❙ EXAMPLE 8   In designing a certain machine part, it is necessary to perform the following simplification.

$$16(8 - x) - 2(8x - x^2) - (64 - 16x + x^2) = 128 - 16x - 16x + 2x^2 - 64 + 16x - x^2$$
$$= 64 - 16x + x^2$$

NOTE ▶ It is fairly common to have expressions in which more than one symbol of grouping is to be removed in the simplification. Normally, *when several symbols of grouping are to be removed, it is more convenient to remove the innermost symbols first.* This is illustrated in the following example.

❙ EXAMPLE 9   **(a)** $3ax - [ax - (5s - 2ax)] = 3ax - [ax - 5s + 2ax]$
$$= 3ax - ax + 5s - 2ax \qquad \text{remove parentheses}$$
$$\text{remove brackets}$$
$$= 5s$$

**(b)** $3a^2b - \{[a - (2a^2b - a)] + 2b\} = 3a^2b - \{[a - 2a^2b + a] + 2b\}$
$$= 3a^2b - \{a - 2a^2b + a + 2b\} \qquad \text{remove parentheses}$$
$$= 3a^2b - a + 2a^2b - a - 2b \qquad \text{remove brackets}$$
$$= 5a^2b - 2a - 2b \qquad \text{remove braces}$$

Calculators use only parentheses for grouping symbols, and we often need to use one set of parentheses within another set. These are called **nested parentheses.** In the next example, note that the innermost parentheses are removed first.

❙ EXAMPLE 10   $2 - (3x - 2(5 - (7 - x))) = 2 - (3x - 2(5 - 7 + x))$
$$= 2 - (3x - 10 + 14 - 2x)$$
$$= 2 - 3x + 10 - 14 + 2x$$
$$= -x - 2$$

One of the most common errors made by beginning students is changing the sign of only the first term when removing symbols of grouping preceded by a minus sign. CAUTION ▶ Remember, *if the symbols are preceded by a minus sign, we must change the sign of all terms.*

**EXERCISES 1.7**

*In Exercises 1–4, make the given changes in the indicated examples of this section, and then solve the resulting problems.*

**1.** In Example 5(a), change $2x$ to $2y$.

**2.** In Example 7(a), change the sign before $(2b - c)$ from $+$ to $-$.

**3.** In Example 9(a), change $[ax - (5s - 2ax)]$ to $[(ax - 5s) - 2ax]$.

**4.** In Example 9(b), change $\{[a - (2a^2b - a)] + 2b\}$ to $\{a - [2a^2b - (a + 2b)]\}$.

*In Exercises 5–52, simplify the given algebraic expressions.*

**5.** $5x + 7x - 4x$

**6.** $6t - 3t - 4t$

**7.** $2y - y + 4x$

**8.** $4C + L - 6C$

**9.** $2F - 2T - 2 + 3F - T$

**10.** $x - 2y + 3x - y + z$

**11.** $a^2b - a^2b^2 - 2a^2b$

**12.** $xy^2 - 3x^2y^2 + 2xy^2$

**13.** $s + (4 + 3s)$

**14.** $5 + (3 - 4n + p)$

**15.** $v - (4 - 5x + 2v)$

**16.** $2a - (b - a)$

**17.** $2 - 3 - (4 - 5a)$

**18.** $\sqrt{A} + (h - 2\sqrt{A}) - 3\sqrt{A}$

**19.** $(a - 3) + (5 - 6a)$

**20.** $(4x - y) - (-2x - 4y)$

**21.** $-(t - 2u) + (3u - t)$

**22.** $2(x - 2y) + (5x - y)$

**23.** $3(2r + s) - (-5s - r)$

**24.** $3(a - b) - 2(a - 2b)$

**25.** $-7(6 - 3j) - 2(j + 4)$

**26.** $-(5t + a^2) - 2(3a^2 - 2st)$

**27.** $-[(6 - n) - (2n - 3)]$

**28.** $-[(A - B) - (B - A)]$

**29.** $2[4 - (t^2 - 5)]$

**30.** $3[-3 - (a - 4)]$

**31.** $-2[-x - 2a - (a - x)]$

**32.** $-2[-3(x - 2y) + 4y]$

**33.** $a\sqrt{LC} - \left[3 - \left(a\sqrt{LC} + 4\right)\right]$

**34.** $9v - [6 - (v - 4) + 4v]$

**35.** $8c - \{5 - [2 - (3 + 4c)]\}$

**36.** $7y - \{y - [2y - (x - y)]\}$

**37.** $5p - (q - 2p) - [3q - (p - q)]$

**38.** $-(4 - x) - [(5x - 7) - (6x + 2)]$

**39.** $-2\{-(4 - x^2) - [3 + (4 - x^2)]\}$

**40.** $-\{-[-(x - 2a) - b] - a\}$

**41.** $5V^2 - (6 - (2V^2 + 3))$

**42.** $-2x + 2((2x - 1) - 5)$

**43.** $-(3t - (7 + 2t - (5t - 6)))$

**44.** $a^2 - 2(x - 5 - (7 - 2(a^2 - 2x) - 3x))$

**45.** $-4[4R - 2.5(Z - 2R) - 1.5(2R - Z)]$

**46.** $3\{2.1e - 1.3[f - 2(e - 5f)]\}$

**47.** In determining the size of a V belt to be used with an engine, the expression $3D - (D - d)$ is used. Simplify this expression.

**48.** When finding the current in a transistor circuit, the expression $i_1 - (2 - 3i_2) + i_2$ is used. Simplify this expression. (The numbers below the $i$'s are *subscripts*. Different subscripts denote different variables.)

**49.** Water leaked into a gasoline storage tank at an oil refinery. Finding the pressure in the tank leads to the expression $-4(b - c) - 3(a - b)$. Simplify this expression.

**50.** Research on a plastic building material leads to $\left[\left(B + \frac{4}{3}\alpha\right) + 2\left(B - \frac{2}{3}\alpha\right)\right] - \left[\left(B + \frac{4}{3}\alpha\right) - \left(B - \frac{2}{3}\alpha\right)\right]$. Simplify this expression.

**51.** A shipment contains $x$ film cartridges for 15 exposures each and $x + 10$ cartridges for 25 exposures each. What is the total number of photographs that can be taken with the film from this shipment?

**52.** Each of two stores has $2n + 1$ mouse pads costing \$3 each and $n - 2$ mouse pads costing \$2 each. How much more is the total value of the \$3 mouse pads than the \$2 mouse pads in the two stores?

## 1.8 MULTIPLICATION OF ALGEBRAIC EXPRESSIONS

To find the product of two or more monomials, we use the laws of exponents as given in Section 1.4 and the laws for multiplying signed numbers as stated in Section 1.2. We first multiply the numerical coefficients to find the numerical coefficient of the product. Then we multiply the literal numbers, remembering that *the exponents may be combined only if the base is the same.*

**EXAMPLE 1**  (a) $3c^5(-4c^2) = -12c^7$  multiply numerical coefficients and add exponents of $c$

(b) $(-2b^2y^3)(-9aby^5) = 18ab^3y^8$  add exponents of same base

(c) $2xy(-6cx^2)(3xcy^2) = -36c^2x^4y^3$

If a product contains a monomial that is raised to a power, *we must first raise it to the indicated power* before proceeding with the multiplication.

**EXAMPLE 2**  (a) $3(2a^2x)^3(-ax) = 3(8a^6x^3)(-ax) = -24a^7x^4$

(b) $2s^3(-st^4)^2(4s^2t) = 2s^3(s^2t^8)(4s^2t) = 8s^7t^9$