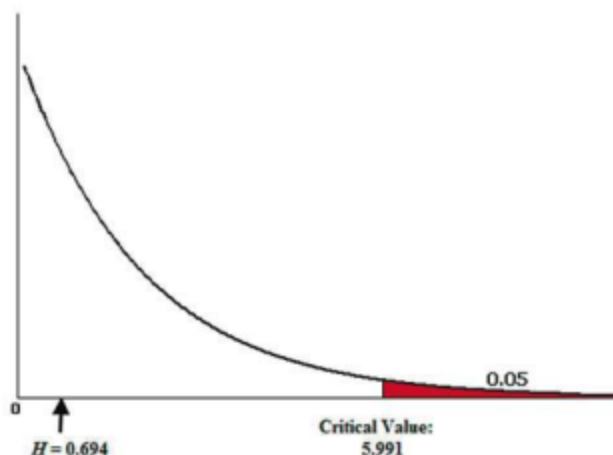


**Figure 13-4**  
**Chi-Square Distribution for**  
**Example 1**



**Rationale:** The Kruskal-Wallis  $H$  test statistic is the rank version of the  $F$  test statistic used in the analysis of variance discussed in Chapter 12. When we deal with ranks  $R$  instead of original values  $x$ , many components are predetermined. For example, the sum of all ranks can be expressed as  $N(N + 1)/2$ , where  $N$  is the total number of values in all samples combined. The expression

$$H = \frac{12}{N(N + 1)} \sum n_i (\bar{R}_i - \bar{\bar{R}})^2$$

where

$$\bar{R}_i = \frac{R_i}{n_i} \quad \text{and} \quad \bar{\bar{R}} = \frac{\sum R_i}{\sum n_i}$$

combines weighted variances of ranks to produce the  $H$  test statistic given here, and this expression for  $H$  is algebraically equivalent to the expression for  $H$  given earlier as the test statistic.

## using TECHNOLOGY

**STATDISK** Enter the data in columns of the data window. Select **Analysis** from the main menu bar, then select **Kruskal-Wallis Test** and select the columns of data. STATDISK will display the sum of the ranks for each sample, the  $H$  test statistic, the  $P$ -value, and the critical value.

**MINITAB** Refer to the *Minitab Student Laboratory Manual and Workbook* for the procedure required to use the options **Stat**, **Nonparametrics**, and **Kruskal-Wallis**. The basic idea is to list all of the sample data in one big column, with another column identifying the sample for the corresponding values. For the data of Table 13-6 in this section, enter the 19 values in Minitab's column C1. In column C2, enter eight 1s followed by six 2s followed by five 3s. Now select **Stat**, **Nonparametrics**, and **Kruskal-Wallis**. In the dialog box, enter C1 for response, C2 for factor, then click **OK**. The Minitab display includes the  $H$  test statistic and the  $P$ -value.

**EXCEL** Excel is not programmed for the Kruskal-Wallis test, but XLSTAT can be used. First enter the data in separate

columns. For example, enter the data in Table 13-6 in three separate columns. Click on **XLSTAT**, select **Nonparametric tests**, then **Comparison of k samples**. For the data in Table 13-6, enter A1:C8 in the data entry box and choose the data format of "One column per sample." Click on the **Options** tab and select **Asymptotic p-value** so that the  $P$ -value will be computed using the chi-square distribution.

**TI-83/84 PLUS** The TI-83/84 Plus calculator is not programmed for the Kruskal-Wallis test, but the program KWTEST can be used. The program KWTEST (by Michael Lloyd) is included on the CD included with this book or it can be downloaded from the site [www.addisonwesley.com/triola](http://www.addisonwesley.com/triola). First download and install the program. (Also download the program ZZRANK, which is used by the program KWTEST.) Next, enter the lists of sample data in separate columns of matrix [A]. Press **PRGM**, select **KWTEST**, then press **ENTER**. The value of the test statistic and the number of degrees of freedom will be provided. (Note: If the samples have different sizes