1.22. a. $\hat{Y} = 168.600000 + 2.034375X$

b. $\hat{Y}_h = 249.975$

c. $\beta_1 = 2.034375$

2.7. a. $t(.995; 14) = 2.977$, $b_1 = 2.0344$, $s\{b_1\} = .0904$, $2.0344 \pm 2.977(.0904)$, $1.765 \leq \beta_1 \leq 2.304$

b. H_0: $\beta_1 = 2$, H_a: $\beta_1 \neq 2$. $t^* = (2.0344 - 2)/.0904 = .381$. If $|t^*| \leq 2.977$ conclude H_0, otherwise H_a. Conclude H_0. P-value= .71

c. $\delta = |.3|/.1 = 3$, power = .50

2.16. a. $\hat{Y}_h = 229.631$, $s\{\hat{Y}_h\} = .8285$, $t(.99; 14) = 2.624$, $229.631 \pm 2.624(.8285)$, $227.457 \leq E\{Y_h\} \leq 231.805$

b. $s\{pred\} = 3.338$, $229.631 \pm 2.624(3.338)$, $220.872 \leq Y_{h(new)} \leq 238.390$

c. $s\{predmean\} = 1.316$, $229.631 \pm 2.624(1.316)$, $226.178 \leq \bar{Y}_{h(new)} \leq 233.084$

d. Yes, yes

e. $W^2 = 2F(.98; 2, 14) = 2(5.241) = 10.482$, $W = 3.238$, $229.631 \pm 3.238(.8285)$, $226.948 \leq \beta_0 + \beta_1 X_h \leq 232.314$, yes, yes

2.26. a.

Source	SS	df	MS
Regression	5,297.5125	1	5,297.5125
Error	146.4250	14	10.4589
Total	5,443.9375	15	

b. H_0: $\beta_1 = 0$, H_a: $\beta_1 \neq 0$, $F^* = 5,297.5125/10.4589 = 506.51$, $F(.99; 1, 14) = 8.86$.If $F^* \leq 8.86$ conclude H_0, otherwise H_a. Conclude H_a.

c.

i:	1	2	3	4	5	6
$Y_i - \hat{Y}_i$:	-2.150	3.850	-5.150	-1.150	.575	2.575
$\hat{Y}_i - \bar{Y}$:	-24.4125	-24.4125	-24.4125	-24.4125	-8.1375	-8.1375

i:	7	8	9	10	11	12
$Y_i - \hat{Y}_i$:	-2.425	5.575	3.300	.300	1.300	-3.700
$\hat{Y}_i - \bar{Y}$:	-8.1375	-8.1375	8.1375	8.1375	8.1375	8.1375

i:	13	14	15	16
$Y_i - \hat{Y}_i$:	.025	-1.975	3.025	-3.975
$\hat{Y}_i - \bar{Y}$:	24.4125	24.4125	24.4125	24.4125

d. $R^2 = .9731$, $r = .9865$

3.6.a and b.

i:	1	2	3	4	5	6
e_i:	-2.150	3.850	-5.150	-1.150	.575	2.575
$\hat{Y}_i$:	201.150	201.150	201.150	201.150	217.425	217.425

i:	7	8	9	10	11	12
e_i:	-2.425	5.575	3.300	.300	1.300	-3.700
$\hat{Y}_i$:	217.425	217.425	233.700	233.700	233.700	233.700

i:	13	14	15	16
e_i:	.025	-1.975	3.025	-3.975
$\hat{Y}_i$:	249.975	249.975	249.975	249.975

c. and d.

Ascending order:	1	2	3	4	5	6
Ordered residual:	-5.150	-3.975	-3.700	-2.425	-2.150	-1.975
Expected value	-5.720	-4.145	-3.196	-2.464	-1.841	-1.280
e_i^*:	-1.592	-1.229	-1.144	-.750	-.665	-.611

Ascending order:	7	8	9	10	11	12
Ordered residual:	-1.150	.025	.300	.575	1.300	2.575
Expected value:	-.755	-.250	.250	.755	1.280	1.841
e_i^*:	-.356	.008	.093	.178	.402	.796

Ascending order:	13	14	15	16
Ordered residual:	3.025	3.300	3.850	5.575
Expected value:	2.464	3.196	4.145	5.720
e_i^*:	.935	1.020	1.190	1.724

H_0: Normal, H_a: not normal. $r = .992$. If $r \geq .941$ conclude H_0, otherwise H_a. Conclude H_0. $t(.25; 14) = -.692$, $t(.50; 14) = 0$, $t(.75; 14) = .692$

Actual: 4/16 7/16 11/16

e. $n_1 = 8$, $\bar{d}_1 = 2.931$, $n_2 = 8$, $\bar{d}_2 = 2.194$, $s = 1.724$,
$t^*_{BF} = (2.931 - 2.194)/1.724\sqrt{(1/8) + (1/8)} = .86$, $t(.975; 14) = 2.145$. If $|t^*_{BF}| \leq 2.145$ conclude error variance constant, otherwise error variance not constant. Conclude error variance constant.

4.5. a. $B = t(.975; 14) = 2.145$, $b_0 = 168.6000$, $s\{b_0\} = 2.6570$, $b_1 = 2.0344$, $s\{b_1\} = .0904$

$168.6000 \pm 2.145(2.6570)$ $\quad 162.901 \leq \beta_0 \leq 174.299$

$2.0344 \pm 2.145(.0904)$ $\quad 1.840 \leq \beta_1 \leq 2.228$

b. Negatively, no

4.9. a. $B = t(.9833; 14) = 2.360$

$X_h = 20$: $209.2875 \pm 2.360(1.0847)$ $\quad 206.727 \leq E\{Y_h\} \leq 211.847$

$X_h = 30$: $229.6312 \pm 2.360(0.8285)$ $\quad 227.676 \leq E\{Y_h\} \leq 231.586$

$X_h = 40$: $249.9750 \pm 2.360(1.3529)$ $\quad 246.782 \leq E\{Y_h\} \leq 253.168$

b. $F(.90; 2, 14) = 2.737$, $W = 2.340$, no

c. $F(.90; 2, 14) = 2.737$, $S = 2.340$, $B = t(.975; 14) = 2.145$

$X_h = 30$: $229.6312 \pm 2.145(3.3385)$ $\quad 222.470 \leq Y_{h(\text{new})} \leq 236.792$

$X_h = 40$: $249.9750 \pm 2.145(3.5056)$ $\quad 242.455 \leq Y_{h(\text{new})} \leq 257.495$

5.5. (1) 1,259 (2) $\begin{bmatrix} 6 & 17 \\ 17 & 55 \end{bmatrix}$ (3) $\begin{bmatrix} 81 \\ 261 \end{bmatrix}$

6.15. b.

$$\begin{array}{c} Y \\ X_1 \\ X_2 \\ X_3 \end{array} \begin{bmatrix} 1.000 & -.7868 & -.6029 & -.6446 \\ & 1.000 & .5680 & .5697 \\ & & 1.000 & .6705 \\ & & & 1.000 \end{bmatrix}$$

c. $\hat{Y} = 158.491 - 1.1416X_1 - 0.4420X_2 - 13.4702X_3$

d&e.

i:	1	2	...	45	46
e_i:	.1129	−9.0797	...	−5.5380	10.0524
Expected Val.:	−0.8186	−8.1772	...	−5.4314	8.1772

f. No

g. $SSR^* = 21,355.5$, $SSE = 4,248.8$, $X^2_{BP} = (21,355.5/2) \div (4,248.8\ /46)^2 = 1.2516$, $\chi^2(.99;3) = 11.3449$. If $X^2_{BP} \leq 11.3449$ conclude error variance constant, otherwise error variance not constant. Conclude error variance constant.

6.16. a. H_0: $\beta_1 = \beta_2 = \beta_3 = 0$, H_a: not all $\beta_k = 0$ $(k = 1, 2, 3)$.

$MSR = 3,040.2$, $MSE = 101.2$, $F^* = 3,040.2/101.2 = 30.05$, $F(.90;3,42) = 2.2191$. If $F^* \leq 2.2191$ conclude H_0, otherwise H_a. Conclude H_a. P-value = 0.4878

b. $s\{b_1\} = .2148$, $s\{b_2\} = .4920$, $s\{b_3\} = 7.0997$, $B = t(.9833;42) = 2.1995$

$-1.1416 \pm 2.1995(.2148)$ $\quad -1.6141 \leq \beta_1 \leq -0.6691$

$-.4420 \pm 2.1995(.4920)$ $\quad -1.5242 \leq \beta_2 \leq 0.6402$

$-13.4702 \pm 2.1995(7.0997)$ $\quad -29.0860 \leq \beta_3 \leq 2.1456$

c. $SSR = 9,120.46$, $SSTO = 13,369.3$, $R = .8260$

6.17. a. $\hat{Y}_h = 69.0103$, $s\{\hat{Y}_h\} = 2.6646$, $t(.95;42) = 1.6820$, $69.0103 \pm 1.6820(2.6646)$, $64.5284 \leq E\{Y_h\} \leq 73.4922$

b. $s\{\text{pred}\} = 10.405$, $69.0103 \pm 1.6820(10.405)$, $51.5091 \leq Y_{h(\text{new})} \leq 86.5115$

7.5. a. $SSR(X_2) = 4,860.26$, $SSR(X_1|X_2) = 3,896.04$, $SSR(X_3|X_2, X_1) = 364.16$, $SSE(X_1, X_2, X_3) = 4,248.84$, *df*: 1, 1, 1, 42

b. H_0: $\beta_3 = 0$, H_a: $\beta_3 \neq 0$. $SSR(X_3|X_1, X_2) = 364.16$, $SSE(X_1, X_2, X_3) = 4,248.84$, $F^* = (364.16/1) \div (4,248.84/42) = 3.5997$, $F(.975;1,42) = 5.4039$. If $F^* \leq 5.4039$ conclude H_0, otherwise H_a . Conclude H_0. P-value = 0.065.

7.14. a. $R^2_{Y1} = .6190$, $R^2_{Y1|2} = .4579$, $R^2_{Y1|23} = .4021$

b. $R^2_{Y2} = .3635$, $R^2_{Y2|1} = .0944$, $R^2_{Y2|13} = .0189$

8.16. b. $\hat{Y} = 2.19842 + .03789X_1 - .09430X_2$

c. $H_0 : \beta_2 = 0$, $H_a : \beta_2 \neq 0$. $s\{b_2\} = .11997$, $t^* = -.09430/.11997 = -.786$, $t(.995; 117) = 2.6185$. If $|t^*| \leq 2.6185$ conclude H_0, otherwise H_a. Conclude H_0.

d.

i:	1	2	...	119	120
$X_{i1}X_{i2}$:	0	14	...	16	0
e_i:	.90281	1.25037	...	-.85042	-.31145

8.20. a. $\hat{Y} = 3.22632 - .00276X_1 - 1.64958X_2 + .06224X_1X_2$

b. $H_0 : \beta_3 = 0$, $H_a : \beta_3 \neq 0$. $s\{b_3\} = .02649$, $t^* = .06224/.02649 = 2.3496$, $t(.975; 116) = 1.9806$. If $|t^*| \leq 1.9806$ conclude H_0, otherwise H_a. Conclude H_a. Alternatively, $SSR(X_1X_2|X_1, X_2) = 2.07126$, $SSE(X_1, X_2, X_1X_2) = 45.5769$, $F^* = (2.07126/1) \div (45.5769/116) = 5.271665$, $F(.95; 1, 116) = 3.9229$. If $F^* \leq 3.9229$ conclude H_0, otherwise H_a. Conclude H_a.

9.9.

Variables in Model	R_p^2	AIC_p	C_p	$PRESS_p$
None	0	262.916	88.16	13,970.10
X_1	.6190	220.529	8.35	5,569.56
X_2	.3635	244.131	42.11	9,254.49
X_3	.4155	240.214	35.25	8,451.43
X_1, X_2	.6550	217.968	5.60	5,235.19
X_1, X_3	.6761	215.061	2.81	4,902.75
X_2, X_3	.4685	237.845	30.25	8,115.91
X_1, X_2, X_3	.6822	216.185	4.00	5,057.886

10.11. a&f.

i:	1	2	...	45	46
t_i:	.0116	$-.9332$	...	$-.5671$	1.0449
D_i:	.000003	.015699	...	.006400	.024702

$t(.998913; 41) = 3.27$. If $|t_i| \leq 3.27$ conclude no outliers, otherwise outliers. Conclude no outliers.

b. $2p/n = 2(4)/46 = .1739$. Cases 9, 28, and 39.

c. $\mathbf{X}'_{\text{new}} = [\ 1 \quad 30 \quad 58 \quad 2.0\ ]$

$$(\mathbf{X}'\mathbf{X})^{-1} = \begin{bmatrix} 3.24771 & .00922 & -.06793 & -.06730 \\ & .00046 & -.00032 & -.00466 \\ & & .00239 & -.01771 \\ & & & .49826 \end{bmatrix}$$

$h_{\text{new, new}} = .3267$, extrapolation

d.

	DFFITS	DFBETAS b_0	DFBETAS b_1	DFBETAS b_2	DFBETAS b_3	D
Case 11:	.5688	.0991	$-.3631$	$-.1900$	.3900	.0766
Case 17:	.6657	$-.4491$	$-.4711$	.4432	.0893	.1051
Case 27:	$-.6087$	$-.0172$	.4172	$-.2499$	.1614	.0867

e. Case 11: 1.10%, case 17: 1.32% , case 27: 1.12%.

16.10. b. $\hat{Y}_{1j} = \bar{Y}_{1.} = 21.500$, $\hat{Y}_{2j} = \bar{Y}_{2.} = 27.750$, $\hat{Y}_{3j} = \bar{Y}_{3.} = 21.417$

c. e_{ij}:

i	$j=1$	$j=2$	$j=3$	$j=4$	$j=5$	$j=6$
1	1.500	3.500	−.500	.500	−.500	.500
2	.250	−.750	−.750	1.250	−1.750	1.250
3	1.583	−1.417	3.583	−.417	.583	1.583

i	$j=7$	$j=8$	$j=9$	$j=10$	$j=11$	$j=12$
1	−1.500	1.500	−2.500	.500	−2.500	−.500
2	−.750	2.250	.250	−.750	−1.750	1.250
3	−.417	−1.417	−2.417	−1.417	.583	−.417

d.

Source	SS	df	MS
Between ages	316.722	2	158.361
Error	82.167	33	2.490
Total	398.889	35	

e. H_0: all μ_i are equal ($i = 1, 2, 3$), H_a: not all μ_i are equal. $F^* = 158.361/2.490 = 63.599$, $F(.99; 2, 33) = 5.31$. If $F^* \leq 5.31$ conclude H_0, otherwise H_a. Conclude H_a. P-value = 0+

17.11. a. $\bar{Y}_{1.} = 21.500$, $\bar{Y}_{2.} = 27.750$, $\bar{Y}_{3.} = 21.417$

b. $MSE = 2.490$, $s\{\bar{Y}_{1.}\} = .456$, $t(.995; 33) = 2.733$, $21.500 \pm 2.733(.456)$, $20.254 \leq \mu_1 \leq 22.746$

c. $\hat{D} = \bar{Y}_{3.} - \bar{Y}_{1.} = -.083$, $s\{\hat{D}\} = .644$, $t(.995; 33) = 2.733$, $-.083 \pm 2.733(.644)$, $-1.843 \leq D \leq 1.677$

d. $H_0: 2\mu_2 - \mu_1 - \mu_3 = 0$, $H_a: 2\mu_2 - \mu_1 - \mu_3 \neq 0$. $F^* = (12.583)^2/1.245 = 127.17$, $F(.99; 1, 33) = 7.47$. If $F^* \leq 7.47$ conclude H_0, otherwise H_a. Conclude H_a.

e. $\hat{D}_1 = \bar{Y}_{3.} - \bar{Y}_{1.} = -.083$, $\hat{D}_2 = \bar{Y}_{3.} - \bar{Y}_{2.} = -6.333$, $\hat{D}_3 = \bar{Y}_{2.} - \bar{Y}_{1.} = 6.250$, $s\{\hat{D}_i\} = .644$ ($i = 1, 2, 3$), $q(.90; 3, 33) = 3.01$, $T = 2.128$

$$-.083 \pm 2.128(.644) \qquad -1.453 \leq D_1 \leq 1.287$$
$$-6.333 \pm 2.128(.644) \qquad -7.703 \leq D_2 \leq -4.963$$
$$6.250 \pm 2.128(.644) \qquad 4.880 \leq D_3 \leq 7.620$$

f. $B = t(.9833; 33) = 2.220$, no

18.7. a. See Problem 16.10c.

b. $r = .984$

d. t_{ij}:

i	$j=1$	$j=2$	$j=3$	$j=4$	$j=5$	$j=6$
1	.9927	2.4931	−.3265	.3265	−.3265	.3265
2	.1630	−.4907	−.4907	.8234	−1.1646	.8234
3	1.0497	−.9360	2.5645	−.2719	.3811	1.0497

i	$j=7$	$j=8$	$j=9$	$j=10$	$j=11$	$j=12$
1	−.9927	.9927	−1.7017	.3265	−1.7017	−.3265
2	−.4907	1.5185	.1630	−.4907	−1.1646	.8234
3	−.2719	−.9360	−1.6401	−.9360	.3811	−.2719

H_0: no outliers, H_a: at least one outlier. $t(.99965; 32) = 3.75$. If $|t_{ij}| \leq 3.75$ conclude H_0, otherwise H_a. Conclude H_0.