EXAMPLE 2 Evaluate by direct substitution

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

$f(x) = 2x^4 - 5x^3 - 4x + 8$	Write original function.
$f(3) = 2(3)^4 - 5(3)^3 - 4(3) + 8$	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

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

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.

x-value →	3	2	−5	0	−4	8	← coefficients

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

3	2	−5	0	−4	8
		6			
	2	1			

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.

3	2	−5	0	−4	8
		6	3	9	15
	2	1	3	5	**23**

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