## **EXAMPLE 2** Evaluate by direct substitution

Use direct substitution to evaluate  $f(x) = 2x^4 - 5x^3 - 4x + 8$  when x = 3.

 $f(\mathbf{x}) = 2\mathbf{x}^{4} - 5\mathbf{x}^{3} - 4\mathbf{x} + 8$  Write original function.  $f(\mathbf{3}) = 2(\mathbf{3})^{4} - 5(\mathbf{3})^{3} - 4(\mathbf{3}) + 8$  Substitute 3 for x. = 162 - 135 - 12 + 8 Evaluate powers and multiply. = 23 Simplify.

**GUIDED PRACTICE** for Examples 1 and 2

Decide whether the function is a polynomial function. If so, write it in standard form and state its degree, type, and leading coefficient.

**1.** f(x) = 13 - 2x **2.**  $p(x) = 9x^4 - 5x^{-2} + 4$  **3.**  $h(x) = 6x^2 + \pi - 3x$ 

Use direct substitution to evaluate the polynomial function for the given value of *x*.

**4.**  $f(x) = x^4 + 2x^3 + 3x^2 - 7$ ; x = -2**5.**  $g(x) = x^3 - 5x^2 + 6x + 1$ ; x = 4

**SYNTHETIC SUBSTITUTION** Another way to evaluate a polynomial function is to use synthetic substitution. This method, shown in the next example, involves fewer operations than direct substitution.

## **EXAMPLE 3** Evaluate by synthetic substitution

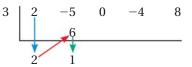
Use synthetic substitution to evaluate f(x) from Example 2 when x = 3.

## Solution

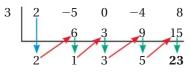
**STEP 1** Write the coefficients of f(x) in order of descending exponents. Write the value at which f(x) is being evaluated to the left.



*STEP 2* Bring down the leading coefficient. Multiply the leading coefficient by the *x*-value. Write the product under the second coefficient. Add.



*STEP 3* Multiply the previous sum by the *x*-value. Write the product under the third coefficient. Add. Repeat for all of the remaining coefficients. The final sum is the value of f(x) at the given *x*-value.



Synthetic substitution gives f(3) = 23, which matches the result in Example 2.

## **AVOID ERRORS**

The row of coefficients for f(x) must include a coefficient of 0 for the "missing"  $x^2$ -term.