Simplify the following equation using the Karnaugh mapping procedure:

$$X = B\overline{C}\overline{D} + \overline{A}B\overline{C}\overline{D} + AB\overline{C}D + \overline{A}BCD + ABCD$$

Solution: Notice in Figure 5–71 that the $B\overline{C}\overline{D}$ term in the original equation fills in *two* cells: $AB\overline{C}\overline{D} + \overline{A}B\overline{C}\overline{D}$. Also notice in Figure 5–71 that we could have encircled four cells and then two cells, but that would not have given us the simplest final equation. By encircling four cells and then another four cells, we are sure to get the simplest final equation. (Always encircle the largest number of cells possible, even if some of the cells have already been encircled in another group.)

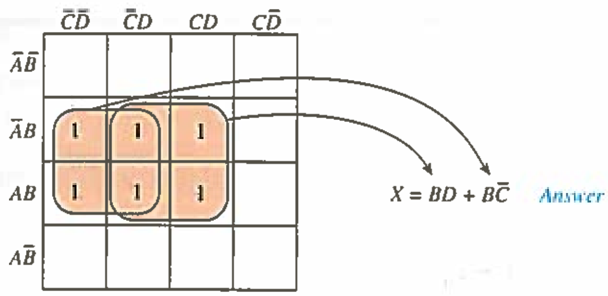

Figure 5–71 Solution to Example 5–25.

Common Misconception

Students often solve a map like this by encircling 4 and 2 instead of 4 and 4. Analyze both results to see why choosing 4 and 4 is better.

EXAMPLE 5–26

Simplify the following equation using the Karnaugh mapping procedure:

$$X = \overline{A}\overline{B}\overline{C} + A\overline{C}\overline{D} + A\overline{B} + ABC\overline{D} + \overline{A}\overline{B}C$$

Solution: Notice in Figure 5–72 that a new technique called **wraparound** is introduced. You have to think of the K-map as a continuous cylinder in the horizontal direction, like the label on a soup can. This makes the left row of cells adjacent to the right row of cells. Also, in the vertical direction, a continuous cylinder like a soup can lying on its side makes the top row of cells adjacent to the bottom row of cells. In Figure 5–72, for example, the four top cells are adjacent to the four bottom cells, to combine as eight cells having the variable $\overline{B}$ in common.

Another circle of four is formed by the wraparound adjacencies of the lower left and lower right pairs combining to have $A\overline{D}$ in common. The final equation becomes $X = \overline{B} + A\overline{D}$. Compare that simple equation with the original equation that had five terms in it.