Decision: Do not reject H_0.

16.8 The hypotheses

$$H_0 : \tilde{\mu} = 20$$
$$H_1 : \tilde{\mu} > 20.$$

$\alpha = 0.05$.
Critical region: $w_{\leq} 11$ for $n = 10$.
Computations:

d_i	-3	12	5	-5	8	5	-8	15	6	4
Rank	1	9	4	4	7.5	4	7.5	10	6	2

Therefore, $w_{=} 12.5$.
Decision: Do not reject H_0.

16.20 The hypotheses

$$H_0 : \tilde{\mu}_1 = \tilde{\mu}_2$$
$$H_1 : \tilde{\mu}_1 \neq \tilde{\mu}_2.$$

$\alpha = 0.05$.
Critiral region: $Z < -1.96$ or $z > 1.96$.
Computations:

Observation	12.7	13.2	13.6	13.6	14.1	14.1	14.5	14.8	15.0	15.0	15.4
Rank	1*	2	3.5*	3.5	5.5*	5.5	7	8	9.5*	9.5	11.5*
Observation	15.4	15.6	15.9	15.9	16.3	16.3	16.3	16.3	16.5	16.8	17.2
Rank	11.5	13*	14.5*	14.5	17.5*	17.5*	17.5	17.5	20	21*	22
Observation	17.4	17.7	17.7	18.1	18.1	18.3	18.6	18.6	18.6	19.1	20.0
Rank	23	24.5	24.5*	26.5*	26.5	28	30	30*	30	32	33

Now $w_1 = 181.5$ and $u_1 = 181.5 - (12)(13)/2 = 103.5$. Then with $\mu_{U_1} = (21)(12)/2 = 126$ and $\sigma_{U_1} = \sqrt{(21)(12)(34)/12} = 26.721$, we find $z = (103.5 - 126)/26.721 = -0.84$.
Decision: Do not reject H_0.

10.23 Test $H_0 : M_1 = M_2$ vs $H_A : M_1 < M_2$.

In the joint sample (already ordered),

$$\underline{89}, \underline{99}, 109, \underline{119}, \underline{139}, 159, 179, \underline{189}, \underline{199}, 209, 219, \underline{229}, 259, 279, 299, 309,$$

the prices of textbooks during Eric's freshman year are underlined. Their ranks in the joint sample are

$$R_i = 1, 2, 4, 5, 8, 9, \text{ and } 12,$$

and the sum of these ranks is the Mann-Whitney-Wilcoxon test statistic,

$$U_{\text{obs}} = \sum_i R_i = \underline{41}.$$

From Table A9 with $n_1 = 7$ and $n_2 = 9$, the p-value is

$$P = \boldsymbol{P}\{U \le 38\} \underline{\in (0.025, 0.05)}.$$

This case is marginal. For all $\alpha \ge 0.05$, there is a significant evidence that during the freshman year, the median price of textbooks was lower, so the median cost of textbooks is rising. However, for any $\alpha \le 0.025$, this evidence is not significant.