 8.83)$	No
$\mu_1 - \mu_4$	$(-18.76, -3.40)$	Yes
$\mu_2 - \mu_3$	$(0.84,\ 16.20)$	Yes
$\mu_2 - \mu_4$	$(-11.40,\ 3.96)$	No
$\mu_3 - \mu_4$	$(-19.91, -4.55)$	Yes

(c)

$\overline{x}_{3.}$	$\overline{x}_{1.}$	$\overline{x}_{2.}$	$\overline{x}_{4.}$
65.55	66.70	74.07	77.78

11.38 (a) H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4$, H_a: $\mu_i \neq \mu_j$ for some $i \neq j$, TS: $F = \text{MSA/MSE}$, RR: $F \geq 5.29$
$f = 6.09 \geq 5.29$. There is evidence to suggest at least two population means are different.

(b)

Difference	Tukey CI	Significantly different
$\mu_1 - \mu_2$	$(-51.19,\ 9.91)$	No
$\mu_1 - \mu_3$	$(-60.43,\ 0.67)$	No
$\mu_1 - \mu_4$	$(-32.55,\ 28.55)$	No
$\mu_2 - \mu_3$	$(-39.79,\ 21.31)$	No
$\mu_2 - \mu_4$	$(-11.91,\ 49.19)$	No
$\mu_3 - \mu_4$	$(-2.67,\ 58.43)$	No

(c)

$\overline{x}_{1.}$	$\overline{x}_{4.}$	$\overline{x}_{2.}$	$\overline{x}_{3.}$
25.56	27.56	46.20	55.44

11.39 (a) H_0: $\mu_1 = \mu_2 = \mu_3$, H_a: $\mu_i \neq \mu_j$ for some $i \neq j$, TS: $F = \text{MSA/MSE}$, RR: $F \geq 3.32$
$f = 30.85 \geq 3.32$. There is evidence to suggest at least two population means are different.

(b)

Difference	Tukey CI	Significantly different
$\mu_1 - \mu_2$	$(32.86,\ 63.56)$	Yes
$\mu_1 - \mu_3$	$(17.75,\ 49.08)$	Yes
$\mu_2 - \mu_3$	$(-29.76,\ 0.17)$	No

(c)

$\overline{x}_{2.}$	$\overline{x}_{3.}$	$\overline{x}_{1.}$
67.80	82.59	116.01

11.40 (a) H_0: $\mu_1 = \mu_2 = \mu_3$, H_a: $\mu_i \neq \mu_j$ for some $i \neq j$, TS: $F = \text{MSA/MSE}$, RR: $F \geq 5.11$
$f = 7.29 \geq 5.11$. There is evidence to suggest at least two population means are different.

(b)

Difference	Bonferroni CI	Significantly different
$\mu_1 - \mu_2$	$(-1.06,\ 7.61)$	No
$\mu_1 - \mu_3$	$(-6.36,\ 2.32)$	No
$\mu_2 - \mu_3$	$(-9.63, -0.96)$	Yes

(c)

$\overline{x}_{2.}$	$\overline{x}_{1.}$	$\overline{x}_{3.}$
16.41	19.69	21.71

11.41 (a) H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5$, H_a: $\mu_i \neq \mu_j$ for some $i \neq j$, TS: $F = \text{MSA/MSE}$, RR: $F \geq 4.43$
$f = 12.82 \geq 4.43$. There is evidence to suggest at least two population means are different.

(b)

Difference	Bonferroni CI	Significantly different
$\mu_1 - \mu_2$	$(-4.66,\ 0.54)$	No
$\mu_1 - \mu_3$	$(-3.36,\ 1.84)$	No
$\mu_1 - \mu_4$	$(-4.36,\ 0.84)$	No
$\mu_1 - \mu_5$	$(-8.04, -2.84)$	Yes
$\mu_2 - \mu_3$	$(-1.30,\ 3.90)$	No
$\mu_2 - \mu_4$	$(-2.30,\ 2.90)$	No
$\mu_2 - \mu_5$	$(-5.98, -0.78)$	Yes
$\mu_3 - \mu_4$	$(-3.60,\ 1.60)$	No
$\mu_3 - \mu_5$	$(-7.28, -2.08)$	Yes
$\mu_4 - \mu_5$	$(-6.28, -1.08)$	Yes

(c)

$\overline{x}_{1.}$	$\overline{x}_{3.}$	$\overline{x}_{4.}$	$\overline{x}_{2.}$	$\overline{x}_{5.}$
14.28	15.04	16.04	16.34	19.72

11.42 (a) H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4$, H_a: $\mu_i \neq \mu_j$ for some $i \neq j$, TS: $F = \text{MSA/MSE}$, RR: $F \geq 3.24$
$f = 7.05 \geq 3.24$. There is evidence to suggest at least two population means are different.

(b)

Difference	Bonferroni CI	Significantly different
$\mu_1 - \mu_2$	$(-11.24,\ -1.56)$	Yes
$\mu_1 - \mu_3$	$(\ -8.02,\ 1.66)$	No
$\mu_1 - \mu_4$	$(-11.06,\ -1.38)$	Yes
$\mu_2 - \mu_3$	$(\ -1.62,\ 8.06)$	No
$\mu_2 - \mu_4$	$(\ -4.66,\ 5.02)$	No
$\mu_3 - \mu_4$	$(\ -7.88,\ 1.80)$	No

(c)

Difference	Tukey CI	Significantly different
$\mu_1 - \mu_2$	$(-11.00,\ -1.80)$	Yes
$\mu_1 - \mu_3$	$(\ -7.78,\ 1.42)$	No
$\mu_1 - \mu_4$	$(-10.82,\ -1.62)$	Yes
$\mu_2 - \mu_3$	$(\ -1.38,\ 7.82)$	No
$\mu_2 - \mu_4$	$(\ -4.42,\ 4.78)$	No
$\mu_3 - \mu_4$	$(\ -7.64,\ 1.56)$	No

(d) The answers in (b) and (c) are the same. We expect this to happen.

11.43 H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4$, H_a: $\mu_i \neq \mu_j$ for some $i \neq j$, TS: $F = \text{MSA/MSE}$, RR: $F \geq 4.26$
$f = 19.51 \geq 4.26$. There is evidence to suggest at least two population means are different.

(b)

Difference	Tukey CI	Significantly different
$\mu_1 - \mu_2$	$(\ 0.39,\ 1.34)$	Yes
$\mu_1 - \mu_3$	$(-0.18,\ 0.76)$	No
$\mu_1 - \mu_4$	$(\ 0.75,\ 1.70)$	Yes
$\mu_2 - \mu_3$	$(-1.05, -0.10)$	Yes
$\mu_2 - \mu_4$	$(-0.11,\ 0.83)$	No
$\mu_3 - \mu_4$	$(\ 0.46,\ 1.41)$	Yes

(c) All differences are consistent, except between margarine, stick (68% fat) and margarine, tub (40% fat). We would expect evidence to suggest these two population means are different. The Tukey CI just barely includes 0.

Section 11.3

11.44 (a) 2, 3, 3 **(b)** $t_{11.} = 21$, $t_{12.} = 31$, $t_{13.} = 37$, $t_{21.} = 28$, $t_{22.} = 32$, $t_{23.} = 48$ **(c)** $t_{1..} = 89$, $t_{2..} = 108$, $t_{.1.} = 49$, $t_{.2.} = 63$, $t_{.3.} = 85$

11.45 (a)

Factor A \ Factor B	1	2	
1	$t_{11.} = 6.5$	$t_{12.} = 15.5$	$t_{1..} = 22.0$
2	$t_{21.} = 12.6$	$t_{22.} = 23.4$	$t_{2..} = 36.0$
3	$t_{31.} = 6.2$	$t_{32.} = 14.3$	$t_{3..} = 20.5$
4	$t_{41.} = 11.0$	$t_{42.} = 16.9$	$t_{4..} = 27.9$
	$t_{.1.} = 36.3$	$t_{.2.} = 70.1$	$t_{...} = 106.4$

(b) 424.82 **(c)** 71.04, 18.5525, 35.7013, 1.5563, 15.23

11.46 (a) $SST = 481.880$, $SSA = 160.820$, $SSB = 76.827$, $SS(AB) = 45.480$, $SSE = 198.753$
(b) $MSA = 53.6067$, $MSB = 38.4133$, $MS(AB) = 7.5800$, $MSE = 8.2814$ **(c)** $f_A = 6.47$, $f_B = 4.64$, and $f_{AB} = 0.92$ **(d)** $f_{AB} = 0.92$; There is no evidence of interaction. $f_A = 6.47 \geq 3.01$; There is evidence of an effect due to factor A. $f_B = 4.64 \geq 3.40$; There is evidence of an effect due to factor B.

11.47 (a)

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Factor A	297.51	2	148.76	10.47	0.0004
Factor B	86.69	2	43.34	3.05	0.0639
Interaction	26.40	4	6.60	0.46	0.7643
Error	383.73	27	14.21		
Total	794.33	35			

(b) $f_{AB} = 0.46$; There is no evidence of interaction. $f_A = 10.47 \geq 5.49$; There is evidence of an effect due to factor A. $f_B = 3.05$; There is no evidence of an effect due to factor B.

11.48

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Factor A	162.64	4	40.66	2.53	0.0476
Factor B	156.54	2	78.27	4.86	0.0103
Interaction	144.23	8	18.03	1.12	0.3596
Error	1206.87	75	16.09		
Total	1670.28	89			

$f_{AB} = 1.12$; There is no evidence of interaction. $f_A = 2.53 \geq 2.49$; There is evidence of an effect due to factor A. $f_B = 4.86 \geq 3.12$; There is evidence of an effect due to factor B.

11.49

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Factor A	121.25	4	30.31	1.57	0.1906
Factor B	91.12	4	22.78	1.18	0.3260
Interaction	174.55	16	10.91	0.57	0.8996
Error	1446.41	75	19.29		
Total	1833.33	99			

$f_{AB} = 0.57$; There is no evidence of interaction. $f_A = 1.57$; There is no evidence of an effect due to factor A. $f_B = 1.18$; There is no evidence of an effect due to factor B.

11.50 (a)

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Type	90.14	2	45.07	3.02	0.0580
Restaurant	266.49	3	88.83	5.96	0.0015
Interaction	56.59	6	9.43	0.63	0.7034
Error	715.60	48	14.91		
Total	1128.82	59			

(b) 60 **(c)** $f_{AB} = 0.63$; There is no evidence of interaction. The other two hypothesis tests can be conducted as usual. **(d)** $f_A = 3.02$; There is no evidence of an effect due to type. $f_B = 5.96 \geq 2.80$; There is evidence of an effect due to restaurant.

11.51 (a)

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Gender	16.33	1	16.33	4.03	0.0500
Job type	184.39	4	46.10	11.39	0.0000
Interaction	19.34	4	4.84	1.19	0.3249
Error	202.42	50	4.05		
Total	422.48	59			

(b) $f_{AB} = 2.39$; There is no evidence of interaction. **(c)** $f_A = 4.03 \geq 7.17$; There is evidence of an effect due to gender. $f_B = 11.39 \geq 3.72$; There is evidence of an effect due to job type.

11.52 $f_{AB} = 1.68$; There is no evidence of interaction. $f_A = 7.23 \geq 3.26$; There is evidence of an effect due to region. $f_B = 19.71 \geq 2.87$; There is evidence of an effect due to road marking quality.

11.53 $f_{AB} = 1.20$; There is no evidence of interaction. $f_A = 3.84$; There is no evidence of an effect due to location. $f_B = 1.09$; There is no evidence of an effect due to bank type.

11.54 (a)

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Injury	68.89	2	34.44	4.15	0.0239
State	4.76	3	1.59	0.19	0.9018
Interaction	93.55	6	15.59	1.88	0.1114
Error	298.72	36	8.30		
Total	465.91	47			

$f_{AB} = 1.88$; There is no evidence of interaction. **(b)** $f_A = 4.15 \geq 2.49$; There is evidence of an effect due to injury cause. $f_B = 0.19$; There is no evidence of an effect due to state.

11.55

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Megapixels	86.201	3	28.73	5.83	0.0039
Printer	2.101	1	2.10	0.43	0.5182
Interaction	6.011	3	2.00	0.41	0.7473
Error	118.315	24	4.93		
Total	212.629	31			

$f_{AB} = 0.41$; There is no evidence of interaction. $f_A = 5.83 \geq 3.01$; There is evidence of an effect due to megapixels. $f_B = 0.43$; There is no evidence of an effect due to printer.

11.56

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Temperature	36.847	2	18.42	8.07	0.0013
School	6.822	3	2.27	1.00	0.4040
Interaction	37.093	6	6.18	2.71	0.0283
Error	82.138	36	2.28		
Total	162.900	47			

$f_{AB} = 2.71 \geq 2.36$; There is evidence of interaction. $f_A = 8.07 \geq 3.26$; There is evidence of an effect due to temperature. $f_B = 1.00$; The effect due to school is inconclusive.

11.57

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Office	30.25	2	15.13	0.40	0.6761
Type	216.00	1	216.00	5.66	0.0286
Interaction	2.25	2	1.13	0.03	0.9705
Error	687.50	18	18.19		
Total	936.00	23			

$f_{AB} = 0.03$; There is no evidence of interaction. $f_A = 0.40$; There is no evidence of an effect due to office. $f_B = 5.66 \geq 3.55$; There is evidence of an effect due to type of development.

11.58 $f_{AB} = 0.34$; There is no evidence of interaction. $f_A = 0.26$; There is no evidence of an effect due to medication. $f_B = 17.93 \geq 4.08$; There is evidence of an effect due to type of care.

11.59 (a)

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Cover	1.5409	3	0.5137	0.87	0.4770
State	3.1184	3	1.0395	1.76	0.1953
Interaction	7.1078	9	0.7898	1.34	0.2919
Error	9.4550	16	0.5909		
Total	21.2222	31			

$f_{AB} = 1.34$; There is no evidence of interaction. **(b)** $f_A = 0.87$; There is no evidence of an effect due to cover type. $f_B = 1.76$; There is no evidence of an effect due to state.

11.60

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Age group	217.13	3	72.3750	6.98	0.0005
Dive type	2.25	1	2.2500	0.22	0.6409
Interaction	205.63	3	68.5417	6.61	0.0007
Error	580.75	56	10.3705		
Total	1005.75	63			

$f_{AB} = 6.61 \geq 6.23$; There is evidence of interaction. $f_A = 6.98 \geq 6.23$; There is evidence of an effect due to age group. $f_B = 0.22$; The effect due to dive type is inconclusive.

11.61

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Location	1995.1	1	1995.11	3.50	0.0712
Room type	7519.4	2	3759.69	6.60	0.0042
Interaction	117.1	2	58.53	0.10	0.9051
Error	17100.3	30	570.01		
Total	26731.9	35			

$f_{AB} = 0.10$; There is no evidence of interaction. **(b)** $f_A = 3.50$; There is no evidence of an effect due to location. $f_B = 6.60 \geq 3.32$; There is evidence of an effect due to room type. **(c)** On average, suburban, semiprivate four-bed rooms provide the smallest square footage per patient.

Chapter Exercises

11.62 (a)

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Factor	32.295	4	8.0737	0.77	0.5489
Error	470.355	45	10.4523		
Total	502.650	49			

(b) 5, 50 **(c)** $f = 0.77$; There is no evidence to suggest at least two of the population mean boat-ramp angles are different.

11.63

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Factor	106568	3	35522.67	4.67	0.0124
Error	151997	20	7599.85		
Total	258565	23			

$f = 4.67 \geq 3.03$; There is evidence to suggest at least two of the population mean wattages of spotlights are different.

11.64 H_0: $\mu_1 = \mu_2 = \mu_3$, H_a: $\mu_i \neq \mu_j$ for some $i \neq j$, TS: $F = \text{MSA}/\text{MSE}$, RR: $F \geq 6.36$
$f = 0.29$; There is no evidence to suggest at least two of the population mean generating capacities are different.

11.65

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Factor	3.7075	3	1.2358	1.67	0.1951
Error	20.6675	28	0.7381		
Total	24.3750	31			

H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4$, H_a: $\mu_i \neq \mu_j$ for some $i \neq j$, TS: $F = \text{MSA}/\text{MSE}$, RR: $F \geq 4.57$
$f = 1.67$; There is no evidence to suggest at least two of the population mean displacements are different.

11.66

Difference	Bonferroni CI	Significantly different
$\mu_1 - \mu_2$	$(-4.38,\ 8.58)$	No
$\mu_1 - \mu_3$	$(-4.08,\ 8.88)$	No
$\mu_1 - \mu_4$	$(1.62,\ 14.58)$	Yes
$\mu_2 - \mu_3$	$(-6.18,\ 6.78)$	No
$\mu_2 - \mu_4$	$(-0.48,\ 12.48)$	No
$\mu_3 - \mu_4$	$(-0.78,\ 12.18)$	No

$\overline{x}_{4.}$	$\overline{x}_{3.}$	$\overline{x}_{2.}$	$\overline{x}_{1.}$
98.2	104.3	104.6	106.7

11.67

Difference	Tukey CI	Significantly different
$\mu_1 - \mu_2$	$(-0.28,\ -0.02)$	Yes
$\mu_1 - \mu_3$	$(-0.19,\ 0.07)$	No
$\mu_1 - \mu_4$	$(-0.28,\ -0.02)$	Yes
$\mu_1 - \mu_5$	$(-0.29,\ -0.02)$	Yes
$\mu_2 - \mu_3$	$(-0.05,\ 0.21)$	No
$\mu_2 - \mu_4$	$(-0.13,\ 0.13)$	No
$\mu_2 - \mu_5$	$(-0.14,\ 0.12)$	No
$\mu_3 - \mu_4$	$(-0.21,\ 0.05)$	No
$\mu_3 - \mu_5$	$(-0.22,\ 0.04)$	No
$\mu_4 - \mu_5$	$(-0.14,\ 0.12)$	No

$\overline{x}_{1.}$	$\overline{x}_{3.}$	$\overline{x}_{2.}$	$\overline{x}_{4.}$	$\overline{x}_{5.}$
0.5566	0.6190	0.7020	0.7023	0.7115

11.68 **(a)** H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4$, H_a: $\mu_i \neq \mu_j$ for some $i \neq j$, TS: $F = \text{MSA}/\text{MSE}$, RR: $F \geq 3.13$
$f = 6.23 \geq 3.13$; There is evidence to suggest at least two of the population mean step heights are different.

(b)

Difference	Bonferroni CI	Significantly different
$\mu_1 - \mu_2$	$(0.0139,\ 0.2892)$	Yes
$\mu_1 - \mu_3$	$(-0.0346,\ 0.2407)$	No
$\mu_1 - \mu_4$	$(-0.0276,\ 0.2477)$	No
$\mu_2 - \mu_3$	$(-0.1862,\ 0.0892)$	No
$\mu_2 - \mu_4$	$(-0.1792,\ 0.0962)$	No
$\mu_3 - \mu_4$	$(-0.1307,\ 0.1447)$	No

$\overline{x}_{2.}$	$\overline{x}_{4.}$	$\overline{x}_{3.}$	$\overline{x}_{1.}$
0.2299	0.2714	0.2784	0.3815

11.69 **(a)** H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5$, H_a: $\mu_i \neq \mu_j$ for some $i \neq j$, TS: $F = \text{MSA}/\text{MSE}$, RR: $F \geq 2.57$
$f = 4.07 \geq 2.57$; There is evidence to suggest at least two of the population mean catfish weights are different. **(b)**

Difference	Tukey CI	Significantly different
$\mu_1 - \mu_2$	$(-33.32,\ 2.63)$	No
$\mu_1 - \mu_3$	$(-33.24,\ 3.46)$	No
$\mu_1 - \mu_4$	$(-36.41,\ -1.09)$	Yes
$\mu_1 - \mu_5$	$(-38.76,\ 1.28)$	No
$\mu_2 - \mu_3$	$(-16.45,\ 17.36)$	No
$\mu_2 - \mu_4$	$(-19.55,\ 12.74)$	No
$\mu_2 - \mu_5$	$(-22.10,\ 15.30)$	No
$\mu_3 - \mu_4$	$(-20.42,\ 12.70)$	No
$\mu_3 - \mu_5$	$(-22.91,\ 15.21)$	No
$\mu_4 - \mu_5$	$(-18.39,\ 18.40)$	No

$\overline{x}_{1.}$	$\overline{x}_{3.}$	$\overline{x}_{2.}$	$\overline{x}_{5.}$	$\overline{x}_{4.}$
20.70	35.59	36.05	39.44	39.45

Recommend Campground. On average, the largest catfish are caught at this location.

11.70 $f_{AB} = 1.78$; There is evidence of interaction. $f_A = 7.58 \geq 4.04$; There is evidence of an effect due to island. $f_B = 1.92$; There is no evidence of an effect due to season.

11.71 $f_{AB} = 2.34$; There is evidence of interaction. $f_A = 2.36$; There is no evidence of an effect due to species ID. $f_B = 5.48 \geq 3.35$; There is evidence of an effect due to age.

11.72

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Group	0.0161	3	0.0054	0.15	0.9287
Tooth type	0.7200	1	0.7200	19.84	0.0002
Interaction	0.0827	3	0.0276	0.76	0.5276
Error	0.8709	24	0.0363		
Total	1.6896	31			

There is no evidence of interaction. There is no evidence of an effect due to group. There is evidence of an effect due to tooth type.

11.73 (a)

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Style	0.0011	1	0.0011	0.13	0.7278
Brand	0.1241	3	0.0414	4.94	0.0315
Interaction	0.0131	3	0.0044	0.52	0.6803
Error	0.0671	8	0.0084		
Total	0.2053	15			

There is no evidence of interaction. There is no evidence of an effect due to style. There is evidence of an effect due to brand. **(b)** Chunky Jif. This combination of style and brand has the smallest mean.

Exercises′

11.74 (a) H_0: $\mu_1 - \mu_2 = 0$, H_a: $\mu_1 - \mu_2 \neq 0$

TS: $T = \frac{(\overline{X}_1 - \overline{X}_2) - 0}{\sqrt{S_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$, RR: $|T| \geq 2.0739$

$t = -2.3462 \leq -2.0739$. There is evidence to suggest the population mean widths are different. $p = 0.0284$.
(b) H_0: $\mu_1 = \mu_2$, H_a: $\mu_i \neq \mu_j$ for some $i \neq j$, TS: $F = \text{MSA}/\text{MSE}$, RR: $F \geq 4.28$
$f = 5.50 \geq 4.28$; There is evidence to suggest the population mean widths are different. $p = 0.0284$.
(c) $t^2 = f$. The p values are the same. And, yes, these values make sense.

11.75 (a) H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5$, H_a: $\mu_i \neq \mu_j$ for some $i \neq j$, TS: $F = \text{MSA}/\text{MSE}$, RR: $F \geq 2.70$
$f = 6.31 \geq 2.70$; There is evidence to suggest at least two of the population mean attenuation values are different. **(b)**

Difference	Bonferroni CI	Significantly different
$\mu_1 - \mu_2$	$(-1.6227, -0.3839)$	Yes
$\mu_1 - \mu_3$	$(-0.7677, 0.4711)$	No
$\mu_1 - \mu_4$	$(-1.0611, 0.1777)$	No
$\mu_1 - \mu_5$	$(-1.3327, -0.0939)$	Yes

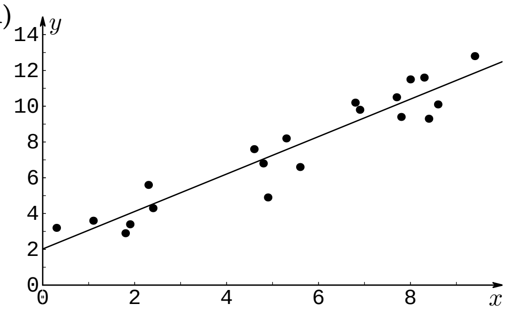
Chapter 12

Section 12.1

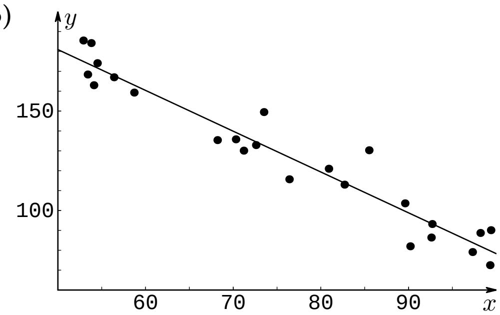
12.1 (a) Appropriate, slope negative. **(b)** Not appropriate, relationship is not linear.
(c) Appropriate, slope zero. **(d)** Not appropriate, no linear relationship.

12.2

(a)



(b)



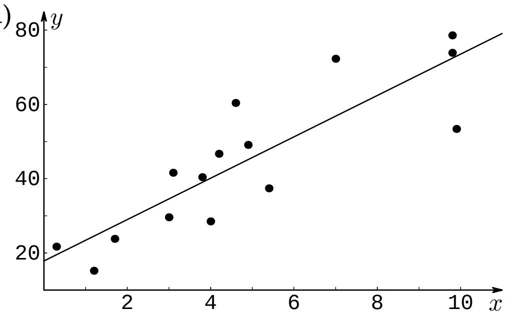
12.3 (a) 615 **(b)** 3.6 **(c)** 0.1217

12.4 (a) -232.38 **(b)** $(-7.2)(-5) = 36$ **(c)** 0.4941

12.5 (a) $y = 41.7004 - 14.8744x$ **(b)** -568.15

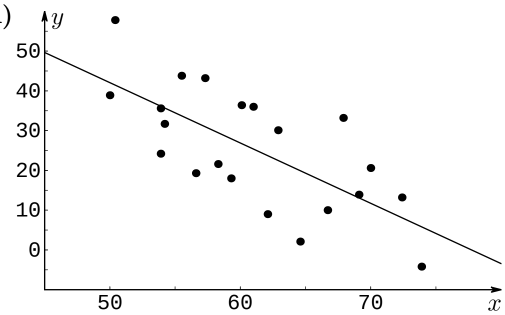
12.6

(a)



A simple linear regression model seems reasonable. The points appear to fall near a straight line.
(b) $y = 17.837 + 5.5714x$ **(c)** 49.594

12.7
(a)



A simple linear regression model seems reasonable. The points appear to fall near a straight line.
(b) $y = 117.91 - 1.5169x$ **(c)** 23.8622 **(d)**

Source of variation	Sum of squares	Degrees of freedom	Mean square	F
Regression	2290.75	1	2290.75	18.18
Error	2393.78	19	125.99	
Total	4684.53	20		

12.8 **(a)** 106 **(b)** 12.2 **(c)** 0.5287

12.9 **(a)** 2.45 **(b)** 0.90 **(c)** 0.4973

12.10 **(a)** 1.8845 **(b)** 1.2495 **(c)** 0.4090

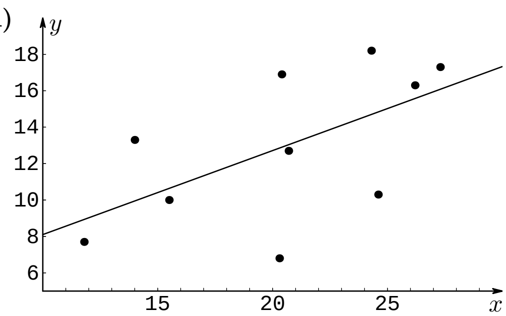
12.11 **(a)** $y = 3.7167 - 1.7016$ **(b)** 1.5897

12.12 **(a)** $y = 0.5739 + 0.0016x$ **(b)** 1.5226

12.13 **(a)** $y = 15.4209 - 3.0266x$ **(b)** 10.4270 **(c)** 9.7006

12.14 **(a)** $y = 24.4297 - 58.9778x$ **(b)** 6.7364 **(c)** 0.1599

12.15
(a)



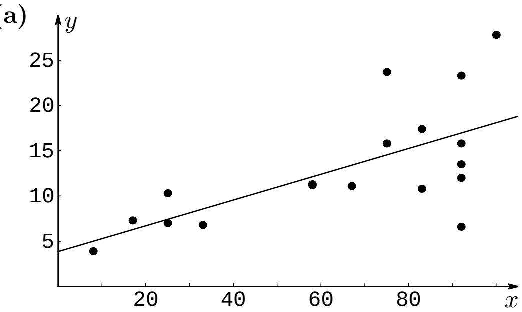
(b) $y = 3.4902 + 0.4612x$ **(c)** 11.7923

12.16 **(a)** $y = 1.3661 + 0.5227x$ **(b)** NOVA table:

Source of variation	Sum of squares	Degrees of freedom	Mean square	F
Regression	257.96	1	257.96	241.72
Error	8.54	8	1.07	
Total	266.50	9		

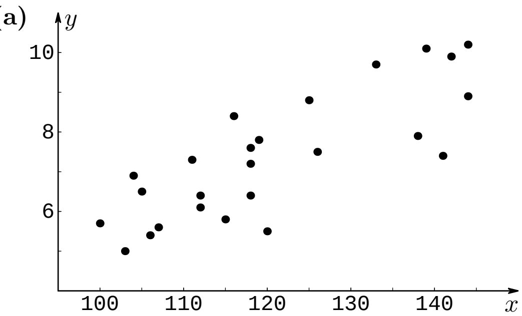
(c) 19.6606

12.17
(a)



(b) $y = 3.8619 + 0.1423x$ **(c)** 14.5344

12.18
(a)



(b) $y = -3.4739 + 0.0898x$ **(c)**

Source of variation	Sum of squares	Degrees of freedom	Mean square	F
Regression	38.55	1	38.55	43.01
Error	20.61	23	0.90	
Total	59.16	24		

(d) 6.5837

12.19 **(a)** $y = -0.8107 + 0.2683x$ **(b)**

Source of variation	Sum of squares	Degrees of freedom	Mean square	F
Regression	6.81	1	6.81	14.95
Error	10.02	22	0.46	
Total	16.83	23		

(c) $r^2 = 0.405$. Approximately 40% of the variation in the data is explained by the regression model.
(d) 40.2933

12.20 **(a)** $y = 0.4629 + 2.8059x$ **(b)**

Source of variation	Sum of squares	Degrees of freedom	Mean square	F
Regression	2.5478	1	2.5478	9.87
Error	2.5822	10	0.2582	
Total	5.1300	11		

(c) $r^2 = 0.497$. Approximately 50% of the variation in the data is explained by the regression model. **(d)** 1.26

12.21 **(a)** $y = -278.05 + 12.2867x$ **(b)**

Source of variation	Sum of squares	Degrees of freedom	Mean square	F
Regression	78681.22	1	78681.22	28.56
Error	77140.64	28	2755.02	
Total	155821.90	29		

(c) $r^2 = 0.505$. **(d)** 483.7254

Section 12.2

12.22 **(a)** ANOVA table:

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	11691.9	1	11691.90	2.58	0.1219
Error	104372.1	23	4537.92		
Total	116064.0	24			

(b) H_0: There is no significant linear relationship.
H_a: There is a significant linear relationship.
TS: $F = \text{MSR}/\text{MSE}$, RR: $F \geq 4.28$
$f = 2.58$. There is no evidence of a significant linear relationship. **(c)** 0.1007 **(d)** 0.3174

12.23 **(a)** ANOVA table:

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	2772.93	1	2772.93	7.26	0.0109
Error	12988.70	34	382.02		
Total	15761.63	35			

(b) H_0: There is no significant linear relationship.
H_a: There is a significant linear relationship.
TS: $F = \text{MSR}/\text{MSE}$, RR: $F \geq 7.44$
$f = 7.26$. There is no evidence of a significant linear relationship. **(c)** 0.1759 **(d)** $0.4194 > 0$. Positive relationship.

12.24 **(a)** H_0: $\beta_1 = 0$, H_a: $\beta_1 \neq 0$, TS: $T = B_1/S_{B_1}$, RR: $|T| \geq 2.0796$. $t = 2.2980 \geq 2.0796$. There is evidence to suggest that $\beta_1 \neq 0$, the regression line is significant. **(b)** $(0.4209, 8.4361)$ **(c)** Yes. The CI does not include 0.

12.25 **(a)** $y = 19.8108 - 1.0198x$

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	14.9084	1	14.9084	5.65	0.0634
Error	13.1891	5	2.6378		
Total	28.0975	6			

(b) H_0: $\beta_0 = 0$, H_a: $\beta_0 \neq 0$, TS: $T = B_0/S_{B_0}$, RR: $|T| \geq 6.8688$. $t = 13.3489 \geq 6.8688$. There is evidence to suggest $\beta_0 \neq 0$, the true regression line does not pass through the origin.
(c) $(13.8268, 25.7948)$

12.26 **(a)** H_0: There is no significant linear relationship. H_a: There is a significant linear relationship. TS: $F = \text{MSR}/\text{MSE}$, RR: $F \geq 4.60$
$f = 4.14$. There is no evidence of a significant linear relationship. $p > 0.05$, $p = 0.0614$
(b) H_0: $\beta_1 = 0$, H_a: $\beta_1 \neq 0$, TS: $T = B_1/S_{B_1}$, RR: $|T| \geq 2.1448$. $t = 2.0337$. There is no evidence to suggest that β_1 is different from 0. $0.05 \leq p \leq 0.10$. 0.0614 **(c)** $t^2 = f$ **(d)** Same. These two hypothesis tests are testing the same null hypothesis.

12.27 **(a)** 0.8771 **(b)** Positive.

12.28 **(a)** $y = 68.0071 - 8.7993x$

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	7462.54	1	7462.54	10.35	0.0324
Error	2884.77	4	721.19		
Total	10347.31	5			

(b) H_0: There is no significant linear relationship.
H_a: There is a significant linear relationship.
TS: $F = \text{MSR}/\text{MSE}$, RR: $F \geq 7.71$
$f = 10.35 \geq 7.71$. There is evidence of a significant linear relationship. **(c)** 0.7212 **(d)** -0.8492. Negative relationship. b_1 is negative. **(e)** $r^2 = 0.7212$

12.29 **(a)** $y = 2.3220 + 0.00093x$

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	2.2824	1	2.2824	9.55	0.0176
Error	1.6731	7	0.2390		
Total	3.9556	8			

(b) H_0: $\beta_1 = 0$, H_a: $\beta_1 \neq 0$, TS: $T = B_1/S_{B_1}$, RR: $|T| \geq 2.3646$. $t = 3.0902 \geq 2.3646$. There is evidence to suggest that β_1 is different from 0.
(c) 0.5770

12.30 **(a)** $y = 980.0067 + 0.4795x$

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	24472.35	1	24472.35	8.32	0.0344
Error	14705.08	6	2941.02		
Total	39177.43	7			

(b) 0.6247 **(c)** $(-0.1907, 1.1497)$ **(d)** H_0: $\beta_0 = 0$, H_a: $\beta_0 > 0$, TS: B_0/S_{B_0}, RR: $T \geq 1.9432$ ($\alpha = 0.05$). $t = 22.5921 \geq 1.9432$. There is evidence to suggest $\beta_0 > 0$. This suggests that even if the owner spends nothing on advertising in a week, he/she will still have a total weekly revenue greater than 0, close to 980.

12.31 **(a)** $y = 2.9430 + 0.6925x$

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	0.1062	1	0.1062	0.40	0.5403
Error	3.4909	13	0.2685		
Total	3.5971	14			

(b) H_0: There is no significant linear relationship.
H_a: There is a significant linear relationship.
TS: $F = \text{MSR/MSE}$, RR: $F \geq 9.07$
$f = 0.40$. There is no evidence of a significant linear relationship. **(c)** $(-6.7570, 12.6430)$. No. The CI includes 0.

12.32 **(a)** $y = 75.3352 + 321.5880x$

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	1960.94	1	1960.94	5.20	0.0350
Error	6785.50	18	376.97		
Total	8746.44	19			

(b) H_0: There is no significant linear relationship.
H_a: There is a significant linear relationship.
TS: $F = \text{MSR/MSE}$, RR: $F \geq 4.41$ ($\alpha = 0.05$)
$f = 5.20 \geq 4.41$. There is evidence of a significant linear relationship. $0.01 \leq p \leq 0.05$
(c) H_0: $\beta_1 = 320$, H_a: $\beta_1 \neq 320$,
TS: $T = (B_1 - 320)/S_{B_1}$, RR: $|T| \geq 2.1199$.
$t = 0.0113$. There is no evidence to suggest β_1 is different from 320. **(d)** $(-90.2444, 733.4210)$

12.33

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	108.54	1	108.54	8.34	0.0277
Error	78.06	6	13.01		
Total	186.60	7			

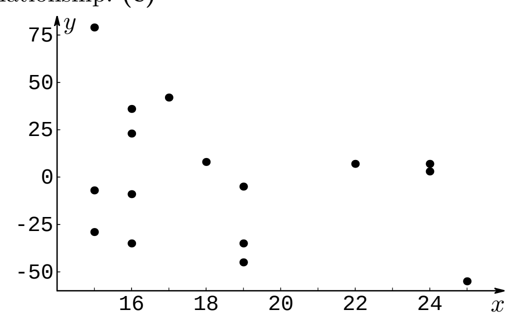
(b) H_0: There is no significant linear relationship.
H_a: There is a significant linear relationship.
TS: $F = \text{MSR/MSE}$, RR: $F \geq 4.41$ ($\alpha = 0.05$)
$f = 8.34 \geq 4.41$. There is evidence of a significant linear relationship. $0.01 \leq p \leq 0.05$
(c) $(-0.1551, -0.0128)$

12.34 **(a)** $y = 1.9195 + 2.7096x$
(b) H_0: $\beta_1 = 0$, H_a: $\beta_1 \neq 0$, TS: $T = B_1/S_{B_1}$, RR: $|T| \geq 2.1788$. $t = 2.3928 \geq 2.1788$. There is evidence to suggest that β_1 is different from 0.
(c) 3.4097 **(d)** 0.3230. Obtain more data.

12.35 **(a)** $y = 58.2111 - 3.1972x$

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	1840.00	1	1840.00	1.55	0.2339
Error	16642.94	14	1188.78		
Total	18482.94	15			

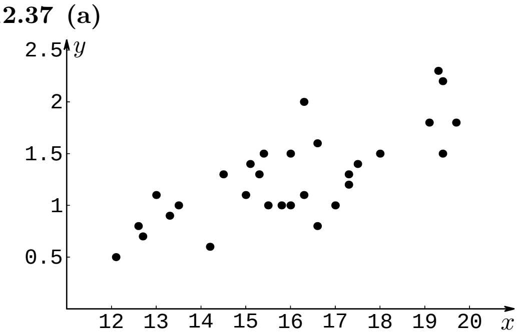
(b) H_0: There is no significant linear relationship.
H_a: There is a significant linear relationship.
TS: $F = \text{MSR/MSE}$, RR: $F \geq 8.86$
$f = 1.55$. There is no evidence of a significant linear relationship. **(c)**



$r = -0.3155$ **(d)** No. There is no evidence of a significant linear relationship.

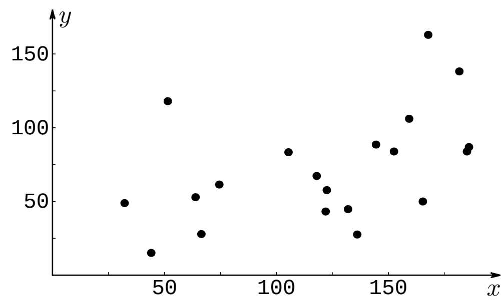
12.36 **(a)** -0.6434 **(b)** Negative relationship. As mean annual temperature increases, the depth of the permafrost layer decreases.

12.37 **(a)**



(b) 0.7548 **(c)** Positive relationship. As the weight increases, the copper content increases.
(d) Independent variable: weight. Dependent variable: copper content.

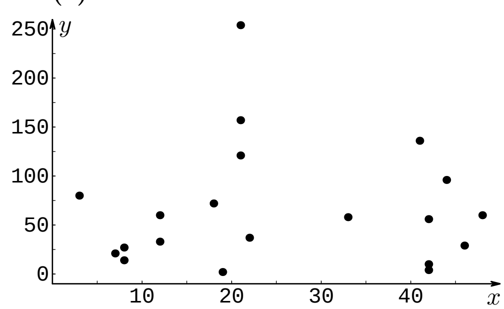
12.38 (a)



(b) 0.4794 **(c)** Support. There is a slight positive relationship.

12.39 (a) 0.4303. There is a slight positive relationship. **(b)** $y = 370.2037 + 92.7141x$.
H_0: There is no significant linear relationship.
H_a: There is a significant linear relationship.
TS: $F = \text{MSR}/\text{MSE}$, RR: $F \geq 4.67$
$f = 2.95$. There is no evidence of a significant linear relationship. $p > 0.05$. **(c)** No. There is no evidence of a significant linear relationship.

12.40 (a)



(b) 0.0101. There is no clear relationship.

12.41 (a) $y = 0.1719 + 0.1157x$

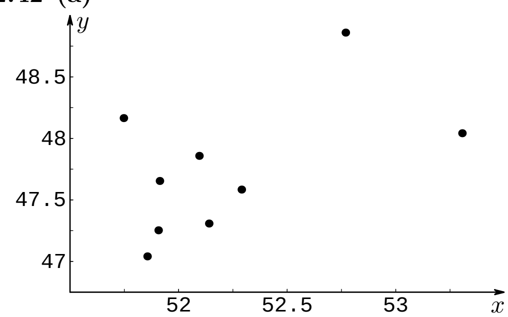
Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	0.3660	1	0.3660	11.67	0.0051
Error	0.3762	12	0.0313		
Total	0.7421	13			

(b) $y = 0.0895 + 0.0087x$

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	0.0246	1	0.0246	0.41	0.5334
Error	0.7176	12	0.0598		
Total	0.7421	13			

(c) Evaporation rate and air velocity. There is a significant linear relationship.

12.42 (a)



(b) 0.5238. As men's time increases, women's time increases.

Section 12.3

12.43 (a) H_0: $y^* = 20$, H_a: $y^* > 20$,
TS: $T = \frac{(B_0 + B_1 x^*) - y_0^*}{S\sqrt{(1/n) + [(x^* - \overline{x})^2 / S_{xx}]}}$, RR: $T \geq 1.7459$
$t = 0.1503$. There is no evidence to suggest the mean value of Y for $x = 16.2$ is greater than 20.
(b) H_0: $y^* = 5$, H_a: $y^* \neq 5$,
TS: $T = \frac{(B_0 + B_1 x^*) - y_0^*}{S\sqrt{(1/n) + [(x^* - \overline{x})^2 / S_{xx}]}}$, RR: $|T| \geq 2.9208$
$t = -0.1240$. There is no evidence to suggest the mean value of Y for $x = 11.5$ is greater than 5.

12.44 (a) $(-100.3043, -94.0097)$, 6.2946
(b) $(-103.2959, -94.4725)$, 8.8233 **(c)** 31.9 is farther from the mean, $\overline{x} = 30.891$, than 31.5.

12.45 (a) $(-20.1474, 123.4294)$, 143.5768
(b) $(-23.8157, 123.7581)$, 147.5738 **(c)** 18.1 is farther from the mean than 19.25.

12.46 (a) $y = -0.9215 + 1.2552x$

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	29.3171	1	29.3271	4.65	0.0745
Error	37.8679	6	6.3113		
Total	67.1950	7			

H_0: There is no significant linear relationship.
H_a: There is a significant linear relationship.
TS: $F = \text{MSR}/\text{MSE}$, RR: $F \geq 5.99$ ($\alpha = 0.05$)

$f = 4.65$. There is no evidence of a significant linear relationship. **(b)** 2.5122 **(c)** H_0: $y^* = 4$, H_a: $y^* > 4$,
TS: $T = \frac{(B_0+B_1x^*)-y_0^*}{S\sqrt{(1/n)+[(x^*-\overline{x})^2/S_{xx}]}}$, RR: $T \geq 1.9432$
$t = 2.7188$. There is evidence to suggest the mean value of Y for $x = 6$ is greater than 4.
(d) $(1.9432, 2.4469)$

12.47 **(a)** $y = 398.6420 - 8.3856x$

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	11954.82	1	11954.82	13.51	0.0028
Error	11502.28	13	884.79		
Total	23457.09	14			

H_0: There is no significant linear relationship.
H_a: There is a significant linear relationship.
TS: $F = \text{MSR/MSE}$, RR: $F \geq 9.07$
$f = 13.51$. There is evidence of a significant linear relationship. **(b)** 29.7454 **(c)** $(16.0985, 160.6499)$. Yes. The PI is completely below 170.

12.48 **(a)** 25.9355 **(b)** H_0: $y^* = 3.5$, H_a: $y^* > 3.5$,
TS: $T = \frac{(B_0+B_1x^*)-y_0^*}{S\sqrt{(1/n)+[(x^*-\overline{x})^2/S_{xx}]}}$, RR: $T \geq 1.7396$
$t = 2.5300 \geq 1.7396$. There is evidence to suggest the mean value of Y for $x = 2.5$ is greater than 3.5.
(c) $(0.1258, 54.7307)$. No. The CI includes 25.

12.49 **(a)** 22.8726 **(b)** $(18.5067, 27.2385)$
(c) H_0: $y^* = 30$, H_a: $y^* > 30$,
TS: $T = \frac{(B_0+B_1x^*)-y_0^*}{S\sqrt{(1/n)+[(x^*-\overline{x})^2/S_{xx}]}}$, RR: $T \geq 2.6245$
$t = -1.2783$. There is no evidence to suggest the mean value of Y for $x = 0.55$ is greater than 30.

12.50 **(a)** 0.6467 **(b)** $(0.6115, 0.9495)$
(c) H_0: $y^* = 0.06$, H_a: $y^* > 0.06$,
TS: $T = \frac{(B_0+B_1x^*)-y_0^*}{S\sqrt{(1/n)+[(x^*-\overline{x})^2/S_{xx}]}}$, RR: $T \geq 2.5395$
$t = 6.6636 \geq 2.5395$. There is evidence to suggest the mean value of Y for $x = 0.06$ is greater than 0.06.

12.51 **(a)** ANOVA summary table:

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	0.031175	1	0.031175	9.11	0.0051
Error	0.102625	30	0.003421		
Total	0.133800	31			

H_0: There is no significant linear relationship.
H_a: There is a significant linear relationship.
TS: $F = \text{MSR/MSE}$, RR: $F \geq 4.17$ ($\alpha = 0.05$)
$f = 9.11 \geq 4.17$. There is evidence of a significant linear relationship. As muscle density increases, so does the HOMA score. **(b)** 0.8048 **(c)** $(0.6272, 0.9830)$

12.52 **(a)** ANOVA summary table:

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	853.50	1	853.50	8.99	0.0103
Error	1234.23	13	94.94		
Total	2087.73	14			

H_0: There is no significant linear relationship.
H_a: There is a significant linear relationship.
TS: $F = \text{MSR/MSE}$, RR: $F \geq 4.67$ ($\alpha = 0.05$)
$f = 8.99 \geq 4.67$. There is evidence of a significant linear relationship. As CPI increases, so does ESI.
(b) 56.8902 **(c)** $(40.1554, 87.2630)$. No. The PI does not include 90.

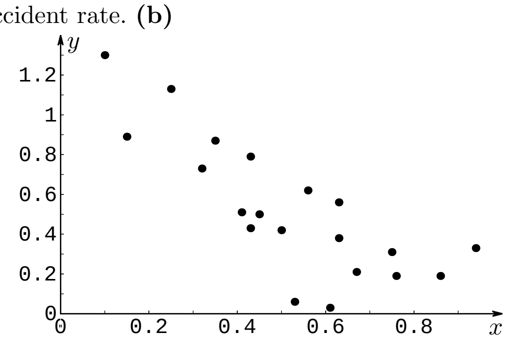
12.53 **(a)** $3.5699 + 0.0021x$ **(b)** ANOVA table:

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	0.8000	1	0.8000	0.15	0.7089
Error	48.4655	9	5.3851		
Total	49.2655	10			

H_0: There is no significant linear relationship.
H_a: There is a significant linear relationship.
TS: $F = \text{MSR/MSE}$, RR: $F \geq 5.12$ ($\alpha = 0.05$)
$f = 0.15$. There is no evidence of a significant linear relationship. No. **(c)** $(-0.3878, 11.7276)$. This PI includes some negative numbers.

12.54 **(a)** $y = 3.2768 + 1.6068x$ **(b)** 35.4128
(c) H_0: $y^* = 52$, H_a: $y^* < 52$,
TS: $T = \frac{(B_0+B_1x^*)-y_0^*}{S\sqrt{(1/n)+[(x^*-\overline{x})^2/S_{xx}]}}$, RR: $T \leq -1.7613$
($\alpha = 0.05$)
$t = -0.0274$. There is no evidence to suggest the mean value of Y for $x = 30$ is less than 52. $p = 0.4893$.

12.55 **(a)** Independent: skid resistance. Dependent: accident rate. **(b)**

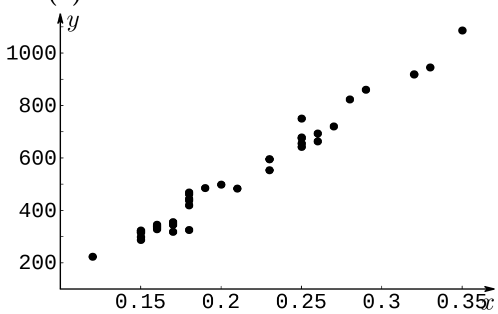


(c) $y = 1.1570 - 1.2285x$
(d) H_0: $y^* = 0.60$, H_a: $y^* < 0.60$,

TS: $T = \frac{(B_0+B_1x^*)-y_0^*}{S\sqrt{(1/n)+[(x^*-\overline{x})^2/S_{xx}]}}$, RR: $T \le -1.7341$ $(\alpha = 0.05)$

$t = -1.1942$. There is no evidence to suggest the mean value of Y for $x = 0.50$ is less than 0.60.

12.56 (a)



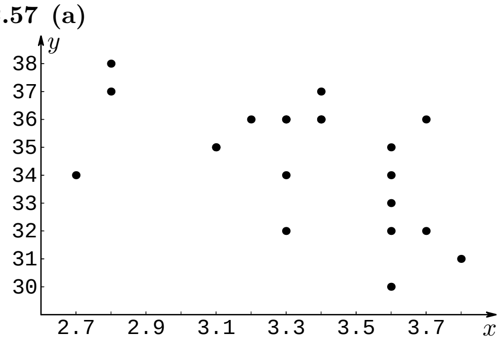
Positive linear relationship.

(b) $y = -259.6269 + 3721.0249x$. No. The line should go through the origin. **(c)** H_0: There is no significant linear relationship. $H_{\rm a}$: There is a significant linear relationship. TS: $F = \text{MSR}/\text{MSE}$, RR: $F \ge 4.05$ $(\alpha = 0.05)$

$f = 2069.99 \ge 4.05$. There is evidence of a significant linear relationship. $p < 0.0001$

(d) $(472.1962, 496.9619)$ **(e)** No. The CI includes 480.

12.57 (a)

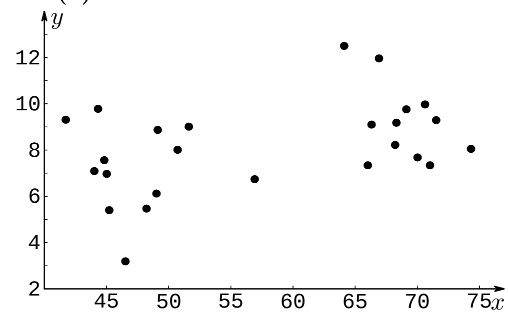


Slight negative relationship. **(b)** $y = 46.91 - 3.70x$ **(c)** $(27.5775, 38.8625)$ **(d)** $(29.2183, 40.1817)$ **(e)** 3.3 is farther from the mean than 3.7.

12.58 (a) $y = 4.5280 + 0.0005x$. As distance increases, so does the cost. **(b)** H_0: There is no significant linear relationship. $H_{\rm a}$: There is a significant linear relationship. TS: $F = \text{MSR}/\text{MSE}$, RR: $F \ge 4.96$ $(\alpha = 0.05)$

$f = 0.3445$. There is no evidence of a significant linear relationship. $p = 0.5702$

12.59 (a)



Slight positive relationship. **(b)** $y = 3.8228 + 0.0751x$ **(c)** $(5.6068, 14.0548)$ **(d)** $(4.3899, 12.2677)$

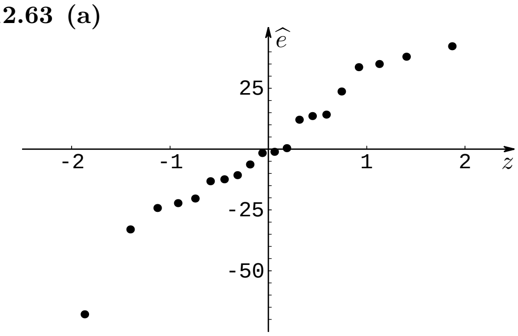
Section 12.4

12.60 (a) 8.8557, −6.3342, −9.6692, −8.6693, −6.7549, 4.3457, 10.7254, 7.5009 **(b)** 0

12.61 (a) −0.9898, −3.0005, 3.1773, 0.1760, 2.5243, 0.7085, −0.0552, 2.0344, −0.7423, 1.0185, −0.3370, −3.5615, −2.0149, 0.4089, −0.2852, 0.9385 **(b)** 0

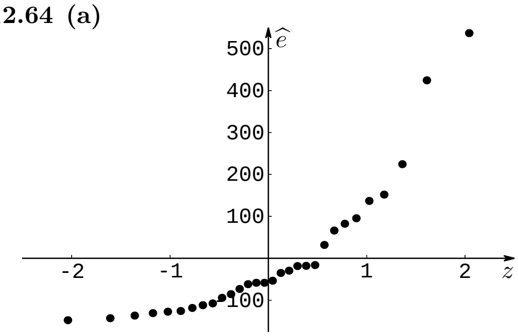
12.62 (a) No **(b)** Yes **(c)** Yes **(d)** No

12.63 (a)



(b) Some. There appears to be an outlier, and the points are slightly wavy.

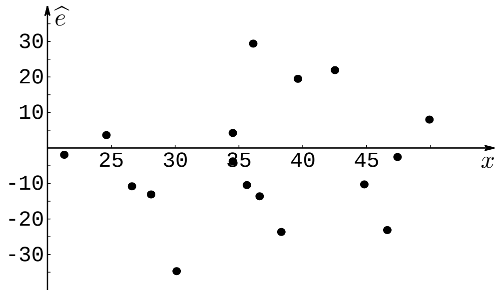
12.64 (a)



(b) Yes. There is a definite curved pattern.

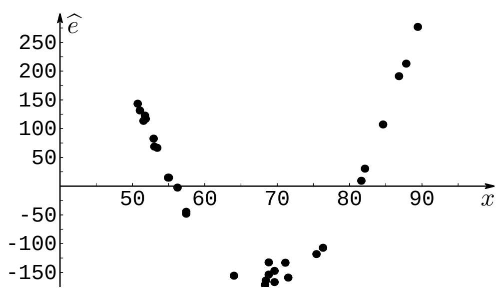
12.65 (a) Yes. The graph suggests the relationship is not linear. **(b)** Yes. The graph suggests the variance is not constant. **(c)** Yes. The graph suggests the relationship is not linear. **(d)** Maybe. There is some evidence the variance is not constant, increases as x increases.

12.66 **(a)** 29.4156, −23.1316, −13.0912, −3.76574, −10.2607, 4.23426, −10.7988, −23.6600, −34.7145, −1.91207, 8.00498, −13.6152, 3.62451, −10.4535, 61.2238, −2.54092, 21.9411, 19.4999 **(b)**



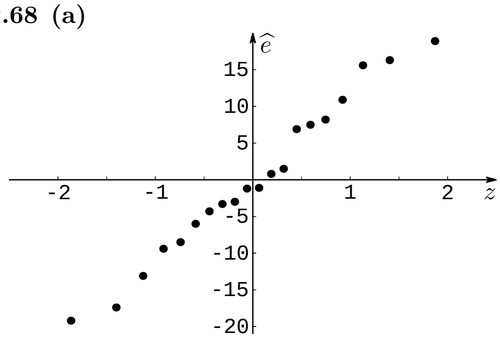
There is no overwhelming evidence of a violation in the regression assumptions. The points appear to be random.

12.67 **(a)** $y = 463.3508 - 3.5333x$ **(b)** −159.0214, 14.7795, 213.0710, 191.2377, −132.5613, −164.1746, −166.8346, 30.4313, 276.9243, −133.1347, 107.2645, −2.4806, −147.3346, −118.1416, −47.9406, 68.8129, −153.7613, 122.7197, 113.5130, −44.5406, −171.5279, 143.3864, 9.3647, 131.6464, 14.8262, 66.6262, 117.0730, −107.1617, 82.6596, −155.7210 **(c)**



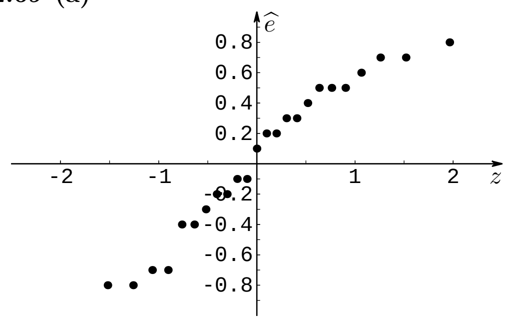
There is evidence to suggest a violation in the regression assumptions. There is a distinct curve in the plot.

12.68 **(a)**



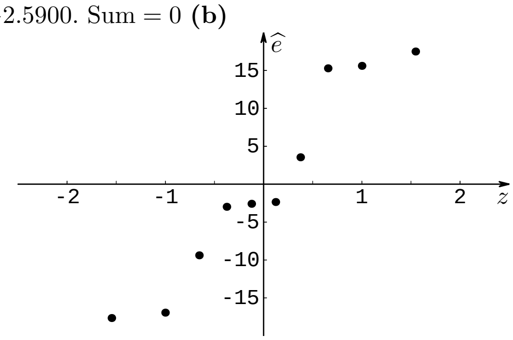
(b) There is no overwhelming evidence that the random error terms are not normal. The points fall along a fairly straight line.

12.69 **(a)**



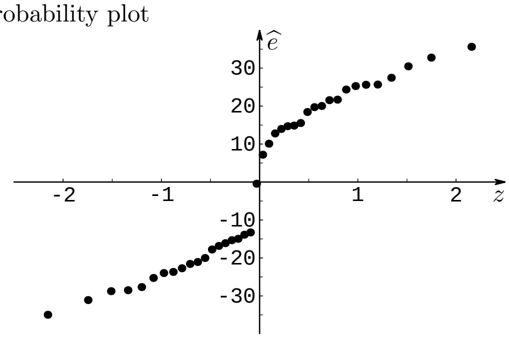
There is some evidence of non normality.

12.70 **(a)** 15.2847, 17.5013, −16.9531, −9.3904, 15.6096, −17.6644, 3.5458, −2.3565, −2.9870, −2.5900. Sum = 0 **(b)**

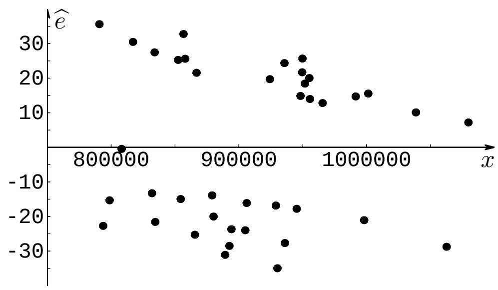


There is evidence to suggest the random error terms are not normal. There is a nonlinear pattern in the graph.

12.71 **(a)** $y = 5.167703 + 0.000119x$ **(b)** Normal probability plot

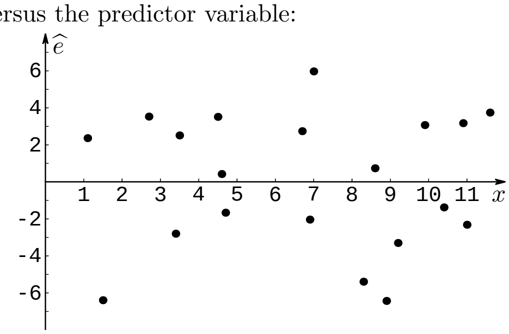


Residuals versus the predictor variable:



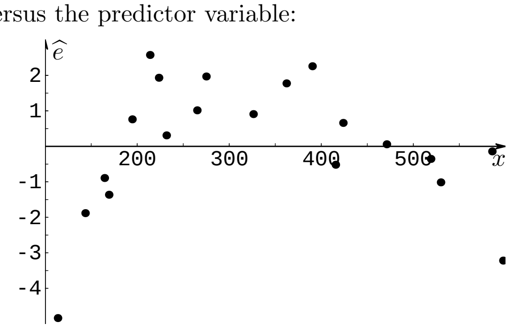
(c) There is evidence to suggest the simple linear regression assumptions are invalid. There is a distinct pattern in the normal probability plot and in the plot of the residuals versus the predictor variable.

12.72 **(a)** 3.7425, −1.3811, 3.5112, −6.3979, 2.3609, 5.9687, −5.3974, 3.0674, −2.0416, 0.4215, 3.5257, −2.8021, 2.5082, 2.7378, −6.4356, −2.3193, −1.6682, −3.3047, 0.7335, 3.1704. Sum = 0 **(b)** Residuals versus the predictor variable:



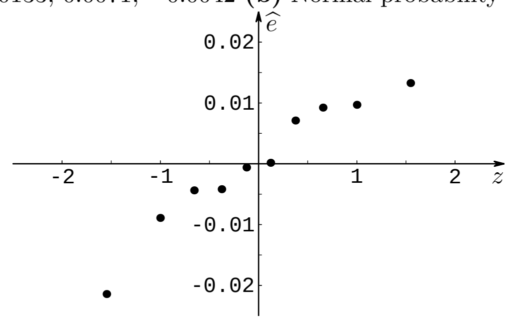
There is no evidence that the simple linear regression assumptions are invalid. There is no discernible pattern in the graph.

12.73 **(a)** −0.5180, 1.7744, −1.0140, 2.2575, 0.9086, −0.8920, 0.6604, −1.3632, −4.8381, 1.9684, 1.0153, −3.2186, 0.7614, −0.3538, −0.1420, 2.5750, 0.3094, −1.8818, 0.0585, 1.9326. Sum = 0 **(b)** Residuals versus the predictor variable:

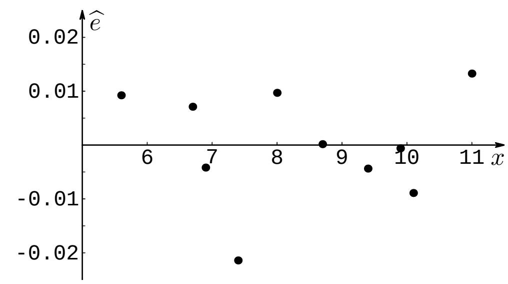


There is evidence that the simple linear regression assumptions are violated. There is a pattern in the graph.

12.74 **(a)** $y = 0.0535 + 0.0065x$. Residuals: 0.0092, −0.0214, 0.0097, 0.0002, −0.0089, −0.0006, −0.0044, 0.0133, 0.0071, −0.0042 **(b)** Normal probability plot:

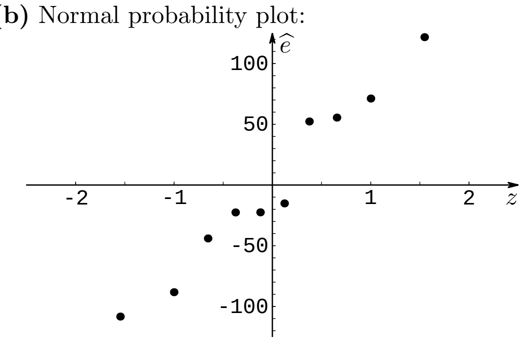


Residuals versus the predictor variable:

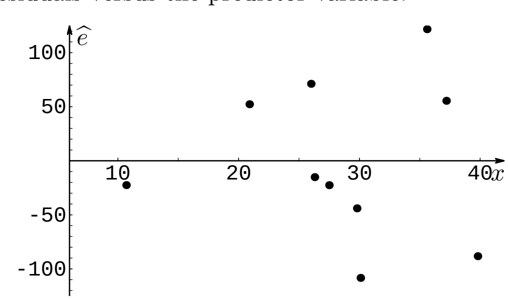


(c) There is no overwhelming evidence to suggest the simple linear regression assumptions are invalid.

12.75 **(a)** $y = 738.0426 + 14.5283x$. Residuals: −43.9849, −15.1359, 71.2226, 55.5060, −108.3433, 52.3167, −22.5698, −88.2675, −22.4950, 121.7512 **(b)** Normal probability plot:

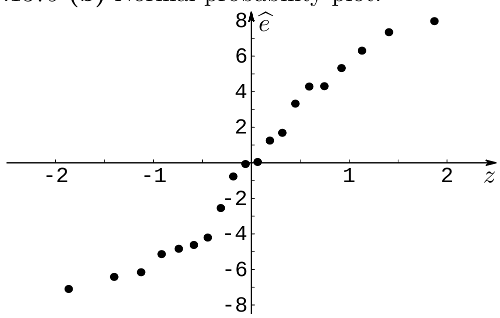


Residuals versus the predictor variable:

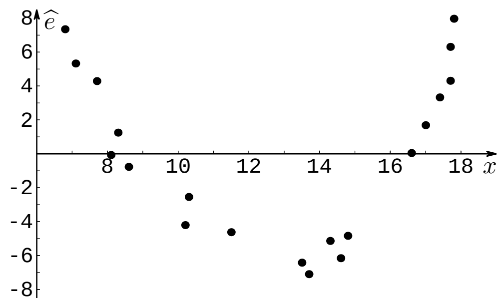


(c) No overwhelming evidence the simple linear regression assumptions are invalid. There is a possible outlier, but the number of observations is small.

12.76 **(a)** $y = -8.4546 + 3.3981x$. Residuals: 6.3086, 5.3283, −4.8369, −0.0698, −0.7688, 4.2894, −6.1573, 3.3281, 7.3477, −2.5456, −6.4194, −4.2058, 1.2506, 7.9688, −7.0991, 0.0465, −4.6233, 4.3086, 1.6873, −5.1379 **(b)** Normal probability plot:

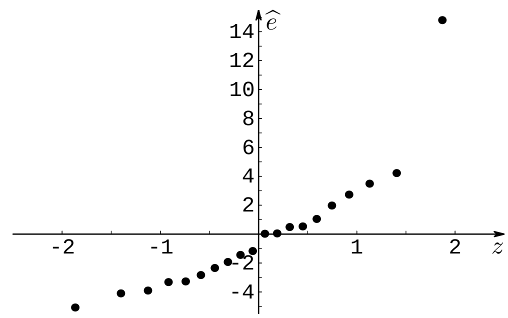


Residuals versus the predictor variable:

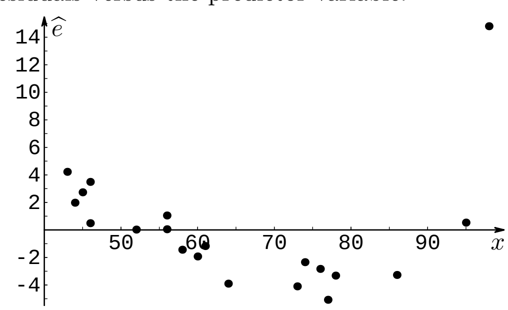


(c) There is evidence to suggest the simple linear regression assumptions are invalid. The normal probability plot is nonlinear. The residuals versus the predictor variable plot has a distinct nonlinear pattern. To improve the regression model, add a quadratic term.

12.77 **(a)** $y = 187.2849 + 0.2440x$. Residuals: −1.4383, −4.0986, 0.0498, −2.3426, 4.2221, 0.4900, −3.9024, 0.5329, 1.9781, −3.3187, −5.0747, 0.0259, −1.9263, 14.8008, 3.4900, −3.2709, 1.0498, −1.1703, −2.8307, 2.7340 **(b)** H_0: There is no significant linear relationship. H_a: There is a significant linear relationship. TS: $F = \text{MSR}/\text{MSE}$, RR: $F \geq 8.29$ $f = 16.19 \geq 8.29$. There is evidence of a significant linear relationship. **(c)** Normal probability plot:

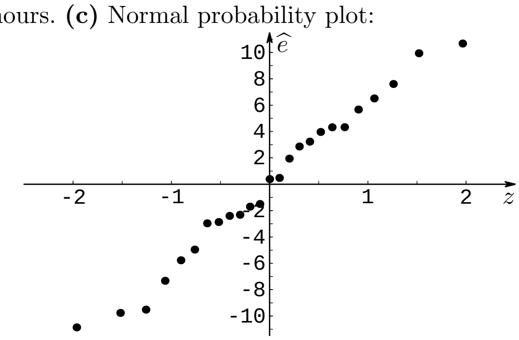


Residuals versus the predictor variable:

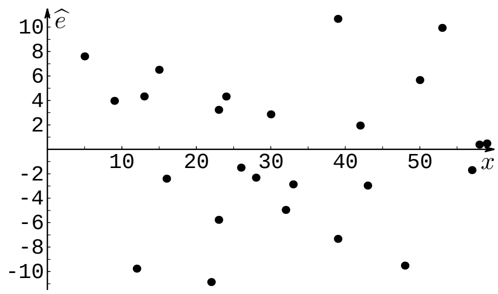


(d) There is evidence to suggest the simple linear regression assumptions are invalid. Both plots suggest there is an outlier, and the residuals versus the predictor variable plot suggests a parabolic pattern. We might try excluding the outlier from the data set, or adding a quadratic term to the model.

12.78 **(a)** $y = 29.8441 + -0.0902x$. Residuals: −2.3173, 0.4801, 4.3291, 5.6679, −5.7685, −2.4002, −2.9638, 4.3217, −9.5126, 9.9386, 2.8631, −10.8588, 10.6753, −7.3247, 3.9681, 6.5095, 3.2315, 7.6071, −4.9564, −9.7612, −1.4978, −1.7004, 1.9460, −2.8662, 0.3898 **(b)** H_0: There is no significant linear relationship. H_a: There is a significant linear relationship. TS: $F = \text{MSR}/\text{MSE}$, RR: $F \geq 2.94$ $f = 1.36$. There is no evidence of a significant linear relationship. There does not appear to be a relationship between commuting distance and sick hours. **(c)** Normal probability plot:



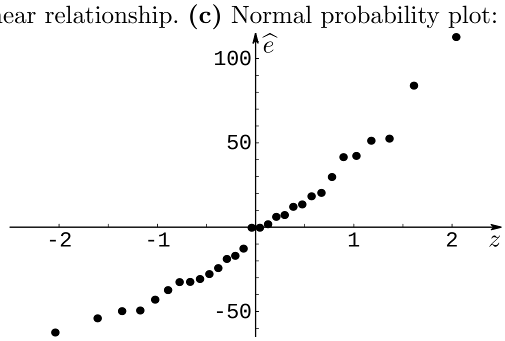
Residuals versus the predictor variable:



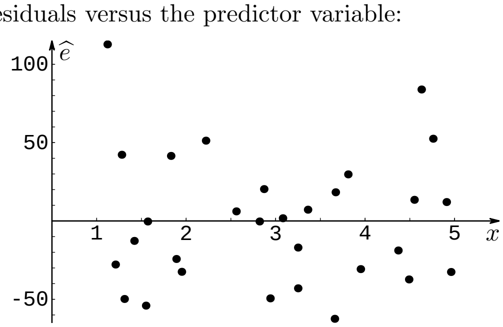
(d) The graphs do not provide any evidence that the simple linear regression assumptions are invalid. The normal probability plot is approximately linear, and the residuals versus the predictor variable plot exhibits no discernible pattern.

12.79 **(a)** $y = 19.3238 + 24.7881x$. Residuals: 18.3040, 41.5141, 112.7136, −32.5726, −18.8476, −32.4605, −37.3222, 13.4905, 12.0668, 52.4850, 1.7290, 7.1883, 29.7337, −49.4007, −12.7228, −16.9850, −30.7366, −0.3410, −54.0453, 51.2467, 20.3345, −0.3261, −42.9850, −24.2732, 42.2475, −62.4481, 6.1188, −49.7961, −27.8173, 83.9075 **(b)** H_0: There is no significant linear relationship. H_a: There is a significant linear relationship. TS: $F = \text{MSR}/\text{MSE}$, RR: $F \geq 13.50$

$f = 15.61 \geq 13.50$. There is evidence of a significant linear relationship. **(c)** Normal probability plot:



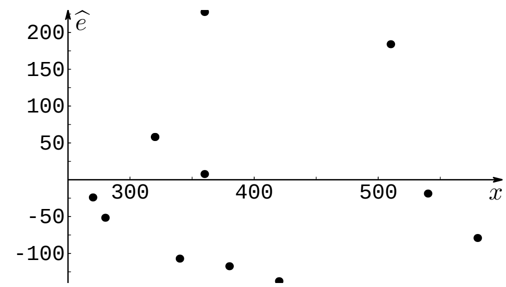
Residuals versus the predictor variable:



(d) The graphs do not provide any evidence that the simple linear regression assumptions are invalid. The normal probability plot is approximately linear, and the residuals versus predictor variable plot exhibits no discernible pattern.

12.80 **(a)** $y = -120.7330 + 2.7583x$. Residuals: −51.5881, −117.4171, 58.0803, 227.7487, 58.0803, −107.0855, −137.7487, 184.0052, 7.7487, −24.0052, −79.0750, −18.7435 **(b)** H_0: There is no significant linear relationship. H_a: There is a significant linear relationship. TS: $F = \text{MSR}/\text{MSE}$, RR: $F \geq 4.96$ $(\alpha = 0.05)$

$f = 59.47 \geq 4.96$. There is evidence of a significant linear relationship. $p < 0.001$ **(c)** Residuals versus the predictor variable:



This graph presents no evidence to suggest that the simple linear regression assumptions are invalid. There is no discernible pattern.

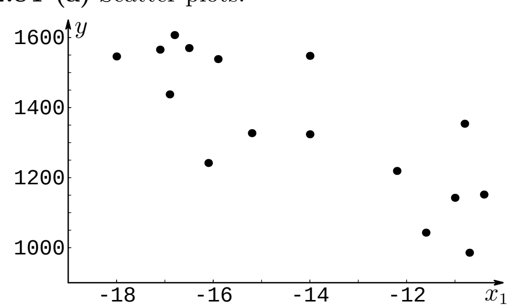
Section 12.5

12.81 **(a)** 482.4 **(b)** As x_1 increases, y increases. **(c)** −5.3 **(d)** 0.1680

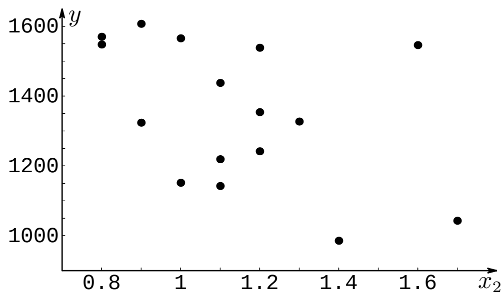
12.82 **(a)** −49.55 **(b)** −23.5 **(c)** 0.8625

12.83 **(a)** $y = 12.7786 + 1.9638x_1 + 7.4479x_2$ **(b)** 168.2178

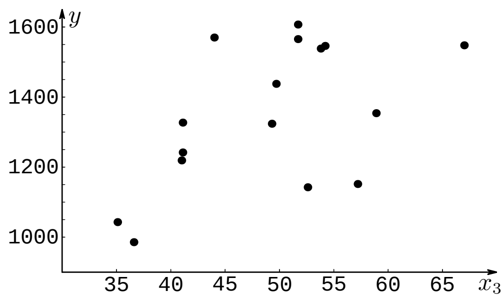
12.84 **(a)** Scatter plots:



Negative relationship.



Negative relationship.



Positive relationship.
(b) $y = 221.9231 - 56.3497x_1 - 124.2215x_2 + 9.5798$. The sign of each estimated regression coefficient reflects the relationship in each scatter plot.
(c) 1121.6179

12.85 **(a)** ANOVA summary table:

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	71.75	5	14.35	3.02	0.0394
Error	80.75	17	4.75		
Total	152.50	22			

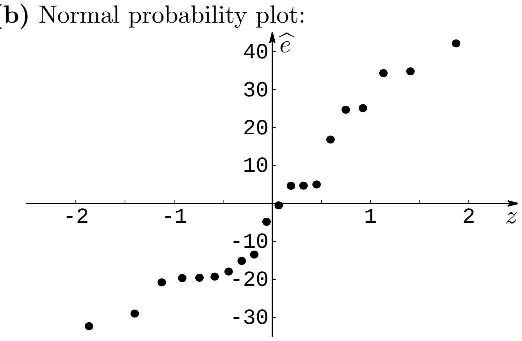
(b) 5 **(c)** H_0: $\beta_1 = \cdots = \beta_5 = 0$, H_a: $\beta_i \neq 0$ for at least one i, TS: $F = \text{MSR/MSE}$, RR: $F \geq 2.81$. $f = 3.02 \geq 2.81$. There is evidence to suggest that at least one of the regression coefficients is different from 0. $0.01 \leq p \leq 0.05$ **(d)** $r^2 = 0.4705$. Approximately 47% of the variation in y is explained by this regression model.

12.86 **(a)** H_0: $\beta_1 = \cdots = \beta_4 = 0$, H_a: $\beta_i \neq 0$ for at least one i, TS: $F = \text{MSR/MSE}$, RR: $F \geq 2.73$ ($\alpha = 0.05$). $f = 6.73 \geq 2.73$. There is evidence to suggest that at least one of the regression coefficients is different from 0. The overall regression is significant. **(b)** β_2, β_3, and β_4 are significantly different from 0. Therefore, x_2, x_3, and x_4 are significant predictor variables. **(c)** The critical value in each test is 2.6763. Using the Minitab output, β_3 is significantly different from 0, and therefore, x_3 is a significant predictor variable. This result is different from part (b).

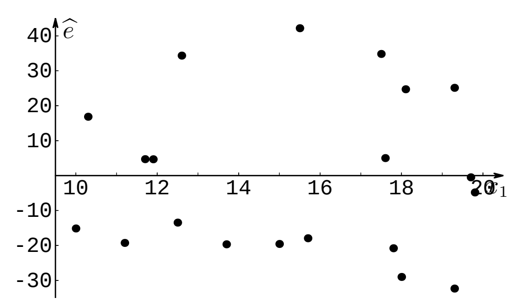
12.87
(a) $y = -46.2192 - 4.2153x_1 + 16.4785x_2 + 1.1186x_3$
(b) H_0: $\beta_1 = \beta_2 = \beta_3 = 0$, H_a: $\beta_i \neq 0$ for at least one i, TS: $F = \text{MSR/MSE}$, RR: $F \geq 4.76$. $f = 32.80 \geq 4.76$. There is evidence to suggest that at least one of the regression coefficients is different from 0. The overall regression is significant. $p = 0.0004$.
(c) $r^2 = 0.9425$ **(d)** β_1: $t = -5.8458$, $p = 0.0011$. β_2: $t = 3.9533$, $p = 0.0075$. β_3: $t = 0.6198$, $p = 0.5582$. x_1 and x_2 are significant predictors.
(e) $(-117.7319, 25.2936)$. There is no evidence to suggest the constant regression coefficient is different from 0. The CI includes 0.

12.88 **(a)** $y = 114.4895 + 6.4722x_1 - 12.8017x_2 + 4.6091x_3 + 0.6409x_4$. $r^2 = 0.7791$ **(b)** β_1: $t = 4.3402$, $p = 0.0015$. β_2: $t = -0.5592$, $p = 0.5883$. β_3: $t = 1.4814$, $p = 0.1693$. β_4: $t = 2.9202$, $p = 0.0153$. Using $\alpha = 0.05$, x_1 and x_4 are significant predictors.
(c) $Y_i = \beta_0 + \beta_1 x_{1i} + \beta_4 x_{4i} + E_i$.
$y = 105.4656 + 5.1074x_1 + 0.6863x_4$. $r^2 = 0.7306$
(d) The second model is better: fewer variables, and r^2 is only slightly lower.

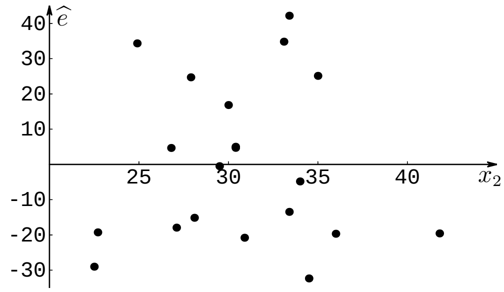
12.89
(a) $y = 7.5139 - 14.9684x_1 + 2.9118x_2 - 0.9704x_3$
(b) Normal probability plot:



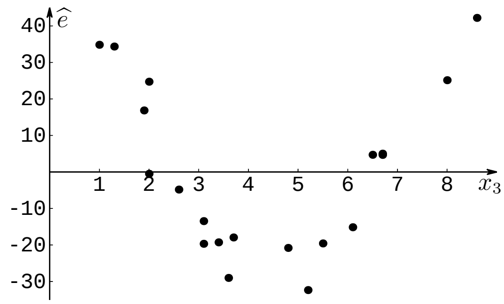
The graph suggests the random error terms are not normal. The pattern is nonlinear. **(c)** Residuals versus x_1:



Residuals versus x_2:



Residuals versus x_3:



This graph suggests a violation in the regression assumptions. Include a quadratic term, x_3^2, to improve the model.

12.90 **(a)** $(5.7072, 10.0835)$. We are 95% confident the true mean value of Y when $\boldsymbol{x} = \boldsymbol{x}^*$ lies in this interval. **(b)** $(2.4597, 13.3310)$. We are 95% confident an observed value of Y when $\boldsymbol{x} = \boldsymbol{x}^*$ lies in this interval.

12.91 **(a)** $y = 12.0825 + 0.0015x_1 - 0.0070x_2$ **(b)** 4.2541 **(c)** H_0: $\beta_1 = \beta_2 = 0$, H_a: $\beta_i \neq 0$ for at least one i, TS: $F = \text{MSR/MSE}$, RR: $F \geq 4.46$. $f = 2.46$. There is no evidence to suggest that at least one of the regression coefficients is different from 0. The overall regression is not significant.

12.92 **(a)** $y = 137.4024 + 0.0282x_1 - 4.4853x_2$ **(b)** H_0: $\beta_1 = \beta_2 = 0$, H_a: $\beta_i \neq 0$ for at least one i, TS: $F = \text{MSR/MSE}$, RR: $F \geq 4.26$. $f = 21.45 \geq 4.26$. There is evidence to suggest that at least one of the regression coefficients is different from 0. The overall regression is significant. **(c)** 307.2159

12.93 **(a)** $y = 2447.7017 + 51.2511x_1 - 10.8445x_2$ **(b)** H_0: $\beta_1 = \beta_2 = 0$, H_a: $\beta_i \neq 0$ for at least one i, TS: $F = \text{MSR/MSE}$, RR: $F \geq 6.93$. $f = 8.19 \geq 6.93$. There is evidence to suggest that at least one of the regression coefficients is different from 0. The overall regression is significant. **(c)** 0.5771. Approximately 58% of the variation in y is explained by this regression model. **(d)** 2708.7832

12.94 **(a)** ANOVA table:

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	114.871	3	38.2903	10.95	0.0003
Error	62.935	18	3.4964		
Total	177.806	21			

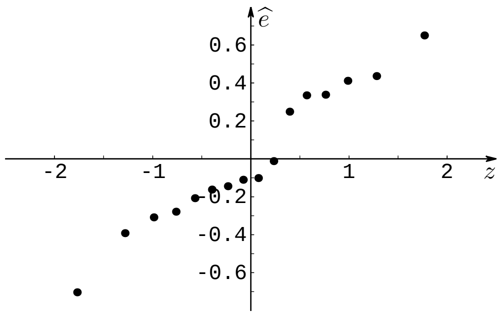
H_0: $\beta_1 = \beta_2 = \beta_3 = 0$, H_a: $\beta_i \neq 0$ for at least one i, TS: $F = \text{MSR/MSE}$, RR: $F \geq 3.16$ $(\alpha = 0.05)$. $f = 10.95 \geq 3.16$. There is evidence to suggest that at least one of the regression coefficients is different from 0. The overall regression is significant. **(b)** β_1: $t = -4.4843$, $0.0001 \leq p \leq 0.0005$. β_2: $t = 2.9369$, $0.005 \leq p \leq 0.01$. β_3: $t = -0.2351$, $p > 0.20$. Temperature and contact area are the most important (significant) predictor variables.

12.95 **(a)** ANOVA table:

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	531.54	3	177.18	6.21	0.0035
Error	599.38	21	28.5419		
Total	1130.92	24			

H_0: $\beta_1 = \beta_2 = \beta_3 = 0$, H_a: $\beta_i \neq 0$ for at least one i, TS: $F = \text{MSR/MSE}$, RR: $F \geq 3.07$ $(\alpha = 0.05)$. $f = 6.21 \geq 3.07$. There is evidence to suggest that at least one of the regression coefficients is different from 0. The overall regression is significant. **(b)** All three variables contribute to the overall significant regression. **(c)** $(52.64, 58.62)$, $(56.21, 68.54)$ **(d)** $(44.12, 67.14)$, $(49.67, 75.08)$ **(e)** $\boldsymbol{x}_1^*$ is closer to the *mean* than $\boldsymbol{x}_2^*$.

12.96
(a) $y = -3.1136 + 0.0554x_1 + 0.5777x_2 + 0.0028x_3$ **(b)** H_0: $\beta_1 = \beta_2 = \beta_3 = 0$, H_a: $\beta_i \neq 0$ for at least one i, TS: $F = \text{MSR/MSE}$, RR: $F \geq 3.49$ $(\alpha = 0.05)$. $f = 3.93 \geq 3.49$. There is evidence to suggest that at least one of the regression coefficients is different from 0. The overall regression is significant. β_1: $t = 2.4743$, $p = 0.0293$. β_2: $t = 2.8634$, $p = 0.0143$. β_3: $t = 0.4409$, $p = 0.6671$. The temperature of the solutions and the concentration of the solutions are the most important (significant) variables. **(c)** Normal probability plot:



There is some evidence to suggest a violation in the multiple linear regression assumptions. The points in this plot are slightly nonlinear.

12.97 **(a)** ANOVA table:

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	8128.67	7	1161.24	14.60	0.0000
Error	2942.32	37	79.52		
Total	11070.99	44			

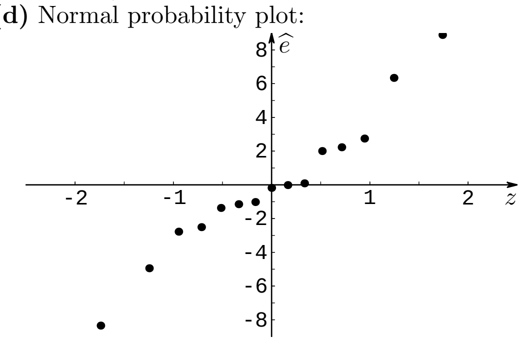
H_0: $\beta_1 = \cdots = \beta_7 = 0$, H_a: $\beta_i \neq 0$ for at least one i, TS: $F = \text{MSR}/\text{MSE}$, RR: $F \geq 2.27$ ($\alpha = 0.05$). $f = 14.60 \geq 2.27$. $p = 0.0000000060682$. There is evidence to suggest that at least one of the regression coefficients is different from 0. The overall regression is significant. $r^2 = 0.7342$. Approximately 73% of the variation in y is explained by this regression model. **(b)** `STPOVRT`: $t = -4.1186$, $p = 0.0002$. `PCTURB`: $t = -3.3004$, $p = 0.0021$. `CASEFTE`: $t = 36.6559$, $p < 0.0001$. `JUDADMIN`: $t = -1.9357$, $p = 0.0606$. `POPSTAB`: $t = 1.1414$, $p = 0.2610$. `TANFNOW`: $t = -1.3733$, $p = 0.1779$. `CWODUM`: $t = 0.9018$, $p = 0.3730$. The most important (significant) predictor variables are `STPOVRT`, `PCTURB`, and `CASEFTE`. **(c)** (i) The percentage of cases with orders would decrease by 0.23829. (ii) The percentage of cases with orders would increase by 0.67485.

12.98 **(a)** $y = 197.1839 - 3.5821x_1 - 6.2638x_2$. **(b)** H_0: $\beta_1 = \beta_2 = 0$, H_a: $\beta_i \neq 0$ for at least one i, TS: $F = \text{MSR}/\text{MSE}$, RR: $F \geq 4.74$. $f = 7.28 \geq 4.74$. There is evidence to suggest that at least one of the regression coefficients is different from 0. The overall regression is significant. **(c)** 0.6752. Approximately 67% of the variation in y is explained by this regression model. **(d)** β_1: $t = -2.3709$, $p = 0.0495$. β_2: $t = -2.9934$, $p = 0.0201$. Both regression coefficients are significantly different from 0. **(e)** Yes. The overall regression is significant, and both variables contribute to the overall significance.

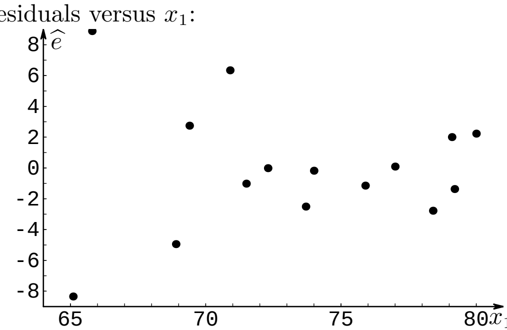
12.99
(a) $y = 132.7100 - 0.7330x_1 - 0.1185x_2 - 37.0694x_3$.
(b) ANOVA table:

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	535.6602	3	178.5534	7.92	0.0043
Error	248.0771	11	22.5525		
Total	783.7373	14			

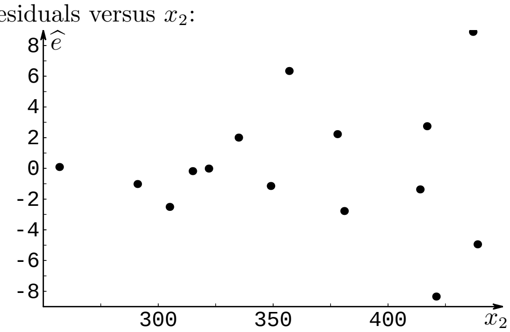
H_0: $\beta_1 = \beta_2 = \beta_3 = 0$, H_a: $\beta_i \neq 0$ for at least one i, TS: $F = \text{MSR}/\text{MSE}$, RR: $F \geq 3.59$ ($\alpha = 0.05$). $f = 7.92 \geq 3.59$. There is evidence to suggest that at least one of the regression coefficients is different from 0. The overall regression is significant. **(c)** β_1: $t = -2.2468$, $p = 0.0461$. β_2: $t = -4.8394$, $p = 0.0005$. β_3: $t = -1.1467$, $p = 0.2758$. The most important (significant) variables are altitude and ozone level.
(d) Normal probability plot:



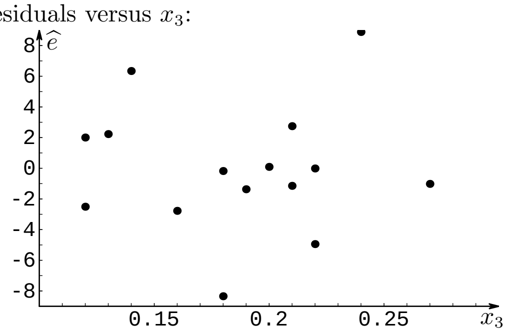
Residuals versus x_1:



Residuals versus x_2:



Residuals versus x_3:



There is some evidence to suggest the errors are not normal.

12.100 **(a)** $y = 8.9155 - 0.0580x_1 - 0.0766x_2 + 0.9028x_3 - 0.0848x_4$ **(b)** H_0: $\beta_1 = \cdots = \beta_4 = 0$, H_a: $\beta_i \neq 0$ for at least one i, TS: $F = \text{MSR}/\text{MSE}$, RR: $F \geq 3.06$. $f = 3.47 \geq 3.06$. There is evidence to suggest that at least one of the regression coefficients is different from 0. The overall regression is significant. $r^2 = 0.4805$ **(c)** β_1: $t = -0.9166$, $p = 0.3739$. β_2: $t = -1.5495$, $p = 0.1421$. β_3: $t = 3.2584$, $p = 0.0053$. β_4: $t = -1.2439$, $p = 0.2326$. Only x_3 is a significant predictor variable. **(d)** H_0: $\beta_4 = 0.93$, H_a: $\beta_1 < 0.93$, TS: $T = (B_4 - 0.93)/S_{B_4}$, RR: $T \leq -1.7531$. $t = -0.1202$. There is no evidence to suggest that $\beta_4 < 0.93$. **(e)** $(1.0429, 1.7151)$

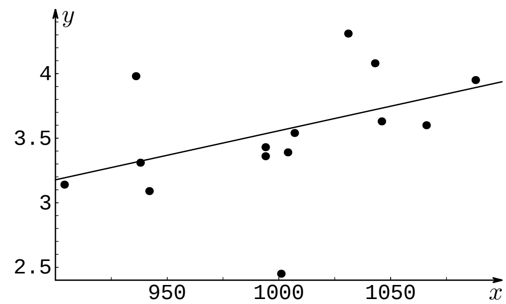
12.101 **(a)** $y = 32245.1664 + 0.5683x_1 - 21.0632x_2 + 9.9886x_3 - 67.9961x_4$ **(b)** H_0: $\beta_1 = \cdots = \beta_4 = 0$, H_a: $\beta_i \neq 0$ for at least one i, TS: $F = \text{MSR}/\text{MSE}$, RR: $F \geq 3.63$. $f = 39.50 \geq 3.63$. There is evidence to suggest that at least one of the regression coefficients is different from 0. The overall regression is significant. $r^2 = 0.9461$ **(c)** β_1: $t = 5.4550$, $p = 0.0004$. β_2: $t = -1.1642$, $p = 0.2743$. β_3: $t = 0.6529$, $p = 0.5302$. β_4: $t = -2.5067$, $p = 0.0067$. The variables x_1 and x_4 are significant. **(d)** H_0: $\beta_1 = 0.55$, H_a: $\beta_1 > 0.55$, TS: $T = (B_1 - 0.55)/S_{B_1}$, RR: $T \leq -1.8331$. $t = 0.1756$. There is no evidence to suggest that $\beta_1 > 0.55$.

Chapter Exercises

12.102 **(a)** 5.7 **(b)** -4.5 **(c)** 0.5393

12.103 **(a)** $y = 2.8408 + 2.1231x$ **(b)** 24.0716 **(c)** 7.0870

12.104 **(a)** Scatter plot:



(b) $y = -0.2427 + 0.0038$ **(c)** ANOVA table:

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	0.5335	1	0.5335	2.6807	0.1275
Error	2.3884	12	0.1990		
Total	2.9220	13			

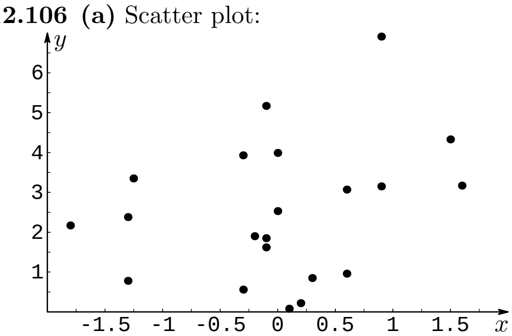
H_0: There is no significant linear relationship.
H_a: There is a significant linear relationship.
TS: $F = \text{MSR}/\text{MSE}$, RR: $F \geq 4.75$
$f = 2.6807$. There is no evidence of a significant linear relationship. **(d)** $y = -0.2039 + 0.0038x$. Yes. $p = 0.0428$

12.105 **(a)** $y = 0.7218 + 0.0059x$. ANOVA table:

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	10.8922	1	10.8922	5.79	0.0285
Error	30.0878	16	1.8805		
Total	40.9800	17			

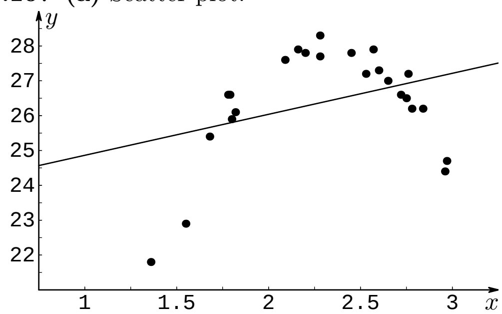
(b) 0.2658. **(c)** 0.5156 **(d)** No. The correlation is only moderate, the regression is barely significant, and the r^2 value is low.

12.106 **(a)** Scatter plot:

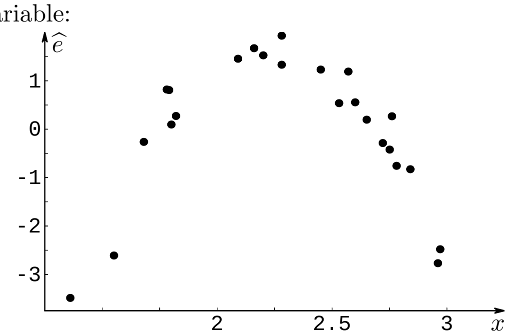


(b) 0.2809. Weak positive relationship.

12.107 **(a)** Scatter plot:



The relationship appears to be quadratic.
(b) $y = 23.6853 + 1.1767x$. H_0: There is no significant linear relationship. H_a: There is a significant linear relationship. TS: $F = \text{MSR}/\text{MSE}$, RR: $F \geq 4.30$ $f = 3.08$. There is no evidence of a significant linear relationship. **(c)** Residuals versus the predictor variable:



(d) Add a quadratic term: x^2.

12.108 **(a)** $y = 1.8280 + 0.0077x$ **(b)** ANOVA table:

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	1.2800	1	1.2800	0.45	0.5057
Error	78.8390	28	2.8157		
Total	80.1190	29			

H_0: There is no significant linear relationship.
H_a: There is a significant linear relationship.
TS: $F = \text{MSR}/\text{MSE}$, RR: $F \geq 4.20$ ($\alpha = 0.05$)
$f = 0.45$. There is no evidence of a significant linear relationship. The dosage of minoxidil does not appear to explain the variation in hair density.
(c) $(1.3218, 3.1072)$

12.109 **(a)** $y = 8.3870 + 0.6024x$ **(b)** ANOVA table:

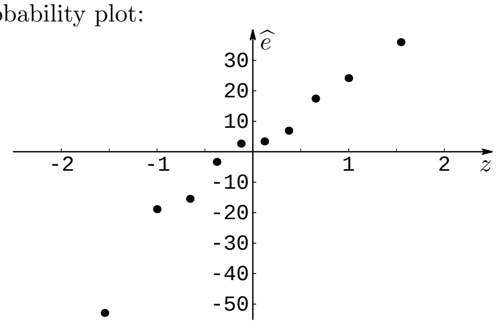
Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	67.39	1	67.39	2.29	0.1370
Error	1414.44	48	29.47		
Total	1481.83	49			

(c) H_0: $\beta_1 = 0$, H_a: $\beta_1 \neq 0$, TS: $T = B_1/S_{B_1}$, RR: $|T| \geq 2.0106$. $t = 1.5123$. There is no evidence to suggest that $\beta_1 \neq 0$, the regression line is not significant. **(d)** No. There is no significant relationship between rating and price.

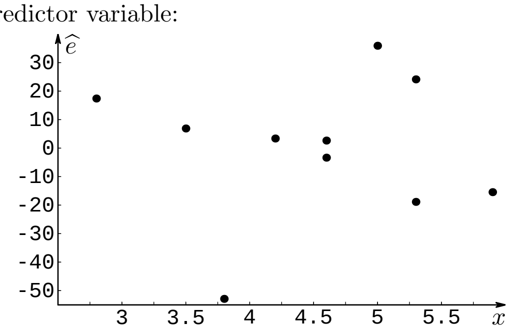
12.110 **(a)** $y = 731.5015 + 39.3108x$. ANOVA table:

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	12331.79	1	12331.79	17.47	0.0031
Error	5646.61	8	705.83		
Total	17978.40	9			

(b) -15.4351, 17.4283, -18.8486, -3.3311, 2.6689, 6.9108, -52.8825, 35.9446, 24.1514, 3.3932 **(c)** Normal probability plot:



There is some evidence of non normality. There appears to be an outlier. **(d)** Residuals versus the predictor variable:



There is some indication of a violation in the regression model assumptions. There is an outlier, and there appears to be a downward sloping pattern in this graph.

12.111 **(a)** $y = 0.3168 + 0.9059x$. ANOVA table:

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	2.8027	1	2.8027	17.23	0.0032
Error	1.3013	8	0.1627		
Total	4.1040	9			

(b) $(0.776, 2.756)$ **(c)** H_0: $y^* = 1$, H_a: $y^* > 1$,

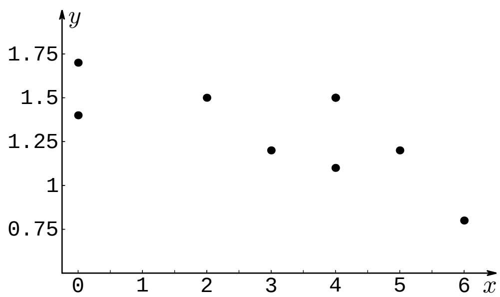
TS: $T = \frac{(B_0+B_1x^*)-y_0^*}{S\sqrt{(1/n)+[(x^*-\overline{x})^2/S_{xx}]}}$, RR: $T \geq 2.8965$
$t = 0.2554$. There is no evidence to suggest the mean value of Y for $x = 0.8$ is greater than 1.

12.112 **(a)** ANOVA table:

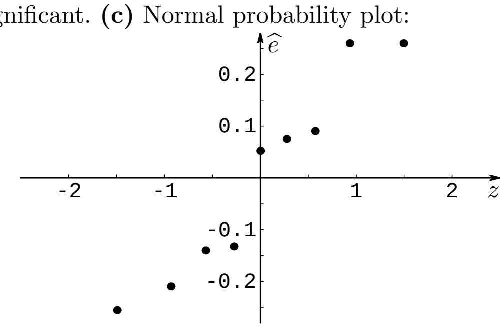
Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	3477.4	1	3477.4	24.03	0.0000
Error	7671.0	53	144.74		
Total	11148.4	54			

(b) 144.74

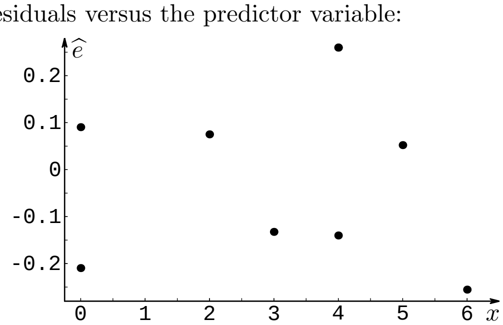
12.113 **(a)** Scatter plot:



Negative relationship. **(b)** $y = 1.6096 - 0.0924x$.
H_0: $\beta_1 = 0$, H_a: $\beta_1 \neq 0$, TS: $T = B_1/S_{B_1}$,
RR: $|T| \geq 2.3646$. $t = -2.6441 \leq -2.3646$. There is evidence to suggest that $\beta_1 \neq 0$, the regression line is significant. **(c)** Normal probability plot:



Residuals versus the predictor variable:



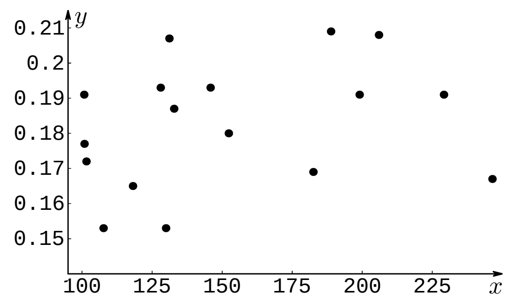
The normal probability plot suggests a violation in the normality assumption.

12.114 **(a)** $y = -0.7614 + 0.0510x$. ANOVA table:

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	1.4216	1	1.4216	28.46	0.0000
Error	0.8990	18	0.499		
Total	2.3207	19			

(b) H_0: $\beta_1 = 0.07$, H_a: $\beta_1 < 0.07$,
TS: $T = (B_1 - 0.07)/S_{B_1}$, $t = -1.9792$. $p = 0.0317$
There is evidence to suggest that $\beta_1 < 0.07$. **(c)** 0.7827 **(d)** Both are positive, reflecting a positive linear relationship.

12.115 **(a)** Scatter plot:



There does not appear to be a linear relationship. The scatter plot appears random.
(b) $y = 0.1673 + 0.0001x$. ANOVA table:

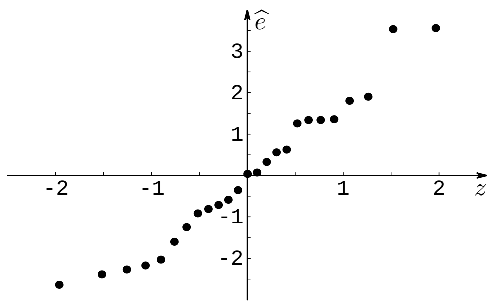
Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	0.0004	1	0.0004	1.15	0.3008
Error	0.0047	15	0.0003		
Total	0.0050	16			

(c) The F test is not significant. There is no evidence to suggest a significant linear relationship.

12.116 $y = 5.3066 + 0.2843x$. ANOVA table:

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	7.4369	1	7.4369	2.34	0.1396
Error	73.0535	23	3.1762		
Total	80.4904	24			

There is no evidence to suggest a significant linear relationship. Normal probability plot:



There is some evidence to suggest a violation in the regression assumptions. The residuals do not appear to be normally distributed.

12.117 **(a)** $y = 13.0865 + 0.0220x_1 - 0.0563x_2$
(b) ANOVA table:

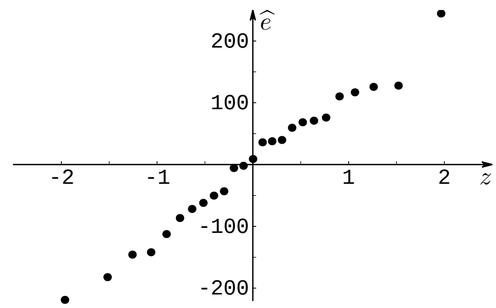
Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	34.3151	2	17.1576	16.73	0.0001
Error	17.4304	17	1.0253		
Total	51.7455	19			

H_0: $\beta_1 = \beta_2 = 0$, H_a: $\beta_i \neq 0$ for at least one i,
TS: $F = \text{MSR}/\text{MSE}$, RR: $F \geq 3.59$ $(\alpha = 0.05)$.
$f = 16.73 \geq 3.59$. There is evidence to suggest that at least one of the regression coefficients is different from 0. The overall regression is significant. $p = 0.0001$.
$r^2 = 0.6632$. Approximately 66% of the variation in the data is explained by the regression model. **(c)** β_1: $t = 3.4520 \geq 2.4581$. β_2: $t = -3.7559 \leq -2.4581$. Both predictor variables are significant. **(d)** $(11.944, 17.029)$
(e) 214.932

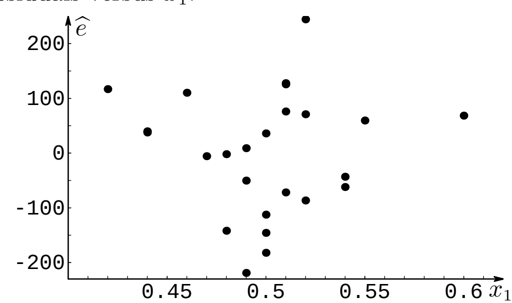
12.118 **(a)** $y = 7274.5117 - 971.4403x_1 - 69.2220x_2 - 64.1724x_3 + 32.1604x_4$. As x_1 increases, y decreases. As x_2 increases, y decreases. As x_3 increases, y decreases. As x_4 increases, y increases. **(b)** ANOVA table:

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	4445366	4	1111342	74.81	0.0000
Error	297126	20	14856		
Total	4742493	24			

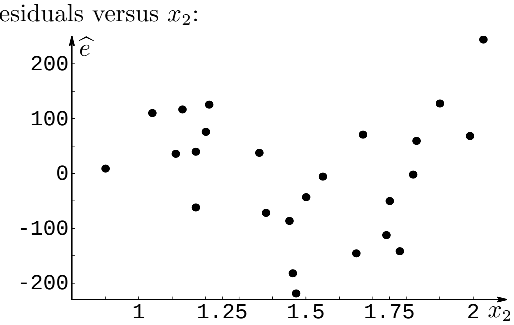
H_0: $\beta_1 = \cdots = \beta_4 = 0$, H_a: $\beta_i \neq 0$ for at least one i,
TS: $F = \text{MSR}/\text{MSE}$, RR: $F \geq 2.87$ $(\alpha = 0.05)$.
$f = 74.81 \geq 2.87$. There is evidence to suggest that at least one of the regression coefficients is different from 0. The overall regression is significant.
$p = 0.0000000000096665$. **(c)** β_1: $t = -1.2730$, $p = 0.2176$. β_2: $t = -0.7246$, $p = 0.4771$. β_3: $t = -12.4987$, $p < 0.0001$. β_4: $t = 12.4091$, $p < 0.0001$. The variables x_3 and x_4 are significant predictors.
(d) Normal probability plot:



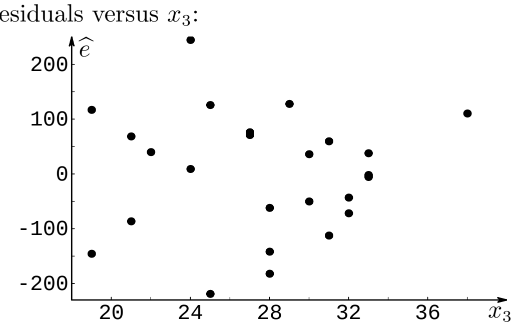
Residuals versus x_1:



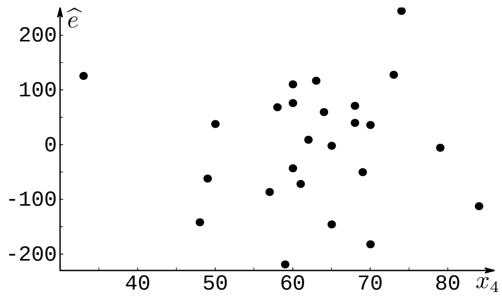
Residuals versus x_2:



Residuals versus x_3:

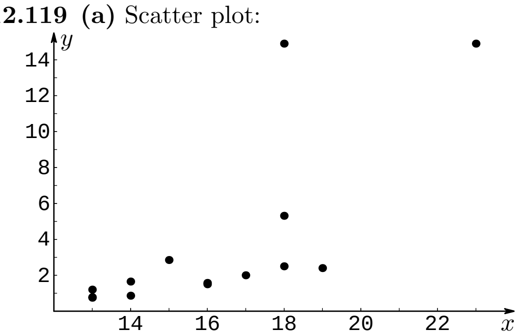


Residuals versus x_4:



There is one possible outlier, but no overwhelming evidence of any violations in the regression assumptions.

12.119 **(a)** Scatter plot:



The relationship appears (positive) linear, with the exception of two outliers. **(b)** $y = -16.2434 + 1.2361x$. ANOVA table:

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	162.50	1	162.50	13.67	0.0031
Error	142.68	12	11.89		
Total	305.18	13			

There is evidence to suggest the total number of wins can be used to predict the per-team payout. The overall test is significant, $p = 0.0031$.
(c) $(5.067, 11.889)$

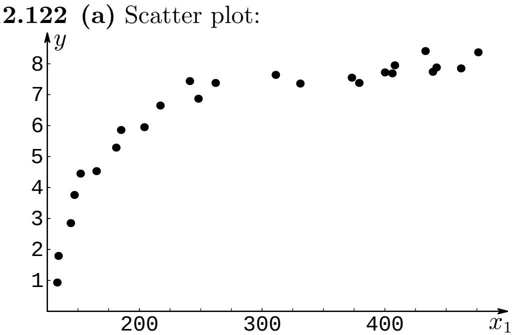
Exercises′

12.120

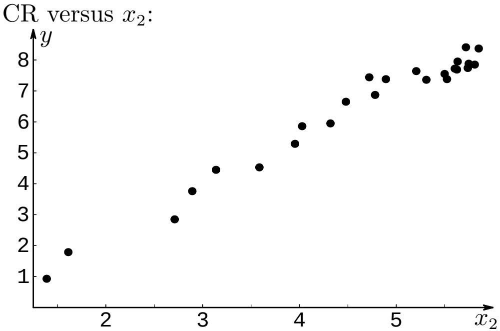
$$\begin{aligned}\sum_{i=1}^{n}(y_i - \widehat{y}_i) &= \sum_{i=1}^{n}(y_i - (\widehat{\beta}_0 + \widehat{\beta}_1 x_i)) \\ &= \sum_{i=1}^{n}(y_i - (\overline{y} - \widehat{\beta}_1\overline{x} + \widehat{\beta}_1 x_i)) \\ &= \sum_{i=1}^{n}(y_i - \overline{y}) - \widehat{\beta}_1\sum_{i=1}^{n}(x_i - \overline{x}) \\ &= n\overline{y} - n\overline{y} - \widehat{\beta}_1(n\overline{x} - n\overline{x}) = 0\end{aligned}$$

12.121 **(a)** $r = 0.8261$. H_0: $\rho = 0$, H_a: $\rho \neq 0$, TS: $T = R\sqrt{n-2}/\sqrt{1-R^2}$, RR: $|T| \geq 2.3060$. $t = 4.1459 \geq 2.3060$. There is evidence to suggest the correlation coefficient is different from 0. **(b)** $y = 9.6815 + 5.8381x$. H_0: $\beta_1 = 0$, H_a: $\beta_1 \neq 0$, TS: $T = B_1/S_{B_1}$, RR: $|T| \geq 2.3060$. $t = 4.1459 \geq 2.3060$. There is evidence to suggest that $\beta_1 \neq 0$, the regression line is significant. **(c)** The value of the test statistic is the same in both tests. Both are testing for the same thing: a significant regression line.

12.122 **(a)** Scatter plot:



The relationship appears to be logarithmic.
(b) 1.3863, 3.9512, 4.7185, 4.7791, 2.8904, 3.1355, 5.6240, 5.7366, 5.8493, 2.7081, 4.0254, 4.4773, 5.2040, 5.4972, 1.6094, 5.6312, 5.7462, 3.5835, 4.3175, 4.8903, 5.3083, 5.5215, 5.6021, 5.7170, 5.8081 **(c)** Scatter plot of CR versus x_2:



This relationship appears to be linear.
(d) $y = -0.8059 + 1.5603x_2$. ANOVA table:

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	p value
Regression	103.16	1	103.16	741.04	0.0000
Error	3.20	23	0.14		
Total	106.36	24			

Chapter 13

Section 13.1

13.1 54.5, 87.2, 43.6, 32.7

13.2 150, 140, 310, 230, 170

13.3 **(a)** H_0: $p_1 = 0.4$, $p_2 = 0.3$, $p_3 = 0.2$, $p_4 = 0.1$, H_a: $p_i \neq p_{i0}$ for at least one i,

TS: $X^2 = \sum_{i=1}^{4}(n_i - e_i)^2/e_i$, RR: $X^2 \geq 11.3449$.
(b) 120, 90, 60, 30 **(c)** $\chi^2 = 2.1528$. There is no evidence to suggest any one of the population proportions differs from its hypothesized value.

13.4 **(a)** H_0: $p_1 = 0.175$, $p_2 = 0.171$, $p_3 = 0.162$, $p_4 = 0.225$, $p_5 = 0.202$, $p_6 = 0.065$, H_a: $p_i \neq p_{i0}$ for at least one i, TS: $X^2 = \sum_{i=1}^{6}(n_i - e_i)^2/e_i$,
RR: $X^2 \geq 11.0705$. **(b)** $\chi^2 = 2.7994$. There is no evidence to suggest any one of the population proportions differs from its hypothesized value.
(c) $p > 0.10$

13.5 H_0: $p_i = 0.20$, H_a: $p_i \neq p_{i0}$ for at least one i,
TS: $X^2 = \sum_{i=1}^{5}(n_i - e_i)^2/e_i$, RR: $X^2 \geq 9.4877$.
$\chi^2 = 4.5200$. There is no evidence to suggest any one of the population proportions differs from its hypothesized value. $p > 0.10$

13.6 RR: $X^2 \geq 7.8147$. $\chi^2 = 11.6 \geq 7.8147$. There is evidence to suggest at least one of the population proportions differs from its hypothesized value.

13.7 RR: $X^2 \geq 9.4877$. $\chi^2 = 10.75 \geq 9.4877$. There is evidence to suggest at least one of the population proportions differs from its hypothesized value.

13.8 RR: $X^2 \geq 9.2103$. $\chi^2 = 1.1214$. There is no evidence to suggest any of the percentages have changed.

13.9 RR: $X^2 \geq 7.8147$. $\chi^2 = 5.0040$. There is no evidence to suggest any one of the population proportions differs from its hypothesized value.

13.10 RR: $X^2 \geq 9.4877$. $\chi^2 = 10.5927 \geq 9.4877$. There is evidence to suggest at least one of the population proportions differs from its hypothesized value.

13.11 RR: $X^2 \geq 15.0863$. $\chi^2 = 15.8340 \geq 15.0863$. There is evidence to suggest at least one of the population proportions differs from its hypothesized value.

13.12 RR: $X^2 \geq 9.4877$. $\chi^2 = 6.0884$. There is no evidence to suggest any one of the population proportions differs from its hypothesized value.

13.13 RR: $X^2 \geq 11.0705$. $\chi^2 = 7.3617$. There is no evidence to suggest any one of the population proportions differs from its hypothesized value.

13.14 RR: $X^2 \geq 7.8147$ ($\alpha = 0.05$).
$\chi^2 = 9.8125 \geq 7.8147$. There is evidence to suggest at least one of the population proportions differs from its hypothesized value; to contradict the economic report. $0.025 \leq p \leq 0.05$.

13.15 RR: $X^2 \geq 16.9190$ ($\alpha = 0.05$).
$\chi^2 = 26.1368 \geq 16.9190$. There is evidence to suggest at least one of the population proportions differs from its hypothesized value; that one (or more) character(s) are more popular than the others. $0.001 \leq p \leq 0.0005$.

13.16 RR: $X^2 \geq 14.8603$. $\chi^2 = 1.5853$. There is no evidence to suggest any one of the population proportions differs from its hypothesized value; no evidence of a shift in the proportion of applications by California location.

13.17 RR: $X^2 \geq 11.3449$. $\chi^2 = 4.9622$. There is no evidence to suggest any one of the population proportions differs from its hypothesized value.

13.18 RR: $X^2 \geq 16.9190$. $\chi^2 = 17.48 \geq 16.9190$. There is evidence to suggest at least one of the population proportions differs from its hypothesized value; evidence to suggest one airport mall is preferred over the rest.

13.19 RR: $X^2 \geq 11.3449$. $\chi^2 = 4.2939$. There is no evidence to suggest any one of the population proportions differs from its hypothesized value; no evidence to suggest the true population proportions have changed.

13.20 **(a)** 0.1302, 0.6791, 0.1655, 0.0252
(b) RR: $X^2 \geq 11.3449$. $\chi^2 = 1.3454$. There is no evidence to suggest any one of the population proportions differs from its hypothesized value; no evidence to suggest the true historical proportions of orders by aircraft family have changed.

13.21 RR: $X^2 \geq 23.2093$. $\chi^2 = 1.2232$. There is no evidence to suggest any one of the population proportions differs from its hypothesized value; no evidence to suggest that the true 2005 population proportions of sales by company have changed.

Section 13.2

13.22 **(a)** 12.5916 **(b)** 15.0863 **(c)** 14.4494 **(d)** 26.1245

13.23 **(a)** 24.9958 **(b)** 20.2777 **(c)** 34.8213 **(d)** 44.2632

13.24

	Category 1	Category 2	Category 3	Category 4	Row total
Population 1	18	14	18	15	65
Population 2	25	21	16	12	74
Population 3	32	33	26	28	119
Col. total	75	68	60	55	258

13.25 **(a)** Row totals: 153, 160, 155. Column totals: 193, 177, 98. Grand total: 468. **(b)** Expected counts: 63.10, 57.87, 32.04; 65.98, 60.51, 33.50; 63.92, 58.62, 32.46. **(c)** RR: $X^2 \geq 11.1433$, $\chi^2 = 4.836$. There is no evidence to suggest the true category proportions are different for any of the populations.

13.26 RR: $X^2 \geq 16.9190$, $\chi^2 = 16.8226$. There is no evidence to suggest the two categorical variables are dependent.

13.27 RR: $X^2 \geq 16.9190$, $\chi^2 = 18.6376 \geq 16.9190$. There is evidence to suggest the true proportion of gamblers at each game is not the same for all casinos.

13.28 RR: $X^2 \geq 16.8119$, $\chi^2 = 9.2674$. There is no evidence to suggest the true proportion of each favorite differs by grocery store.

13.29 RR: $X^2 \geq 9.2103$, $\chi^2 = 13.3876 \geq 9.2103$. There is evidence to suggest the true proportion of writing implement differs by store. $0.001 \leq p \leq 0.005$.

13.30 RR: $X^2 \geq 14.8603$, $\chi^2 = 89.0769 \geq 14.8603$. There is overwhelming evidence to suggest the true proportion of perceived power differs by political party.

13.31 RR: $X^2 \geq 11.3449$, $\chi^2 = 2.6781$. There is no evidence to suggest the proportion of number of times spent helping with homework is different for boys and girls.

13.32 RR: $X^2 = 7.8794$, $\chi^2 = 11.2179 \geq 7.8794$. There is evidence to suggest that food and wine are dependent. This suggests that diners are still following the traditional food-and-wine pairings.

13.33 RR: $X^2 \geq 16.8119$, $\chi^2 = 1.2975$. There is no evidence to suggest that perceived greatest risk and country are dependent.

13.34 RR: $X^2 = 26.2170$, $\chi^2 = 27.3005 \geq 26.2170$. There is evidence to suggest that resort activity and age group are dependent.

13.35 RR: $X^2 \geq 16.2662$, $\chi^2 = 26.0127 \geq 16.2662$. There is evidence to suggest the risk of colon cancer and diet are dependent. $p < 0.0001$.

13.36 RR: $X^2 \geq 5.9915$, $\chi^2 = 6.4189 \geq 5.9915$. There is evidence to suggest that stress level and injury are dependent.

13.37 RR: $X^2 \geq 31.9999$, $\chi^2 = 34.7235 \geq 31.9999$. There is evidence to suggest the type of violation and the type of pool are dependent. $0.001 \leq p \leq 0.005$.

13.38 RR: $X^2 = 32.9095$, $\chi^2 = 108.5042 \geq 32.9095$. There is evidence to suggest that incident type and day are dependent.

Chapter Exercises

13.39 RR: $X^2 \geq 7.8147$, $\chi^2 = 0.8033$. There is no evidence to suggest the data are inconsistent with the past proportions.

13.40 RR: $X^2 \geq 9.4877$, $\chi^2 = 10.0769 \geq 9.4877$. There is evidence to suggest at least one of the population proportions differs from its hypothesized value.

13.41 RR: $X^2 \geq 11.3449$, $\chi^2 = 1.8990$. There is no evidence to suggest the data are inconsistent with past proportions.

13.42 RR: $X^2 \geq 27.8772$, $\chi^2 = 32.9803 \geq 27.8772$. There is evidence to suggest at least one of the population proportions differs from its hypothesized value; that one music genre is most preferred.

13.43 RR: $X^2 \geq 9.4877$, $\chi^2 = 7.9711$. There is no evidence to suggest any of the true population proportions differs from its hypothesized value.

13.44 RR: $X^2 \geq 21.0261$, $\chi^2 = 18.3478$. There is no evidence to suggest that the true proportions associated with transfer plans are different for any of the populations.

13.45 RR: $X^2 \geq 18.5476$, $\chi^2 = 78.0454 \geq 18.5476$. There is overwhelming evidence to suggest the true proportion of grocery shopping frequency is not the same for all countries.

13.46 RR: $X^2 \geq 12.5916$, $\chi^2 = 10.2014$. There is no evidence to suggest the true proportion of each type of countertop purchased differs for supply stores.

13.47 RR: $X^2 \geq 11.3449$, $\chi^2 = 9.6684$. There is no evidence to suggest the performance on the mathematics PSSA exam is associated with school district.

13.48 **(a)** RR: $X^2 \geq 18.4668$, $\chi^2 = 26.0201 \geq 18.4668$. There is evidence to suggest that portfolio majority and outlook for economic recovery are dependent. **(b)** $p \leq 0.0001$ **(c)** About half in stocks, 30% in bonds, and 20% in mutual funds.

13.49 RR: $X^2 \geq 21.6660$, $\chi^2 = 26.6081 \geq 21.6660$. There is evidence to suggest an association between music type and time spent shopping.

13.50 RR: $X^2 \geq 7.8147$, $\chi^2 = 190.4011 \geq 7.8147$. There is overwhelming evidence to suggest an association between class and survival status.

Exercises′

13.51

Interval	Frequency	Probability
<370	18	0.0228
370–385	67	0.1359
385–400	175	0.3413
400–415	184	0.3413
415–430	75	0.1359
≥430	14	0.0228

(b) RR: $X^2 \geq 11.0705$, $\chi^2 = 3.8800$. There is no evidence to suggest any of the true population proportions differs from its hypothesized value; no evidence to suggest the weights do not fit the hypothesized distribution.

13.52 **(a)** H_0: $p_1 - p_2 = 0$, H_a: $p_1 - p_2 \neq 0$
TS: $Z = \frac{\widehat{P}_1 - \widehat{P}_2}{\sqrt{\widehat{P}_c(1-\widehat{P}_c)\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}}$. $z = 1.3422$, $p = 0.1795$.
There is no evidence to suggest the population proportion of children who witnessed violence is different in Washington and suburban Pennsylvania.
(b) $\chi^2 = 1.8015$, $p = 0.1795$. **(c)** $z^2 = \chi^2$. The p values are the same. These relationships make sense because we are examining the difference of two population proportions in both tests.

Technology Corner
RR: $X^2 \geq 58.6192$, $\chi^2 = 62.4388 \geq 58.6192$, $p = 0.0041$. There is evidence to suggest that flossing frequency and brushing frequency are dependent.

Chapter 14

Section 14.1

14.1 **(a)** 7 **(b)** 3 **(c)** 6 **(d)** 13

14.2 **(a)** $x = 2$, $p = 0.0547$. There is no evidence to suggest the population median is less than 16.
(b) $x = 9$, $p = 0.0730$. There is no evidence to suggest the population median is greater than -25.
(c) $x = 13$, $p = 0.2632$. There is no evidence to suggest the population median is different from 8.
(c) $x = 20$, $p = 0.0041$. There is no evidence to suggest the population median is different from 125.

14.3 $x = 16$, $p = 0.0022 \leq 0.05$. There is evidence to suggest $\widetilde{\mu}_1 > \widetilde{\mu}_2$.

14.4 $x = 7$, $p = 0.0433$. There is no evidence to suggest $\widetilde{\mu}_1 - \widetilde{\mu}_2 \neq 3$.

14.5 $x = 2$, $p = 0.0065 \leq 0.05$. There is evidence to suggest the median is less than 1.38.

14.6 $x = 9$, $p = 0.4119$. There is no evidence to suggest the median is less than 2.

14.7 $x = 17$, $p = 0.0320 \leq 0.05$. There is evidence to suggest the median mileage is greater than 100.

14.8 $x = 9$, $p = 0.1221$. There is no evidence to suggest the median diameter is different from 24.

14.9 $x = 23$, $p = 0.1279$. There is no evidence to suggest the median age of sports fans has increased.

14.10 $x = 15$, $p = 0.8506$. There is no evidence to suggest the median down payment has changed from 3000.

14.11 $x = 14$, $p = 0.1153$. There is no evidence to suggest the median chlorophyll amount in surface water is different in April and August.

14.12 $x = 15$, $p = 0.1537$. There is no evidence to suggest the median bulk density has decreased after dredging.

14.13 $x = 13$, $p = 0.0037$. There is evidence to suggest the median VOC concentration is smaller when the scrubber is installed.

14.14 **(a)** $x = 9$, $p = 0.0872$. There is no evidence to suggest the median pulse rate before the calcium blocker medication is different from the median pulse rate after the medication. **(b)** The distribution of pulse rates is probably not continuous.

Section 14.2

14.15

(a)

Difference	Absolute difference	Rank
−19	19	9.0
−7	7	4.0
6	6	3.0
−32	32	16.0
−24	24	11.5
17	17	8.0
12	12	5.0
−29	29	15.0
−27	27	14.0
−26	26	13.0
−38	38	18.0
−22	22	10.0
−36	36	17.0
−1	1	2.0
−24	24	11.5
0	0	1.0
−13	13	6.0
−15	15	7.0

(b)

Difference	Absolute difference	Rank
1.4	1.4	16.0
−0.2	0.2	2.5
1.6	1.6	21.5
0.3	0.3	5.0
−0.4	0.4	8.0
−0.8	0.8	12.0
−1.5	1.5	18.5
−0.6	0.6	10.0
0.1	0.1	1.0
−1.2	1.2	14.0
0.8	0.8	12.0
−1.5	1.5	18.5
1.5	1.5	18.5
−0.4	0.4	8.0
−1.5	1.5	18.5
1.6	1.6	21.5
−1.3	1.3	15.0
−0.3	0.3	5.0
0.8	0.8	12.0
0.4	0.4	8.0
−0.3	0.3	5.0
1.9	1.9	23.0
0.2	0.2	2.5

(c)

Difference	Absolute difference	Rank
3.0	3.0	16.5
−4.0	4.0	23.0
1.0	1.0	5.0
−3.0	3.0	16.5
−2.0	2.0	9.5
−1.0	1.0	5.0
−4.0	4.0	23.0
−4.0	4.0	23.0
−2.0	2.0	9.5
−3.0	3.0	16.5
−2.0	2.0	9.5
−2.0	2.0	9.5
−2.0	2.0	9.5
0.0	0.0	2.0
3.0	3.0	16.5
3.0	3.0	16.5
0.0	0.0	2.0
3.0	3.0	16.5
−3.0	3.0	16.5
4.0	4.0	23.0
−3.0	3.0	16.5
0.0	0.0	2.0
2.0	2.0	9.5
1.0	1.0	5.0
4.0	4.0	23.0

(d)

Difference	Absolute difference	Rank
3.0	3.0	16.5
−4.0	4.0	23.0
1.0	1.0	5.0
−3.0	3.0	16.5
−2.0	2.0	9.5
−1.0	1.0	5.0
−4.0	4.0	23.0
−4.0	4.0	23.0
−2.0	2.0	9.5
−3.0	3.0	16.5
−2.0	2.0	9.5
−2.0	2.0	9.5
−2.0	2.0	9.5
0.0	0.0	2.0
3.0	3.0	16.5
3.0	3.0	16.5
0.0	0.0	2.0
3.0	3.0	16.5
−3.0	3.0	16.5
4.0	4.0	23.0
−3.0	3.0	16.5
0.0	0.0	2.0
2.0	2.0	9.5
1.0	1.0	5.0
4.0	4.0	23.0

14.16 **(a)** $t_+ = 39.0$, $p = 0.2524$. There is no evidence to suggest the median is different from 70. **(b)** $t_+ = 56.0$, $p = 0.0616$. There is no evidence to suggest the median is less than 0.7. **(c)** $t_+ = 100.5$, $p = 0.0004 \leq 0.02$. There is evidence to suggest the median is greater than −45. **(d)** $t_+ = 94.0$, $p = 0.040$. There is no evidence to suggest the median is different from 450.

14.17 $t_+ = 150.5$, $p = 0.0896$. There is no evidence to suggest $\widetilde{\mu}_1$ is different from $\widetilde{\mu}_2$.

14.18 **(a)** $t_+ = 116$, $p = 0.0055 \leq 0.05$. There is evidence to suggest the mean (median) oxidation rate is greater than 120. **(b)** The distribution is symmetric.

14.19 $t_+ = 30.5$, $p = 0.0036$. There is no evidence to suggest the median renal blood-flow rate is different from 3.

14.20 $t_+ = 113$, $p = 0.1908$. There is no evidence to suggest the median grout strength is different from 6000.

14.21 $t_+ = 29.5$, $p = 0.0032 \leq 0.05$. There is evidence to suggest a difference in median reliabilities. This test suggests the reliability has increased from 1996 to 2000.

14.22 There is evidence to suggest the median five-minute secretion amount is less after the injection.

14.23 $t_+ = 137$, $p > 0.1012$. There is no evidence to suggest the median Dpd value after the vitamin D supplement is less than before the vitamin D supplement.

14.24 $t_+ = 214.5$, $p = 0.3547$. There is no evidence to suggest a difference in median collection times.

14.25 **(a)** $x = 6$, $p = 0.2272$. There is no evidence to suggest the median arsenic concentration is greater than 0.30. **(b)** $t_+ = 105.5$, $p = 0.0253 \leq 0.05$. There is evidence to suggest the median arsenic concentration is greater than 0.30. **(c)** The conclusions are different. The signed-rank test is more accurate. It takes into account more information from the sample.

14.26 $t_+ = 26$, $p = 0.0955$. There is no evidence to suggest the median is less than 118.

Section 14.3

14.27

(a)

Sample 1		Sample 2	
Obs	Rank	Obs	Rank
37	6	45	10
21	1	42	9
46	11	22	2
29	4	41	8
34	5	24	3
		39	7

(b)

Sample 1		Sample 2	
Obs	Rank	Obs	Rank
4.5	15.0	4.6	16.0
1.8	5.0	6.6	18.0
3.4	13.0	1.2	2.0
1.4	3.0	6.0	17.0
2.2	7.5	2.4	10.0
2.1	6.0	2.3	9.0
1.5	4.0	2.2	7.5
3.7	14.0	0.4	1.0
		2.5	11.0
		2.7	12.0

(c)

Sample 1		Sample 2	
Obs	Rank	Obs	Rank
820	11.0	850	25.0
809	4.0	840	21.0
872	33.0	813	6.0
826	15.0	842	23.0
814	7.0	870	30.0
887	39.0	839	20.0
825	14.0	888	40.0
884	38.0	816	8.0
876	35.0	822	13.0
862	27.0	879	36.0
858	26.0	821	12.0
846	24.0	865	28.5
841	22.0	832	19.0
801	2.0	865	28.5
892	41.0	818	9.5
871	31.5	827	16.0
882	37.0	899	42.0
803	3.0	818	9.5
		831	18.0
		830	17.0
		810	5.0
		875	34.0
		871	31.5
		800	1.0

14.28 **(a)** 35.0 **(b)** 82.5 **(c)** 256.5

14.29 **(a)** $W \leq 7$, $\alpha = 0.0357$. **(b)** $W \geq 24$, $\alpha = 0.0571$. **(c)** $W \leq 16$ or $W \geq 44$, $\alpha = 0.0540$. **(d)** $W \leq 27$, $\alpha = 0.0100$. **(e)** $W \leq 44$ or $W \geq 75$, $\alpha = 0.1142$. **(f)** $W \geq 90$, $\alpha = 0.0103$.

14.30 **(a)** 277.5, 971.25, 31.1649 **(b)** 333, 999, 31.6070 **(c)** 214.5, 965.25, 31.0685 **(d)** 234, 1014, 31.8434 **(e)** 552, 2208, 46.9894 **(f)** 700, 3500, 59.1608

14.31 $w = 28$, $p > 0.1412$. There is no evidence to suggest $\widetilde{\mu}_1 > \widetilde{\mu}_2$.

14.32 $z = -1.7067$. There is no evidence to suggest $\widetilde{\mu}_1 \neq \widetilde{\mu}_2$.

14.33 $w = 49$, $p = 0.0274 \leq 0.05$. There is evidence to suggest the population medians are different.

14.34 $w = 28.5$, $p = 0.0512$. There is no evidence (just barely) to suggest the population median fat contents are different.

14.35 **(a)** RR: $W \leq 35$, ($\alpha = 0.0131$). $w = 31 \leq 35$. There is evidence to suggest the median impact strength is higher for the new jackhammer. **(b)** 0.0020

14.36 $w = 146$, $p = 0.0005 \leq 0.01$. There is evidence to suggest the median slapshot speed of NHL defensemen is greater than the median slapshot speed of NHL forwards.

14.37 $w = 307.5$, $z = 1.8981$, $p = 0.0577$. There is no evidence to suggest the population median holding temperatures are different.

14.38 $w = 340.5$, $z = -3.9975$, $p = 0.000032$. There is excellent evidence to suggest the population median amount of protein in SBP is greater than the population median amount of protein in WTL.

Section 14.4

14.39 113.5, 86, 265.5

14.40 RR: $H \geq 13.2767$. $h = 16.1591 \geq 13.2767$. There is evidence to suggest at least two of the populations are different.

14.41 RR: $H \geq 7.8147$, $h = 5.2723$. There is no evidence to suggest the populations are different.

14.42 RR: $H \geq 5.9915$, $h = 6.5184 \geq 5.9915$. There is evidence to suggest at least two of the populations are different.

14.43 RR: $H \geq 10.5966$, $h = 14.9356 \geq 10.5966$. There is evidence to suggest at least two of the populations are different.

14.44 RR: $H \geq 7.8147$, $h = 6.3338$. There is no evidence to suggest the populations are different.

14.45 **(a)** RR: $H \geq 5.9915$, $h = 7.1960 \geq 5.9915$. There is evidence to suggest at least two of the populations are different. **(b)** $0.025 \leq p \leq 0.05$

14.46 RR: $H \geq 11.3449$, $h = 3.6953$. There is no evidence to suggest the tunnel-walking-time populations are different.

14.47 RR: $H \geq 9.3484$, $h = 4.8911$. There is no evidence to suggest the fat populations are different.

14.48 RR: $H \geq 5.9915$, $h = 1.3713$. There is no evidence to suggest the uncompressed depth populations are different. $p > 0.20$.

14.49 **(a)** RR: $H \geq 5.9915$, $h = 22.5890 \geq 5.9915$. There is evidence to suggest at least two of the length-of-service populations are different. **(b)** Public safety and communications. Support services and communications. The corresponding rank sums are very far apart.

Section 14.5

14.50 **(a)** 8 **(b)** 8 **(c)** 11 **(d)** 15

14.51 **(a)** $v_1 = 3$, $v_2 = 9$, $\alpha = 0.0788$. **(b)** $v_1 = 3$, $v_2 = 11$, $\alpha = 0.0264$. **(c)** $v_1 = 3$, $v_2 = 11$, $\alpha = 0.0260$. **(d)** $v_1 = 4$, $v_2 = 14$, $\alpha = 0.0256$.

14.52 **(a)** 8 **(b)** 5 **(c)** 8 **(d)** 15

14.53 **(a)** 13, 5.5. **(b)** 18.5, 8.25. **(c)** 4.68, 0.4109. **(d)** 27, 12.7451.

14.54 RR: $V \leq 7$ or $V \geq 17$. $v = 13$. There is no evidence to suggest the order of observations is not random.

14.55 **(a)** RR: $|Z| \geq 2.5758$. $z = 2.9463 \geq 2.5758$. There is evidence to suggest the order of observations is not random. **(b)** 0.0032

14.56 RR: $V \leq 3$ or $V \geq 8$ ($\alpha = 0.0385$). $v = 5$. There is no evidence to suggest the order of observations is not random with respect to gender.

14.57 RR: $V \leq 5$ or $V \geq 14$ ($\alpha = 0.0498$). $v = 9$. There is no evidence to suggest the order of observations is not random.

14.58 RR: $|Z| \geq 2.3263$. $z = 1.2546$. There is no evidence to suggest the order of observations is not random.

14.59 **(a)** RR: $V \leq 3$ or $V \geq 9$ ($\alpha = 0.1161$). $v = 8$. There is no evidence to suggest the order of observations is not random. **(b)** 0.5091

14.60 RR: $V \leq 3$ or $V \geq 10$ ($\alpha = 0.0242$). $v = 9$. There is no evidence to suggest the order of observations is not random.

14.61 RR: $|Z| \geq 1.9600$. $z = -2.6271 \leq -1.9600$. There is evidence to suggest the order of observations is not random.

Section 14.6

14.62

(a)

Sample 1		Sample 2		
Obs	Rank	Obs	Rank	d_i
54	5	113	1	4
17	2	114	2	0
28	3	139	4	−1
69	6	173	6	0
13	1	145	5	−4
49	4	121	3	1

(b)

Sample 1		Sample 2		
Obs	Rank	Obs	Rank	d_i
57	8	35	2	6
40	4	50	6	−2
32	1	51	7	−6
56	7	57	9	−2
33	2	38	3	−1
60	9	45	5	4
51	5	44	4	1
35	3	52	8	−5
53	6	32	1	5

(c)

Sample 1 Obs	Rank	Sample 2 Obs	Rank	d_i
22.5	5	27.0	11	−6
27.0	9	30.5	14	−5
22.8	6	21.6	2	4
26.5	8	27.9	12	−4
29.9	14	33.0	15	−1
20.8	4	22.9	5	−1
19.3	1	24.7	7	−6
28.3	13	22.2	3	10
19.5	2	24.3	6	−4
20.3	3	26.2	10	−7
28.2	12	25.1	9	3
27.9	11	29.4	13	−2
27.8	10	22.6	4	6
31.6	15	24.8	8	7
25.3	7	20.3	1	6

(d)

Sample 1 Obs	Rank	Sample 2 Obs	Rank	d_i
49.0	10.0	78.1	17.0	−7.0
51.2	11.0	60.8	2.0	9.0
46.7	6.0	70.4	9.0	−3.0
54.9	14.5	42.2	1.0	13.5
53.6	12.0	64.9	3.0	9.0
48.9	9.0	70.8	10.0	−1.0
46.8	7.5	74.3	14.0	−6.5
46.2	5.0	68.4	6.0	−1.0
55.8	18.0	66.5	5.0	13.0
40.8	1.0	75.9	16.0	−15.0
46.8	7.5	65.9	4.0	3.5
55.7	17.0	70.3	8.0	9.0
54.9	14.5	71.4	11.0	3.5
45.0	4.0	75.6	15.0	−11.0
55.1	16.0	72.0	13.0	3.0
43.2	2.0	69.4	7.0	−5.0
43.8	3.0	71.7	12.0	−9.0
53.9	13.0	78.3	18.0	−5.0

14.63 **(a)** 0.5357. Moderate positive relationship. **(b)** 0.3333. Weak positive relationship. **(c)** 0.0637. No definitive relationship. **(d)** −0.2922. Weak negative relationship.

14.64

(a)

Sample 1 Obs	Rank	Sample 2 Obs	Rank	d_i
1.5	6.5	7.3	6.5	0.0
1.8	10.0	6.8	3.0	7.0
1.5	6.5	7.4	8.5	−2.0
1.6	8.0	7.5	10.0	−2.0
1.7	9.0	6.7	2.0	7.0
1.4	4.5	7.4	8.5	−4.0
1.3	3.0	7.2	4.5	−1.5
1.2	1.5	7.2	4.5	−3.0
1.4	4.5	7.3	6.5	−2.0
1.2	1.5	6.6	1.0	0.5

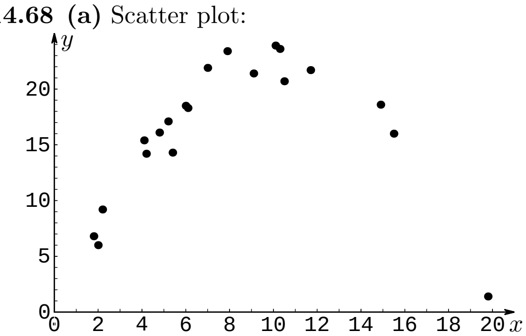
(b) 0.1512 **(c)** 0.1667 **(d)** There are tied observations.

14.65 0.7714. There is a positive relationship between x and y. As the price of a stateroom increases, so does the number of days before sailing. Therefore, this suggests that cruise prices are reduced at the last minute.

14.66 0.1758. This suggests a weak positive relationship.

14.67 −0.4429. This suggests a weak to moderate negative relationship. As the bulk density increases, the soil texture decreases.

14.68 **(a)** Scatter plot:



(b) 0.4842. Positive relationship. **(c)** The scatter plot suggests the relationship is quadratic, not linear.

14.69 −0.7901. This suggests a strong negative relationship. As the central body fat increases, the lifestyle score decreases.

14.70 **(a)**

Sample 1 Obs	Sample 1 Rank	Sample 2 Obs	Sample 2 Rank	d_i
71	9.0	64	7.5	1.5
69	6.5	56	1.0	5.5
66	3.0	65	9.5	−6.5
69	6.5	62	4.0	2.5
62	1.0	65	9.5	−8.5
67	4.0	64	7.5	−3.5
69	6.5	57	2.5	4.0
64	2.0	63	5.5	−3.5
73	10.0	57	2.5	7.5
69	6.5	63	5.5	1.0

(b) −0.5887 **(c)** −0.5212. **(d)** There are tied observations. There is a moderate negative relationship. As x increases, y decreases.

14.71 −0.3656. There is a weak negative relationship. As the cost of a book increases, the number of weeks on the best seller list decreases.

Chapter Exercises

14.72 $x = 10$, $p = 0.1509$. There is no evidence to suggest the median nitrogen emissions amount is greater than 5.

14.73 **(a)** RR: $X \geq 14$ ($\alpha = 0.0577$). $x = 16 \geq 14$. There is evidence to suggest the median amount of stored DDT on farms is greater than 2. **(b)** 0.0059.

14.74 $x = 15$, $p = 0.0414 \leq 0.05$. There is evidence to suggest the median coverage amount is different from 2.

14.75 **(a)** RR: $X \leq 6$ ($\alpha = 0.0207$). $x = 5 \leq 6$. There is evidence to suggest the median freon weight before service is less than the median freon weight after service. **(b)** Yes. The sign test suggests the median freon weight after service is larger.

14.76 RR: $T_+ \leq 36$ ($\alpha = 0.0523$). $t_+ = 73$. There is no evidence to suggest the mean kiwi weight is less than 2370. $p > 0.1057$.

14.77 **(a)** RR: $T_+ \leq 20$ ($\alpha = 0.0108$). $t_+ = 17.5 \leq 20$. There is evidence to suggest the median spray height is less than 630. **(b)** 0.0062 **(c)** The distribution is not assumed to be symmetric.

14.78 RR: $T_+ \leq 5$ or $T_+ \geq 40$ ($\alpha = 0.0390$). $t_+ = 33$. There is no evidence to suggest the median plunge height is different from 42. $p = 0.2500$.

14.79 RR: $T_+ \geq 100$ ($\alpha = 0.0523$). $t_+ = 133 \geq 100$. There is evidence to suggest the median time spent working per week for those well off is greater than for those who just manage.

14.80 RR: $W \leq 20$ or $W \geq 45$ ($\alpha = 0.0480$). $w = 45.5 \geq 45$. There is evidence to suggest the median number of miles driven is different for people who carry an organ donor card and for those who do not.

14.81 **(a)** $W \leq 52$ or $W \geq 84$ ($\alpha = 0.1048$). $w = 78.5$. There is no evidence to suggest there is a difference in the absorbed radiation by machine. **(b)** 0.2786

14.82 RR: $|Z| \geq 1.96$. $w = 311$, $z = 3.2560 \geq 1.96$. There is evidence to suggest the median pressures are different. $p = 0.0011$.

14.83 RR: $|Z| \geq 3.2905$. $w = 533$, $z = 2.5940$. There is no evidence to suggest the land value for farmland is different in these two counties.

14.84 RR: $H \geq 5.9915$, $h = 13.66 - 3 \geq 5.9915$. There is evidence to suggest at least two slate weight populations are different.

14.85 RR: $H \geq 9.3484$, $h = 3.1241$. There is no evidence to suggest the transmitter power populations are different. $p = 0.3729$.

14.86 RR: $H \geq 5.9915$, $h = 9.1032 \geq 5.9915$. There is evidence to suggest at least two of the paintball weight population distributions are different.

14.87 **(a)** RR: $H \geq 7.8147$, $h = 8.4760 \geq 7.8147$. There is evidence to suggest at least two of the nail-gun speed population distributions are different. **(b)** $0.025 \leq p \leq 0.05$. **(c)** Hitachi. This brand has the highest median speed and the highest average rank.

14.88 **(a)** RR: $V \leq 4$ or $V \geq 11$ ($\alpha = 0.0709$). $v = 7$. There is no evidence to suggest the order of observations is not random with respect to exterior finish. **(b)** Cannot tell. We don't know the historical proportion of home-builders who use vinyl. Therefore, we cannot tell if this proportion has increased.

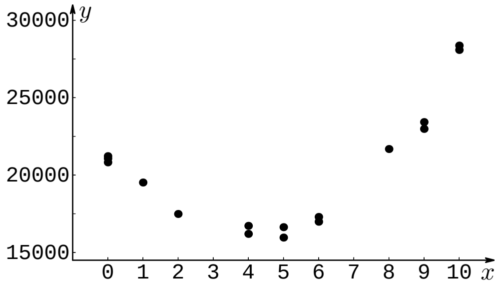
14.89 **(a)** RR: $V \leq 3$ or $V \geq 10$ ($\alpha = 0.0476$). $v = 10 \geq 10$. There is evidence to suggest the order of observations is not random with respect to email password. **(b)** 0.0476.

14.90 RR: $|Z| \geq 1.96$. $z = 2.3725 \geq 1.96$. There is evidence to suggest the order of automobiles entering the parking garage is not random.

14.91 RR: $|Z| \geq 2.5758$. $z = 1.7872$. There is no evidence to suggest the order of observations is not random. $p = 0.0739$.

14.92 −0.5952. Moderate negative relationship. As a patient's mood increases, systolic blood pressure tends to decrease.

14.93 **(a)** Scatter plot:



(b)

x		y		
Obs	Rank	Obs	Rank	d_i
0	2.0	21221	11.0	−9.0
2	5.0	17487	7.0	−2.0
0	2.0	21070	10.0	−8.0
0	2.0	20822	9.0	−7.0
10	15.5	28084	15.0	0.5
6	10.5	16986	5.0	5.5
9	13.5	22983	13.0	0.5
10	15.5	28366	16.0	−0.5
9	13.5	23423	14.0	−0.5
5	8.5	16634	3.0	5.5
1	4.0	19519	8.0	−4.0
6	10.5	17295	6.0	4.5
4	6.5	16200	2.0	4.5
8	12.0	21683	12.0	0.0
5	8.5	15962	1.0	7.5
4	6.5	16719	4.0	2.5

(c) 0.4397 **(d)** 0.4434 **(e)** There are tied observations. **(f)** Either 0 or 10. The scatter plot suggests the relationship is quadratic.

14.94 −0.4126. Weak to moderate negative relationship. This suggests as the quality score increases, the total number of people in the hospital decreases.

14.95 **(a)** −0.6000. Moderate negative relationship. This suggests as the temperament score increases, the pigmentation score decreases. **(b)** An all-white head Holstein would have a very high temperament score. This would probably be a very jittery animal.

14.96 **(a)** RR: $H \geq 9.2103$, $h = 32.8940 \geq 9.2103$. There is excellent evidence to suggest at least two of the populations are different. **(b)** $p < 0.0001$ **(c)** The safest time to drive is *other times*.

Exercises′

14.97 **(a)** RR: $X \geq 11$ ($\alpha = 0.0592$). $x = 15$. There is overwhelming evidence to suggest the median amount of particulates before the smoking regulations is less than the median amount after the regulations.
(b) RR: $T_+ \geq 89$ ($\alpha = 0.0535$). $t_+ = 120 \geq 89$. There is evidence to suggest the median amount of particulates before the smoking regulations is less than the median amount after the regulations.
(c) RR: $Z \geq 1.6449$. $z = 4.4382 \geq 1.6449$. There is evidence to suggest the median amount of particulates before the smoking regulations is less than the median amount after the regulations. **(d)** All three tests lead to the same conclusion. The rank sum test is probably the most appropriate. It takes into account more information in the sample.

14.98 **(a)** 0.5549. Moderate positive relationship. This suggests as the added pressure increases, the power also increases. **(b)** RR: $Z \geq 2.3263$. $z = 2.4187 \geq 2.3263$. There is evidence to suggest the true population correlation between ranks is greater than 0.