Requirement of Normality or $n > 30$ This t test is *robust* against a departure from normality, meaning that the test works reasonably well if the departure from normality is not too extreme. Verify that there are no outliers and that the histogram or dotplot has a shape that is not very far from a normal distribution.

If the original population is not itself normally distributed, we use the condition $n > 30$ for justifying use of the normal distribution, but there is no exact specific minimum sample size that works for all cases. Sample sizes of 15 to 30 are sufficient if the population has a distribution that is not far from normal, but some other populations have distributions that are extremely far from normal, and sample sizes greater than 30 might be necessary. In this text we use the simplified criterion of $n > 30$ as justification for treating the distribution of sample means as a normal distribution, regardless of how far the distribution departs from a normal distribution.

Here is a brief review of important properties of the Student t distribution first presented in Section 7-3:

Important Properties of the Student t Distribution

1. The Student t distribution is different for different sample sizes (see Figure 7-5 in Section 7-3).

2. The Student t distribution has the same general bell shape as the standard normal distribution; its wider shape reflects the greater variability that is expected when s is used to estimate σ.

3. The Student t distribution has a mean of $t = 0$ (just as the standard normal distribution has a mean of $z = 0$).

4. The standard deviation of the Student t distribution varies with the sample size and is greater than 1 (unlike the standard normal distribution, which has $\sigma = 1$).

5. As the sample size n gets larger, the Student t distribution gets closer to the standard normal distribution.

| Example 1 | **Cell Phone Radiation: *P*-Value Method** |

Listed below are the measured radiation emissions (in W/kg) corresponding to a sample of these cell phones: Samsung SGH-tss9, Blackberry Storm, Blackberry Curve, Motorola Moto, T-Mobile Sidekick, Sanyo Katana Eclipse, Palm Pre, Sony Ericsson, Nokia 6085, Apple iPhone 3G S, and Kyocero Neo E1100 (based on data are from the Environmental Working Group). Use a 0.05 significance level to test the claim that cell phones have a mean radiation level that is less than 1.00 W/kg.

    0.38   0.55   1.54   1.55   0.50   0.60   0.92   0.96   1.00   0.86   1.46

| **Solution** |

Requirement check (1) For the purposes of this test, we will assume that the sample is a simple random sample, but it appears that one cell phone of each brand was measured, so this is not a simple random sample of the cell phones in use. This will be discussed further in the interpretation that follows. (2) The sample size is $n = 11$, which is not greater than 30, so we must determine whether the sample appears to be from a population having a normal distribution. With only 11 sample values, a histogram isn't very helpful, but there are no outliers and the accompanying normal quantile plot shows that the points