5.2.  
1) The parameter of interest is the difference in breaking strengths, \( \mu_1 - \mu_2 \) and \( \Delta \sigma = 10 \)
2) \( H_0: \mu_1 - \mu_2 = 10 \) or \( \mu_1 = \mu_2 \)
3) \( H_1: \mu_1 - \mu_2 > 10 \) or \( \mu_1 > \mu_2 \)
4) \( \alpha = 0.05 \)
5) The test statistic is
\[
Z_0 = \frac{(\bar{x}_1 - \bar{x}_2) - \Delta}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}
\]
6) Reject \( H_0 \) if \( Z_0 > z_{\alpha} = 1.645 \)
7) \( \bar{x}_1 = 162.7 \quad \bar{x}_2 = 155.4 \quad \delta = 10 \)
\[
\sigma_1 = 1.0 \quad \sigma_2 = 1.0 \quad n_1 = 10 \quad n_2 = 12
\]
\[
Z_0 = \frac{(162.7 - 155.4) - 10}{\sqrt{\frac{(1.0)^2}{10} + \frac{(1.0)^2}{12}}} = -6.31
\]
8) Since \(-6.31 < 1.645\) do not reject the null hypothesis and conclude there is insufficient evidence to support the use of plastic 1 at \( \alpha = 0.05 \).

5.3.  
a) 1) The parameter of interest is the difference in mean burning rate, \( \mu_1 - \mu_2 \)
2) \( H_0: \mu_1 - \mu_2 = 0 \) or \( \mu_1 = \mu_2 \)
3) \( H_1: \mu_1 - \mu_2 \neq 0 \) or \( \mu_1 \neq \mu_2 \)
4) \( \alpha = 0.05 \)
5) The test statistic is
\[
Z_0 = \frac{(\bar{x}_1 - \bar{x}_2) - \Delta}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}
\]
6) Reject \( H_0 \) if \( Z_0 < -z_{\alpha/2} = -1.96 \) or \( Z_0 > z_{\alpha/2} = 1.96 \)
7) \( \bar{x}_1 = 18.02 \quad \bar{x}_2 = 24.37 \quad \delta = 0 \)
\[
\sigma_1 = 3 \quad \sigma_2 = 3 \quad n_1 = 20 \quad n_2 = 20
\]
\[
Z_0 = \frac{(18.02 - 24.37) - 0}{\sqrt{\frac{3^2}{20} + \frac{3^2}{20}}} = -6.70
\]
8) Since \(-6.70 < -1.96\) reject the null hypothesis and conclude the mean burning rates do not differ significantly at \( \alpha = 0.05 \).
b) P-value = \( 2(\Phi(-6.70)) = 2(0) = 0 \)
c) \( \beta = \Phi\left( \frac{\Delta - \Delta_0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}} \right) - \Phi\left( \frac{-\Delta - \Delta_0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}} \right) \)
\[
= \Phi\left( 1.96 - \frac{2.5}{\sqrt{\frac{3^2}{20} + \frac{3^2}{20}}} \right) - \Phi\left( -1.96 - \frac{2.5}{\sqrt{\frac{3^2}{20} + \frac{3^2}{20}}} \right)
= \Phi(1.96 - 2.64) - \Phi(-1.96 - 2.64) = \Phi(-0.68) - \Phi(-4.6)
= 0.2483 - 0
= 0.2483
\]
d) \( (\bar{x}_1 - \bar{x}_2) - z_{\alpha/2} \sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}} \leq \mu_1 - \mu_2 \leq (\bar{x}_1 - \bar{x}_2) + z_{\alpha/2} \sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}} \)
\[
(18.02 - 24.37) - 1.96 \sqrt{\frac{3^2}{20} + \frac{3^2}{20}} \leq \mu_1 - \mu_2 \leq (18.02 - 24.37) + 1.96 \sqrt{\frac{3^2}{20} + \frac{3^2}{20}}
-8.21 \leq \mu_1 - \mu_2 \leq -4.49
\]

We are 95% confident that the mean burning rate for solid fuel propellant 2 exceeds that of propellant 1 by between 4.49 and 8.21 cm/s.
5-15. a) The parameter of interest is the difference in mean catalyst yield, \( \mu_1 - \mu_2 \). 
2) \( H_0: \mu_1 - \mu_2 = 0 \) or \( \mu_1 = \mu_2 \) 
3) \( H_1: \mu_1 - \mu_2 < 0 \) or \( \mu_1 < \mu_2 \) 
4) \( \alpha = 0.01 \) 
5) The test statistic is 
\[
\bar{t}_0 = \frac{(\bar{x}_1 - \bar{x}_2) - \Delta_0}{s_p \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}
\]
6) Reject the null hypothesis if \( t_0 < -t_{\alpha,n_1+n_2-2} \) where \( -t_{0.0125} = -2.485 \)

7) \( \bar{x}_1 = 86.2 \quad \bar{x}_2 = 89.38 \quad \Delta_0 = 0 \) 
\[
s_p = \sqrt{\frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1 + n_2 - 2}} \]
\[
s_1 = 2.91 \quad s_2 = 2.07 \quad s_p = \sqrt{\frac{11(2.91)^2 + 14(2.07)^2}{25}} = 2.47
\]
\[
n_1 = 12 \quad n_2 = 15
\]
\[
\bar{t}_0 = \frac{(86.2 - 89.38) - 0}{2.47 \sqrt{\frac{1}{12} + \frac{1}{15}}} = -3.32
\]

8) Since \(-3.32 < -2.485\), reject the null hypothesis and conclude that the mean yield of catalyst 2 significantly exceeds that of catalyst 1 at \( \alpha = 0.01 \).

b) 95% confidence interval: \( t_{0.025,25} = 2.060 \)
\[
(\bar{x}_1 - \bar{x}_2) - t_{a/2,n_1+n_2-2}(s_p) \sqrt{\frac{1}{n_1} + \frac{1}{n_2}} \leq \mu_1 - \mu_2 \leq (\bar{x}_1 - \bar{x}_2) + t_{a/2,n_1+n_2-2}(s_p) \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}
\]
\[
(86.2 - 89.38) - 2.060(2.47) \sqrt{\frac{1}{12} + \frac{1}{15}} \leq \mu_1 - \mu_2 \leq (86.2 - 89.38) + 2.060(2.47) \sqrt{\frac{1}{12} + \frac{1}{15}}
\]
\[-5.151 \leq \mu_1 - \mu_2 \leq -1.209
\]

We are 95% confident that the mean yield of catalyst 2 exceeds that of catalyst 1 by between 1.209 and 5.151.

5-17. a) The parameter of interest is the difference in mean etch rate, \( \mu_1 - \mu_2 \). 
2) \( H_0: \mu_1 - \mu_2 = 0 \) or \( \mu_1 = \mu_2 \) 
3) \( H_1: \mu_1 - \mu_2 \neq 0 \) or \( \mu_1 \neq \mu_2 \) 
4) \( \alpha = 0.05 \) 
5) The test statistic is 
\[
\bar{t}_0 = \frac{(\bar{x}_1 - \bar{x}_2) - \Delta_0}{s_p \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}
\]
6) Reject the null hypothesis if \( t_0 < -t_{a/2,n_1+n_2-2} \) where \( -t_{0.025,18} = -2.101 \) or \( t_0 > t_{a/2,n_1+n_2-2} \) where \( t_{0.025,18} = 2.101 \)

7) \( \bar{x}_1 = 9.97 \quad \bar{x}_2 = 10.4 \quad \Delta_0 = 0 \) 
\[
s_p = \sqrt{\frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1 + n_2 - 2}} \]
\[
s_1 = 0.422 \quad s_2 = 0.231 \quad s_p = \sqrt{\frac{10(0.422)^2 + 10(0.231)^2}{18}} = 0.340
\]
\[
n_1 = 10 \quad n_2 = 10
\]
\[
\bar{t}_0 = \frac{(9.97 - 10.4) - 0}{0.340 \sqrt{\frac{1}{10} + \frac{1}{10}}} = -2.82
\]

8) Since \(-2.82 < -2.101\) reject the null hypothesis and conclude the two machines mean etch rates do significantly differ at \( \alpha = 0.05 \).
b) P-value = 2P(t < -2.82) = 2(0.005) < P-value < 2(0.010) = 0.010 < P-value < 0.020

c) 95% confidence interval: \( t_{0.025,18} = 2.101 \)

\[
(\bar{x}_1 - \bar{x}_2) - t_{\alpha/2,n_1+n_2-2} (s_p) \sqrt{\frac{1}{n_1} + \frac{1}{n_2}} \leq \mu_1 - \mu_2 \leq (\bar{x}_1 - \bar{x}_2) + t_{\alpha/2,n_1+n_2-2} (s_p) \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}
\]

\[
(9.97 - 10.4) - 2.101(0.34) \sqrt{\frac{1}{10} + \frac{1}{10}} \leq \mu_1 - \mu_2 \leq (9.97 - 10.4) + 2.101(0.34) \sqrt{\frac{1}{10} + \frac{1}{10}}
\]

\[-0.749 \leq \mu_1 - \mu_2 \leq 0.111
\]

We are 95% confident that the mean etch rate for solution 2 exceeds that for solution 1 by between 0.111 and 0.749.

5-23. 1) The parameter of interest is the difference in mean coating thickness, \( \mu_1 - \mu_2 \).

2) \( H_0: \mu_1 - \mu_2 = 0 \)

3) \( H_1: \mu_1 - \mu_2 > 0 \)

4) \( \alpha = 0.01 \)

5) The test statistic is

\[
t_0 = \frac{(\bar{x}_1 - \bar{x}_2) - \delta}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}
\]

6) Reject the null hypothesis if \( t_0 > t_{0.01,14} \) where \( t_{0.01,14} = 2.624 \) since

\[
v = \left( \frac{s_1^2}{n_1} + \frac{s_2^2}{n_2} \right)^2 = 16.09
\]

7) \( \bar{x}_1 = 101.28 \quad \bar{x}_2 = 101.7 \)

\( s_1 = 5.08 \quad s_2 = 20.1 \)

\( n_1 = 11 \quad n_2 = 13 \)

\[
t_0 = \frac{(101.28 - 101.7) - 0}{\sqrt{\left(\frac{5.08}{11}\right)^2 + \left(\frac{20.1}{13}\right)^2}} = -0.07
\]

8) Since \(-0.07 < 2.539\), do not reject the null hypothesis and conclude that increasing the temperature does not significantly reduce the mean coating thickness at \( \alpha = 0.01 \).

P-value = P(t > 0.602), \( 0.40 < \text{P-value} \)

5-24. If \( \alpha = 0.01 \), construct a 99% lower one-sided confidence interval on the difference to answer this question. \( t_{0.01,14} = 2.624 \)

\[
(\bar{x}_1 - \bar{x}_2) - t_{\alpha,v} \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}} \leq \mu_1 - \mu_2
\]

\[
(101.28 - 101.7) - 2.624 \sqrt{\frac{(5.08)^2}{11} + \frac{(20.1)^2}{13}} \leq \mu_1 - \mu_2
\]

\[-15 \leq \mu_1 - \mu_2
\]

Since the interval covers the value 0, we are 99% confident there is no difference in the mean coating thickness between the two temperatures; that is, raising the process temperature does not significantly reduce the mean coating thickness.
5.31. a) $\bar{d} = 0.667 \quad s_d = 2.964 \quad n = 12$

95% confidence interval:

$$\bar{d} - t_{a/2,n-1} \left( \frac{s_d}{\sqrt{n}} \right) \leq \mu_d \leq \bar{d} + t_{a/2,n-1} \left( \frac{s_d}{\sqrt{n}} \right)$$

$$0.667 - 2.201 \left( \frac{2.964}{\sqrt{12}} \right) \leq \mu_d \leq 0.667 + 2.201 \left( \frac{2.964}{\sqrt{12}} \right)$$

$$-1.216 \leq \mu_d \leq 2.55$$

Since zero is contained within this interval, we are 95% confident there is no significant indication that one design language is preferable.

5.32. 1) The parameter of interest is the difference in blood cholesterol level, $\mu_d$ where $d_i = \text{Before} - \text{After}$.
2) $H_0 : \mu_d = 0$
3) $H_1 : \mu_d > 0$
4) $\alpha = 0.05$
5) The test statistic is

$$t_0 = \frac{\bar{d}}{s_d / \sqrt{n}}$$

6) Reject the null hypothesis if $t_0 > t_{0.05,14}$ where $t_{0.05,14} = 1.761$

7) $\bar{d} = 26.867$
   $s_d = 19.04$
   $n = 15$

$$t_0 = \frac{26.867}{19.04 / \sqrt{15}} = 5.465$$

8) Since $5.465 > 1.761$ reject the null and conclude the data support the claim that low the mean difference in cholesterol levels is significantly less after fat diet and aerobic exercise program at the 0.05 level of significance.

5.36. 1) The parameter of interest is the difference in mean weight loss, $\mu_d$ where $d_i = \text{Before} - \text{After}$.
2) $H_0 : \mu_d = 10$
3) $H_1 : \mu_d > 10$
4) $\alpha = 0.05$
5) The test statistic is

$$t_0 = \frac{\bar{d} - \Delta_0}{s_d / \sqrt{n}}$$

6) Reject the null hypothesis if $t_0 > t_{0.05,9}$ where $t_{0.05,9} = 1.833$

7) $\bar{d} = 17$
   $s_d = 6.41$
   $n = 10$

$$t_0 = \frac{17 - 10}{6.41 / \sqrt{10}} = 3.45$$

8) Since $3.45 > 1.833$ reject the null and conclude there is evidence to support the claim that this particular diet modification program is effective in producing a mean weight loss of at least 10 lbs at the 0.05 level of significance.