17.5  

a. Compute the 95% control limits for the p chart.

\[
\bar{p} = \text{Center line} = \frac{750}{15,000} = 0.05 \%
\]

Limits = \( \bar{p} \pm Z \sqrt{\frac{\bar{p}(100 - \bar{p})}{n}} \)

\[
= 0.05 \pm 1.96 \sqrt{\frac{0.05(100 - 0.05)}{100}}
\]

\[
= 0.05 \pm 1.96(0.21)
\]

\[
= 0.05 \pm 0.41
\]

\[
= 0.05 \pm 0.41 = 0.41 \text{ and } 0.04 \%
\]

b. Plot the 10 semesters of sample data on a control chart.

\[
\begin{array}{c|c|c|c}
\text{Percent Academic Drops} & \text{Sample Numbers} & \text{Upper Control Limit} & \text{Center Line} & \text{Lower Control Limit} \\
\hline
0.0 & 1 & \text{Upper Control Limit} & \text{Center Line} & \text{Lower Control Limit} \\
1.0 & 2 & \text{Sample Numbers} & \text{Percent Academic Drops} & \text{Upper Control Limit} \\
2.0 & 3 & \text{Sample Numbers} & \text{Percent Academic Drops} & \text{Center Line} \\
3.0 & 4 & \text{Sample Numbers} & \text{Percent Academic Drops} & \text{Lower Control Limit} \\
4.0 & 5 & \text{Sample Numbers} & \text{Percent Academic Drops} & \text{Center Line} \\
5.0 & 6 & \text{Sample Numbers} & \text{Percent Academic Drops} & \text{Lower Control Limit} \\
6.0 & 7 & \text{Sample Numbers} & \text{Percent Academic Drops} & \text{Center Line} \\
7.0 & 8 & \text{Sample Numbers} & \text{Percent Academic Drops} & \text{Lower Control Limit} \\
8.0 & 9 & \text{Sample Numbers} & \text{Percent Academic Drops} & \text{Center Line} \\
9.0 & 10 & \text{Sample Numbers} & \text{Percent Academic Drops} & \text{Lower Control Limit}
\end{array}
\]

c. Has there been a change in the percentage of academic drops per semester?

The trend of the control chart would suggest that the number of academic drops per semester has fallen. We see, in particular, a string of seven consecutive plots (samples 4 through 10) that fall below the center line.
17.7  a. Compute the $3\sigma$ control limits for $\bar{x}$.

$$= 12 \pm .180(3)$$

$$= 12 \pm .54 = 11.46 \text{ and } 12.54 \text{ inches}$$

b. Plot these sample means on a $3\sigma$ control chart for $\bar{x}$.

c. Decide if the process is in control.

No. Three plots (Samples 3, 5, and 6) are above the upper control limit. We also find a string of five consecutive plots (Samples 5 through 9) constituting a downward trend [cf. criteria presented by Chase et al.].
17.10 a. Compute the 3σ control limits and the center line for an \( \bar{x} \) chart.

From Table 17.3: \( A = .75(1/\sqrt{n}) = .75(1/\sqrt{200}) = .053 \)

Center Line = 12.5 watts

Limits = \( \bar{x} \pm A(\bar{R}) = 12.5 \pm .053(1.2) = 12.436 \) and 12.564 watts

b. Compute the 3σ control limits and center line for an R chart.

Center Line = \( \bar{R} = 1.2 \) watts

From Table 17.3: 
\[
D_1 = .45 + .001(n) = .45 + .001(200) = .65 \\
D_2 = 1.55 - .0015(n) = 1.55 - .0015(200) = 1.25
\]

Lower Limit = \( D_1(\bar{R}) = .65(1.2) = .78 \) watts

Upper Limit = \( D_2(\bar{R}) = 1.25(1.2) = 1.5 \) watts

c. Plot the sample data on the \( \bar{x} \) and R charts and decide if the quality performance of the unit is in control.

The R chart suggests normal behavior in terms of process dispersion (as measured by sample ranges).
The x-bar chart shows one plot (sample 6) above the upper control limit. [One may argue, as well, that the x-bar chart shows erratic behavior on the part of the sample means.] This constitutes evidence that the process is out of control—using the criteria of Keller & Warrack or Chase et al. Note that *both* the R chart and the x-bar chart must show normal behavior since we are investigating both process mean and process dispersion.

The process should be investigated to find and correct assignable cause(s) of poor performance.