

Name:
Instructor:

Key

Date:
Section:

1.5 Exponents

Objectives

- 1 Use the product rule for exponents.
- 2 Use the quotient rule for exponents.
- 3 Use the negative exponent rule.
- 4 Use the zero exponent rule.
- 5 Use the rule for raising a power to a power.
- 6 Use the rule for raising a product to a power.
- 7 Use the rule for raising a quotient to a power.

Key Vocabulary

product rule for exponents, quotient rule for exponents, negative exponent rule, zero exponent rule, power rule, raising a product to a power rule, raising a quotient to a power rule

- 1 Use the product rule for exponents.

Example 1 Simplify.

a) $3^2 \cdot 3^3 = 3^5$

b) $x^3 \cdot x^5 = x^8$

c) $y^4 \cdot y^7 = y^{11}$

d) $4^3 \cdot 4^2 = 4^5$

- 2 Use the quotient rule for exponents.

Example 2 Simplify.

a) $\frac{5^1}{5^3} = 5^{-2}$

a) $\frac{5^3}{5^1} = 5^2$

b) $\frac{3^3}{3^6} = 3^{-3} = \frac{1}{3^3}$

c) $\frac{x^9}{x^5} = x^4$

d) $\frac{m^3}{m^4} = m^{-1}$ or $\frac{1}{m}$

- 3 Use the negative exponent rule.

Example 3 Write each expression without negative exponents.

a) $6^{-2} = \frac{1}{6^2}$

b) $5a^{-5} = \frac{5}{a^5}$

c) $\frac{1}{f^{-3}} = f^3$

d) $\frac{9}{x^{-2}} = 9x^2$

Example 4 Simplify.

a) $\frac{6xy^3}{y^{-2}z} = \frac{6xy^5}{z}$

b) $\frac{-6^{-2}x^3y^{-1}}{x^3 - 6^2y}$

c) $3^{-1} + 2^{-1} = \frac{1}{3} + \frac{1}{2} = \frac{2}{6} + \frac{3}{6} = \frac{5}{6}$

d) $3 \cdot 2^{-3} + 7 \cdot 4^{-2} = \frac{3}{2^3} + \frac{7}{4^2} = \frac{3}{8} + \frac{7}{16} = \frac{6}{16} + \frac{7}{16} = \frac{13}{16}$

Answers: 1a) $3^5 = 243$ b) x^8 c) y^8 d) $4^5 = 1024$ 2a) $5^2 = 25$ b) $3^{-3} = \frac{1}{27}$ c) x^4 d) $m^{-1} = \frac{1}{m}$ 3a) $\frac{1}{36}$ b) $\frac{5}{a^5}$ c) f^3

d) $9x^2$ 4a) $\frac{6xy^5}{z}$ b) $\frac{x^3}{36y}$ c) $\frac{5}{6}$ d) $\frac{13}{16}$

Examples 1.5

4 Use the zero exponent rule.

Example 5 Simplify.

a) 150^0
1

b) $8x^0$
8.1
8

c) $-xy^0$
-x

d) $-(xy)^0$
-1

5 Use the rule for raising a power to a power.

Example 6 Simplify. Assume that the base is not zero.

a) $(3^2)^3$
 3^6
729

b) $(x^{-2})^5$
 x^{-10}
 $\frac{1}{x^{10}}$

c) $(4^{-2})^2$
 4^{-4}
 $\frac{1}{4^4} = \frac{1}{256}$

d) $(y^{-3})^5$
 y^{-15}
 $\frac{1}{y^{15}}$

6 Use the rule for raising a product to a power.

Example 7 Simplify.

a) $(-4x^3)^3$
 $-4^3 x^9$
 $-64x^9$

b) $(2m^{-4}n^3)^2$
 $\frac{4n^6}{m^8}$

c) $(\frac{1}{2}r^3s^2)^{-2}$
 $\frac{4}{r^6s^4}$

d) $(-4x^{-3}y^4)^2$
 $\frac{16y^8}{x^6}$

7 Use the rule for raising a quotient to a power.

Example 8 Simplify.

a) $(\frac{3}{x^3})^2$
 $\frac{9}{x^6}$

b) $(\frac{16m^3n^4}{8mn^2})^3$
simp 1st
 $(\frac{2m^2n^2}{1})^3$
 $8m^6n^6$

c) $(\frac{4x^2y^{-3}}{8x^3y})^2$
simp 1st
 $(\frac{1}{2y^4})^2$
 $\frac{1}{4y^8}$

d) $(\frac{3e^5f^{-2}}{(e^{-3}f^4)^{-2}})^{-3}$
 $(\frac{e^{-\frac{1}{3}}f^4}{3e^5f^{-2}})^2$
 $\frac{e^{-6}f^8}{27e^{15}f^{-6}}$
 $\frac{f^{14}}{27e^{21}}$

Answers: 5a) 1 b) 8 c) -x d) -1 6a) $3^6 = 729$ b) $\frac{1}{x^{10}}$ c) $\frac{1}{256}$ d) $\frac{1}{y^{15}}$ 7a) $-64x^9$ b) $\frac{4n^6}{m^8}$ c) $\frac{4}{r^6s^4}$ d) $\frac{16y^8}{x^6}$ 8a) $\frac{9}{x^6}$

b) $8m^6n^6$ c) $\frac{1}{4y^8}$ d) $\frac{f^{14}}{27e^{21}}$

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Practice Set 1.5

Use the choices below to fill in each blank.

product rule
quotient rule

negative exponent rule
zero exponent rule

power rule
additive Inverse

- $a^m \cdot a^n = a^{m+n}$ is called the _____.
- $a^{-m} = \frac{1}{a^m}$ is called the _____.
- $(a^m)^n = a^{m \cdot n}$ is called the _____.
- $a^0 = 1$ is called the _____.

Simplify each expression. Write the answer without negative exponents.
Assume that all bases represented by variables are nonzero.

- | | | |
|------------------------------------|---|-----------|
| 5. $4^2 \cdot 4^1$ | 6. $x^2 \cdot x^5$ | 5. _____ |
| | | 6. _____ |
| 7. $\frac{3^5}{3^2}$ | 8. $\frac{x^7}{x^4}$ | 7. _____ |
| | | 8. _____ |
| 9. $\left(\frac{2}{3}\right)^{-2}$ | 10. $-(4)^{-2}$ | 9. _____ |
| | | 10. _____ |
| 11. $6x^{-2}y^{-3}z$ | 12. $\frac{14xy^2z^{-3}}{7x^{-3}y^{-1}z^4}$ | 11. _____ |
| | | 12. _____ |
| 13. $7x^0$ | 14. $-7x^0$ | 13. _____ |
| | | 14. _____ |
| 15. $(-7x)^0$ | 16. $-(-7x)^0$ | 15. _____ |
| | | 16. _____ |

Practice Set 1.5

Simplify each expression. Write the answer without negative exponents. Assume that all bases represented by variables are nonzero.

17. $\left(\frac{5}{x^3}\right)^3$

18. $(-3x^2y^{-3})^{-2}$

17. _____

18. _____

19. $\left(\frac{4x^3y^2z^5}{2xy^5z^7}\right)^{-1}$

20. $\left(\frac{2x^{-1}y^3z^{-2}}{6x^{-2}y^{-3}z^4}\right)^{-2}$

19. _____

20. _____

21. $\frac{(3x^{-3}y^2)^{-2}}{(x^{-4}y^{-2})^{-3}}$

22. $\frac{(2m^{-1}n^3p^{-2})^{-1}}{(3mn^{-2}p^4)^2}$

21. _____

22. _____

23. $3 \cdot 4^{-2} + 6 \cdot 8^{-1}$

24. $4^{-1} + 5^{-1}$

23. _____

24. _____

Determine what exponents must be placed in the [] to make each expression true.

25. $\left(\frac{x^2y^{-3}}{x^{\square}y^2}\right)^2 = \frac{x^{12}}{y^{10}}$

26. $\left(\frac{x^{\square}y^3z^{-1}}{x^4y^{-2}z^{-3}}\right)^{-1} = \frac{x^2}{y^5z^2}$

25. _____

26. _____

Challenge

27. $\left(\frac{x^{\frac{1}{2}}y^3}{x^{-1}y^{\frac{3}{2}}}\right)^{\frac{1}{2}}$

27. _____