7-2: MULTIPLICATION PROPERTIES OF EXPONENTS

Lesson Objectives:

- *Multiply powers*
- *Work with scientific notation*

1 Multiplying

PROPERTY: MULTIPLYING POWERS WITH THE SAME BASE

For every nonzero number a and integers m and n,

$$a^m \cdot a^n = a^{m+n}$$

$x^2 \cdot x^5$

$x \cdot x \cdot x \cdot x \cdot x \cdot x \cdot x$

x^7

EXAMPLE 1: MULTIPLYING POWERS

Simplify each expression.

1. $11^4 \cdot 11^3$

11^{4+3}

11^7

2. $5^{-2} \cdot 5^2$

5^{-2+2}

5^0

1

$\frac{5^{-2} \cdot 5^2}{1}$

$\frac{5^2}{5^2} = \frac{25}{25}$

$= 1$

3. $4^3 \cdot 4^2$

4^{3+2}

4^5

1024

4. $5^{-6} \cdot 5^4$

5^{-6+4}

5^{-2}

$\frac{5^{-2}}{1}$

$\frac{1}{5^2} = \frac{1}{25}$

5. $3^8 \cdot 3^5$

3^{8+5}

3^{13}

6. $6^{-7} \cdot 6^9$

6^{-7+9}

6^2

36

7. $(-2)^3 \cdot (-2)^{-5}$

$(-2)^{3+(-5)}$

$(-2)^{-2}$

$\frac{(-2)^{-2}}{1}$

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

8. $2^8 \cdot 2^{-9} \cdot 2^3$

$2^{8+(-9)+3}$

2^2

4

When variable factors have more than one base, be careful to combine only the powers with the same base.

EXAMPLE 2: MULTIPLYING POWERS IN AN ALGEBRAIC EXPRESSION

Simplify each expression.

9. $(3d^{-4})(5d^8)$

$(3 \cdot 5)(d^{-4} \cdot d^8)$

$15d^4$

10. $(-8m^4)(4m^8)$

$(-8 \cdot 4)(m^4 \cdot m^8)$

$-32m^{12}$

11. $n^{-6} \cdot n^{-9}$

n^{-15}

$\frac{n^{-15}}{1}$

$\frac{1}{n^{15}}$

12. $a^3 \cdot a^1$

a^4

13. $(3p^{-15})(6p^{11})$

$(3\cdot6)(p^{-15}\cdot p^{11})$

$\frac{18p^{-4}}{1}$

$\frac{18}{p^4}$

14. $p^7 \bullet q^5 \bullet p^6$

$(p^7\cdot p^6)q^5$

$p^{13}q^5$

$\begin{array}{r} 3 \\ 1.5 \\ \times\ 6 \\ \hline 9.0 \end{array}$

15. $(-1.5a^5b^2)(6a)$

$(-1.5\cdot6)(a^5\cdot a)b^2$

$-9a^6b^2$

16. $\frac{1}{b^7 \bullet b^5}$

$\frac{1}{b^{7+5}}$

$\frac{1}{b^{12}}$

17. $(-2d^3e^3)(6d^4e^6)$

$(-2\cdot6)(d^3\cdot d^4)(e^3\cdot e^6)$

$-12d^7e^9$

18. $p^{-5} \bullet q^2 \bullet p^4$

$(p^{-5}\cdot p^4)q^2$

$p^{-1}q^2$

$\frac{q^2}{p}$

19. $\frac{1}{n^7 \bullet n^{-5}}$

$\frac{1}{n^2}$

20. $(8d^4)(4d^7)$

$(8\cdot4)(d^4\cdot d^7)$

$32d^{11}$

2 Working With Scientific Notation

EXAMPLE 3: MULTIPLYING NUMBERS IN SCIENTIFIC NOTATION

$a \times 10^n$ where $1 \le a < 10$

Simplify each expression. Write each answer in proper scientific notation.

21. $(7\times10^2)(4\times10^5)$

$(7\cdot4)\times(10^2\cdot10^5)$

$28\times10^{7+1}$

2.8×10^8

22. $(7\times10^7)(5\times10^{-5})$

$(7\cdot5)\times(10^7\cdot10^{-5})$

$35\times10^{2+1}$

3.5×10^3

23. $(3\times10^8)(3\times10^4)$

$(3\cdot3)\times(10^8\cdot10^4)$

9×10^{12}

$\begin{array}{r} 1 \\ 9.5 \\ \times\ 3 \\ \hline 28.5 \end{array}$

24. $(9.5\times10^{-4})(3\times10^{-5})$

$(9.5\cdot3)\times(10^{-4}\cdot10^{-5})$

$28.5\times10^{-9+1}$

2.85×10^{-8}

25. $(5\times10^7)(4\times10^3)$

26. $(6\times10^{-6})(5.2\times10^4)$

27. $(4\times10^6)(9\times10^8)$

$(4\cdot9)\times(10^6\cdot10^8)$

$36\times10^{14+1}$

3.6×10^{15}

$\begin{array}{r} 61 \\ \times\ 8 \\ \hline 48.8 \end{array}$

28. $(6.1\times10^9)(8\times10^{14})$

$(6.1\cdot8)\times(10^9\cdot10^{14})$

$48.8\times10^{23+1}$

4.88×10^{24}

EXAMPLE 4: REAL-WORLD PROBLEM SOLVING

29. A human body contains about $3.2\times10^{4}\,\mu L$ (microliters) of blood for each pound of body weight. Each microliter of blood contains about 5×10^{6} red blood cells. Find the approximate number of red blood cells in the body of a 125-pound person.

$$125\ \text{lb}\cdot\frac{3.2\times10^{4}\ \mu L}{1\ \text{lb}}\cdot\frac{5\times10^{6}\ \text{r.b.c.}}{1\ \mu L}$$

$$(125\cdot3.2\cdot5)\times(10^{4}\cdot10^{6})\ \text{r.b.c.}$$

$$2000\times10^{10+3}\ \text{r.b.c.}$$

2×10^{13} red blood cells

30. In 1990, the St. Louis metropolitan area had an average of $82\times10^{-6}\ \frac{g}{m^{3}}$ of pollution in the air. How many grams of pollutants where there in $2\times10^{3}\,m^{3}$ of air?

31. Light travels approximately 5.87×10^{12} miles in one year. This distance is called a light-year. Suppose a star is 2×10^{4} light-years away. How many miles away is that star?

32. The weight of 1 m^{3} of air is approximately 1.3×10^{3} grams. Suppose that the volume of air inside of a building is 3×10^{6} m^{3}. How much does the air inside the building weigh?

33. Light travels 1.18×10^{10} inches in 1 second. How far will light travel in 1 nanosecond or 1×10^{-9} seconds?

$$\frac{1.18\times10^{10}\ \text{in}}{1\ \text{sec}}\cdot\frac{1\times10^{-9}\ \text{sec}}{1\ \text{nanosec}}$$

$$(1.18\cdot1)\times(10^{10}\cdot10^{-9})\ \text{in/nano}$$

1.18×10^{1} in/nanosec

Due Friday

7-2

Name _____ **Practice Worksheet** Period _____

Simplify each expression.

1. $10^{-6} \cdot 10^{5} \cdot 10^{1}$

2. $(1.025)^{2}(1.025)^{-2}$

3. $5t^{-2} \cdot 2t^{-5}$

4. $(-2.4n^{4})(2n^{-1})$

5. $(15a^{3})(-3a)$

6. $(4c^{4})(ac^{3})(3a^{5}c)$

7. $-m^{2} \cdot 4r^{3} \cdot 12r^{-4} \cdot 5m$

8. $(4 \times 10^{6})(2 \times 10^{-3})$

9. $(5 \times 10^{7})(3 \times 10^{14})$

10. Earth's crust contains approximately 120 trillion metric tons of gold. One metric ton of gold is worth about $64 million. What is the approximate value of the gold in the Earth's crust?

11. Light travels through space at a constant speed of about 3 X 10^{5} km/s. Sunlight reflecting from the moon takes about 1.28 X 10^{0} s to reach Earth. Find the distance from the moon to Earth.

Complete each equation.

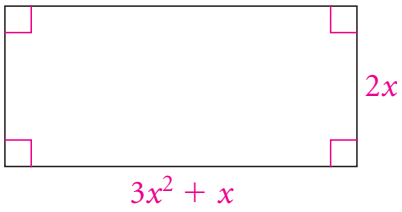
12. $2^{?} \cdot 2^{4} = 2^{-1}$

13. $c^{?} \cdot c^{-5} = c^{6}$

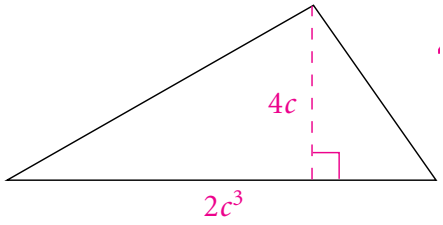
14. $x^{3}y^{?} \cdot x^{?} = y^{2}$

Find the area of each figure.

15. $A_{rectangle} = lw$



16. $A_{triangle} = \frac{1}{2}bh$



Correct each error.

17. $4a^2 \cdot 3a^5 = (4 + 3)a^{2+5}$
$= 7a^7$

18. $3^4 \cdot 2^2 = 6^{4+2}$

Simplify.

19. $\dfrac{5}{c \bullet c^{-4}}$

20. $2a^2(3a+5)$

21. $8m^3(m^2+7)$

22. $-4x^3(2x^2-9x)$

23. $3^x \bullet 3^{2-x} \bullet 3^2$

24. $2^n \bullet 2^{n+2} \bullet 2$

25. $(a+b)^2(a+b)^{-1}$

26. $5^{x+1} \bullet 5^{1-x}$