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# 4 Polynomials

## 4–1 Exponents

**Objective:** To write and simplify expressions involving exponents.

### Vocabulary

**Power of a number** A product of equal factors. For example, $2 \times 2 \times 2$, or $2^3$, is the third power of 2.

**Base of a power** The number that is used as a factor. For example, 2 is the base in $2^3$.

**Exponent** In a power, the number that indicates how many times the base is used as a factor. For example, 3 is the exponent in $2^3$.

**Exponential form** The expression $2^3$ is the exponential form of $2 \cdot 2 \cdot 2$.

**CAUTION 1** Be careful when an expression contains both parentheses and exponents.
$(3y)^2$ means $(3y)(3y)$. 2 is the exponent of the base $3y$.
$3y^2$ means $3 \cdot y \cdot y$. 2 is the exponent of the base $y$.

**CAUTION 2** Follow the correct order when simplifying expressions.
1. First simplify expressions within grouping symbols.
2. Then simplify powers.
3. Then simplify products and quotients in order from left to right.
4. Then simplify sums and differences in order from left to right.

***Example 1*** Write each expression in exponential form.
a. $5 \cdot 5 \cdot 5$ b. $a \cdot a \cdot a \cdot a \cdot a$ c. $-2 \cdot x \cdot y \cdot 5 \cdot x \cdot x$

***Solution*** a. $5^3$ b. $a^5$ c. $-10x^3y$

**Write each expression in exponential form.**

1. $x \cdot x \cdot x \cdot x$ $\mathbf{x^4}$
2. $m \cdot m$ $\mathbf{m^2}$
3. $3 \cdot t \cdot t \cdot t \cdot t$ $\mathbf{3t^4}$
4. $c \cdot e \cdot 2 \cdot c \cdot e$ $\mathbf{2c^2e^2}$
5. $-4 \cdot z \cdot z \cdot z$ $\mathbf{-4z^3}$
6. $y \cdot y \cdot (-2)$ $\mathbf{-2y^2}$
7. $-2 \cdot x \cdot x \cdot 3 \cdot x$ $\mathbf{-6x^3}$
8. $5 \cdot n \cdot (-3)$ $\mathbf{-15n}$
9. $a \cdot a \cdot a \cdot b \cdot b$ $\mathbf{a^3b^2}$
10. $c \cdot c \cdot d \cdot d \cdot d \cdot c$ $\mathbf{c^3d^3}$
11. $m \cdot 6 \cdot n \cdot m$ $\mathbf{6m^2n}$
12. $u \cdot v \cdot u \cdot v \cdot 8$ $\mathbf{8u^2v^2}$

***Example 2*** Evaluate $x^3$ if $x = -2$.

***Solution***
$x^3 = (-2)^3$ Replace $x$ with $-2$.
$= (-2)(-2)(-2)$ Simplify.
$= -8$

13. Evaluate $x^4$ if $x = -2$. **16**
14. Evaluate $x^3$ if $x = -3$. **−27**
15. Evaluate $y^5$ if $y = -1$. **−1**
16. Evaluate $x^2$ if $x = -5$. **25**


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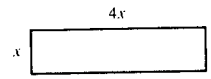
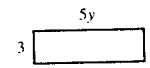
## 4–1 Exponents *(continued)*

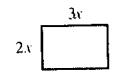
***Example 3*** Find the area of the rectangle.




***Solution*** Area = length × width
$= 4x \cdot x$
$= 4x^2$

**Find the area of each rectangle. 17. $15y$ 18. $6x^2$ 19. $24z^2$**

17.



18.
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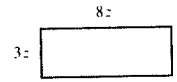


***Example 4*** Simplify: a. $-2^4$ b. $(-2)^4$ c. $(1 + 2)^3$ d. $1 + 2^3$

***Solution***
a. $-2^4 = -(2 \cdot 2 \cdot 2 \cdot 2) = -16$
b. $(-2)^4 = (-2)(-2)(-2)(-2) = 16$
c. $(1 + 2)^3 = 3^3 = 27$
d. $1 + 2^3 = 1 + 2 \cdot 2 \cdot 2 = 1 + 8 = 9$

**Simplify.**

20. a. $3^4$ **81** b. $4^3$ **64**
21. a. $-3^2$ **−9** b. $(-3)^2$ **9**
22. a. $-2^3$ **−8** b. $(-2)^3$ **−8**
23. a. $2 \cdot 4^2$ **32**, b. $(2 \cdot 4)^2$ **64**
24. a. $5 - 2^2$ **1** b. $(5 - 2)^2$ **9**
25. a. $2 - 5^2$ **−23** b. $(2 - 5)^2$ **9**
26. a. $5 - 3^2$ **−4** b. $(5 - 3)^2$ **4**
27. a. $2 \cdot 5 - 3^2$ **1** b. $(2 \cdot 5 - 3)^2$ **49**

***Example 5*** Evaluate $(2a - b)^2$ if $a = 2$ and $b = -3$.

***Solution***
$(2a - b)^2 = [2 \cdot 2 - (-3)]^2$ Replace $a$ with 2 and $b$ with $-3$.
$= [4 + 3]^2$ Simplify the expression within the brackets.
$= 7^2$
$= 49$

**Evaluate each expression if $x = 2$ and $y = -1$.**

28. a. $2x + y^2$ **5** b. $(2x + y)^2$ **9**
29. a. $2 + xy^2$ **4** b. $(2 + xy)^2$ **0**
30. a. $2x + y^3$ **3** b. $(2x + y)^3$ **27**
31. a. $(x + 2y)^3$ **0** b. $x^3 + 2y^3$ **6**
32. a. $2x - y^2$ **3** b. $(2x - y)^2$ **25**
33. a. $2 - xy^2$ **0** b. $(2 - xy)^2$ **16**
34. a. $2x - y^3$ **5** b. $(2x - y)^3$ **125**
35. a. $(x - 2y)^3$ **64** b. $x^3 - 2y^3$ **10**

## Mixed Review Exercises

**Solve.**

1. $-6x = 42$ **{−7}**
2. $2(n - 3) = 24$ **{15}**
3. $24 = -8x$ **{−3}**
4. $-n + 6 = 8$ **{−2}**
5. $x - 5 = -3$ **{2}**
6. $-y + 10 = 6$ **{4}**
7. $-\frac{1}{2}(x + 3) = 4$ **{−11}**
8. $\frac{1}{3}x = 10$ **{30}**



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