Name:
Instructor:

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) $y^1 \cdot y^7$ y^8

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

2 Use the quotient rule for exponents.

Example 2 Simplify.

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

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

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

b) $\frac{-6^{-2}x^3y^{-1}}{6^2y} = \frac{-1x^3}{36y}$

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

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

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) $\frac{13}{16}$

4 **Use the zero exponent rule.**

Example 5 Simplify.

a) 150^0 b) $8x^0$ c) $-xy^0$ d) $-(xy)^0$

1 $8 \cdot 1$ $-x$ -1

8

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

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

a) $(3^2)^3$ b) $(x^{-2})^5$ c) $(4^{-2})^2$ d) $(y^{-3})^5$

3^6 x^{-10} 4^{-4} y^{-15}

$\frac{1}{x^{10}}$ $\frac{1}{4^4}$ $\frac{1}{y^{15}}$

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

Example 7 Simplify.

a) $(-4x^3)^3$ b) $(2m^{-4}n^3)^2$ c) $\left(\frac{1}{2}r^3s^2\right)^{-2}$ d) $(-4x^{-3}y^4)^2$

-4^3x^9 $2^2m^{-8}n^6$ $\left(\frac{1}{2}\right)^{-2} r^{-6} s^{-4}$ $16(x^{-6})y^8$

$\frac{4n^6}{m^8}$ $\frac{4}{r^6s^4}$ $\frac{16y^8}{x^6}$

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

Example 8 Simplify.

a) $\left(\frac{3}{x^3}\right)^2$ b) $\left(\frac{16m^3n^4}{8mn^2}\right)^3$ c) $\left(\frac{4x^3y^{-3}}{8x^3y}\right)^2$ d) $\frac{(3e^5f^{-2})^{-3}}{(e^{-3}f^4)^{-2}}$

$\frac{9}{x^6}$ $\left(\frac{2m^2n^2}{1}\right)^3$ $\left(\frac{1}{2y^4}\right)^2$ $\frac{3^{-3}e^{-15}f^6}{e^6f^{-8}}$

$8m^6n^6$ $\frac{1}{4y^8}$ $\frac{f^6f^8}{3^3e^6e^{15}}$

$\frac{f^{14}}{27e^{21}}$

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) $\frac{f^{14}}{27e^{21}}$

Name: Date:
Instructor: Section:

Practice Set 1.5

Use the choices below to fill in each blank.

product rule	negative exponent rule	power rule
quotient rule	zero exponent rule	additive Inverse

1. $a^m \cdot a^n = a^{m+n}$ is called the _____.

2. $a^{-m} = \frac{1}{a^m}$ is called the _____.

3. $\left(a^m\right)^n = a^{m \cdot n}$ is called the _____.

4. $a^0 = 1$ 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. $\left(-3x^2y^{-3}\right)^{-2}$

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

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

21._____

22._____

23. $3\cdot4^{-2}+6\cdot8^{-1}$

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

23._____

24._____

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

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

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

25._____

26._____

Challenge

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

27._____