Chapter 16

16–1. H_0: $\tilde{\mu} = 7.0$ $\quad n = 10$
H_1: $\tilde{\mu} = 7.0$

$\alpha = 0.05$

CR: $R \leq R^*_\alpha$ (Table X)

$$R^+ = 8,\ R^- = 2 \ \Rightarrow\ R = 2$$

Since $R > R^*_\alpha$, do not reject H_0

16–2. H_0: $\tilde{\mu} = 8.5$
H_1: $\tilde{\mu} \neq 8.5$

$\alpha = 0.05$
$R^+ = 8,\ R^- = 11,\ R = \min(8, 11) = 8,\ R^*_{0.05} = 5$

Since $R > R^*_{0.05}$, do not reject H_0

16–3. (a) H_0: $\tilde{\mu} = 3.5$ $\quad$ Critical Region: $R^- < R^*_d$
H_1: $\tilde{\mu} > 3.5$

(b) $n = 10$ $\quad \alpha = 0.05$ $\quad R^*_{0.05} = 1$
$R = 3$ $\quad$ Since $R^- > R^*_{0.05}$, do not reject H_0

(c) Probability of not rejecting H_0 ($\tilde{\mu} = 3.5$) when $\tilde{\mu} = 4.5$

$$p \ = \ P(X > 1) \ = \ \int_1^\infty \frac{1}{\beta} e^{-(1/\beta)x}\, dx \ = \ e^{-1/\beta}$$

16–4. $n = 10$ $\quad \sigma = 1$
H_0: $\mu = 0$
H_1: $\mu > 0$

(a) $\alpha = 0.025$

(b) $p = P(X > 0) = P(Z > -1) = 1 - \Phi(-1) = 0.8413$
$R^*_{0.05} = 1$
$$\beta = 1 - \sum_{x=0}^{1} \binom{10}{x} (0.1587)^x (0.8413)^{10-x} = 0.487$$

16–5. H_0: $\tilde{\mu}_d = 0$
H_1: $\tilde{\mu}_d \neq 0$

$\alpha = 0.05$

CR: $R < R^*_{0.05} = 1$
$R^- = 2,\ R^+ = 6 \ \Rightarrow\ R = 2$
Since R is not less than R^*, do not reject H_0

16–8. H_0: $\mu = 7$ $\qquad R^+ = 50.5$
H_1: $\mu \neq 7$ $\qquad R^- = 4.5$
$R = \min(50.5, 4.5) = 4.5$
$R_{0.05} = 8$ $\qquad$ reject H_0

16–9. H_0: $\mu = 8.5$ $\qquad n = 20$
H_1: $\mu \neq 8.5$

$\alpha = .05$

CR: $R \leq R^*_{0.05} = 52$

$R^+ = 19 + 10.5 + \cdots + 1 = 88.5$
$R^- = 12 + 20 + \cdots + 3.5 = 121.5$
$R = 88.5 > R^*_{0.05}$
$\therefore$ do not reject H_0
conclude titanium content is 8.5%

16–10. H_0: $\mu = 8.5$ $\qquad \mu_R = \dfrac{20(21)}{4} = 10.5$

H_1: $\mu \neq 8.5$ $\qquad \sigma^2_R = \dfrac{10(21)(41)}{24} = 717.5$

$$Z_0 = \frac{85 - 105}{\sqrt{717.5}} = -0.747$$

16–12. $R^+ = 24.5$ $\qquad R = \min(24.5, 11.5) = 11.5$
$R^- = 11.5$ $\qquad R^*_{0.05} = 3$

Do not reject H_0, $\mu_d = 0$.

16–13. H_0: $\mu_1 = \mu_2$ $\quad n_1 = 8 \quad n_2 = 9$
H_1: $\mu_1 > \mu_2$

CR: $R_1 < R^*_\alpha = 51$ Table IX

$\alpha = 0.05$

$R_2 = 75$, $R_1 = 78$
Since R_2 is not less than or equal to 51, do not reject H_0. Conclude the two circuits are equivalent.

16–14. $n_1 = n_2$
$R_1 = 40$
$R_2 = 6(13) - 40 = 38$
$R^*_{0.05} = 26$

Do not reject H_0

Airline	Minutes	Rank
D	0	1
D	1	2.5
A	1	2.5
A	2	4
A	3	5
A	4	6.5
D	4	6.5
A	8	8
D	9	9
D	10	10
D	13	11
A	15	12

16–15. $n_1 = n_2 = 10, \qquad n > 8$ large-sample approximation

H_0: $\mu_1 = \mu_2$
H_1: $\mu_1 \neq \mu_2$

$\alpha = 0.05$

CR: $|Z_0| > Z_{0.025} = 1.96$

$$\mu_{R_1} = \frac{(20)(21)}{4} = 105, \qquad \sigma^2_{R_1} = \frac{10(10)(21)}{12} = 175$$

$$R_1 = 1 + 2 + 3 + \cdots + 19.5 = 77$$

$$Z_0 = \frac{77 - 105}{\sqrt{175}} = -2.117; |Z_0| = 2.117 > 1.96$$

Reject H_0; conclude unit 2 is superior.

16–16. H_0: techniques do not differ
H_1: techniques differ

	Ranks				R_i
1	14	11.5	6	7	38.5
2	16	11.5	9	15	51.5
3	5	8	10	13	36
4	15	3	1.5	4	10

$$S^2 = \frac{1}{15}\left[1495 - \frac{16(17)^2}{4}\right] = 22.6$$

$$K = \frac{1}{22.6}\left[\frac{38.5^2}{4} + \frac{51.5^2}{4} + \frac{36^2}{4} + \frac{10^2}{4} - \frac{16(17)^2}{4}\right] = 10.03$$

$\chi^2_{0.05,3} = 7.81$, reject H_0; conclude the techniques differ

16–17. H_0: methods do not differ
H_1: methods differ
$\alpha = 0.10$
CR: $K > \chi^2_{0.10,2} = 4.61$

Method	Ranks					r_i
1	10.5	9	12	7	5	43.5
2	10.5	15	14	8	6	53.5
3	1	4	3	2	13	83

$$K = \frac{12}{15(16)}\left(\frac{43.5^2}{5} + \frac{53.5^2}{5} + \frac{53.5^2}{5} + \frac{23^2}{5}\right) - 3(16) = 4.835$$

at 0.1 significance, reject H_0.

16–18. H_0: manufacturers do not differ
H_1: they differ

	Ranks					R_i
A	12	1	3	9	13	38
B	4	17	14	7	20	62
C	19	15	16	11	18	79
D	5	10	2	8	6	31

$$K = \frac{12}{20(21)}\left[\frac{38^2 + 62^2 + 79^2 + 31^2}{5}\right] - 3(21) = 8.37$$

$\chi^2_{0.05,3} = 7.81$. Reject H_0; conclude the manufacturers differ.