$c^{225}, c^{30}, (c^8)^2 = c^{16}, c^{25}, c^{10}, c^{21}$

7-3: MORE MULTIPLICATION PROPERTIES OF EXPONENTS

Lesson Objectives:

- *Raise a power to a power*
- *Raise a product to a power*

$c^5(c^3)^2 \Rightarrow c^5 \cdot c^3 \cdot c^3 = c^{11}$

1 Raising a Power to a Power

PROPERTY: RAISING A POWER TO A POWER

For every nonzero number *a* and integers *m* and *n*, $(a^m)^n = a^{m \cdot n}$

Situation	Rule for Exponents	Example
Adding Like Terms	Stay the same	$2x^2+3x^2=5x^2$
Multiplying The Same Base	Add	$x^2 \cdot x^3 = x^5$
Power of a Power	Multiply	$(x^2)^3 = x^6$

a) $(5^4)^2 = 5^{4 \cdot 2} = 5^8$

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

EXAMPLE 1: SIMPLIFYING A POWER RAISED TO A POWER
Simplify each expression.

1. $(x^3)^6$ x^{18}

2. $(2^{-3})^4$ 2^{-12} $\frac{1}{2^{12}} = \frac{1}{4096}$

3. $(s^2)^2$ s^4

4. $(d^2)^{-4}$ d^{-8} $\frac{1}{d^8}$

5. $(a^4)^6$ a^{24}

6. $(b^{-3})^2$ b^{-6} $\frac{1}{b^6}$

7. $(m^{-5})^{-3}$ m^{15}

8. $(y^7)^{-4}$ y^{-28} $\frac{1}{y^{28}}$

Be sure to use the order of operations to simplify the expressions in parentheses first.

EXAMPLE 2: SIMPLIFYING AN EXPRESSION WITH POWERS
Simplify each expression.

9. $c^5(c^3)^2$ $c^5 c^6$ c^{11}

10. $2^5(2^4)^{-2}$ $2^5 \cdot 2^{-8}$ 2^{-3} $\frac{1}{2^3} = \frac{1}{8}$

11. $x^4(x^4)^3$ $x^4 \cdot x^{12}$ x^{16}

12. $(a^4)^{-5} \cdot a^{13}$ $a^{-20} a^{13}$ a^{-7} $\frac{1}{a^7}$

13. $y^{21}\left(y^{6}\right)^{-3}$

$y^{21}y^{-18}$

y^{3}

14. $n^{6}\left(n^{-2}\right)^{5}$

$n^{6}n^{-10}$

n^{-4}

$\frac{1}{n^{4}}$

15. $\left(b^{2}\right)^{4}\cdot b^{-9}$

$b^{8}b^{-9}$

b^{-1}

$\frac{1}{b}$

16. $d^{3}\left(d^{2}\right)^{5}$

$d^{3}d^{10}$

d^{13}

17. Find the value of a if:

$a=7$

$x^{-5}\left(x^{a}\right)^{3}=x^{16}$

$x^{-5}\cdot x^{3a}=x^{16}$

$x^{-5+3a}=x^{16}$

$-5+3a=16$

$+5 \quad +5$

$\frac{3a}{3}=\frac{21}{3}$

$a=7$

18. Find the value of a, b, and c if:

$a\left(x^{2}\right)^{3}\left(y^{4}\right)^{5}\cdot -4\left(x^{b}\right)^{4}\left(y^{-2}\right)^{c}=12x^{2}y^{30}$

$a=-3,\ b=-1,\ c=-5$

2 Raising a Product to a Power

(group)

PROPERTY: RAISING A PRODUCT TO A POWER

For every nonzero numbers a and b and integer n, $(ab)^{n}=a^{n}b^{n}$

a) $(3x)^{4}=(3x)(3x)(3x)(3x)$

$3^{4}x^{4}=81x^{4}$

EXAMPLE 3: SIMPLIFYING A PRODUCT RAISED TO A POWER

Simplify each expression.

19. $\left(4a^{5}\right)^{3}$

$4^{3}(a^{5})^{3}$

$64a^{15}$

20. $\left(m^{-3}n^{4}\right)^{-4}$

$m^{12}n^{-16}$

$\frac{m^{12}}{n^{16}}$

21. $\left(x^{2}y\right)^{4}$

$x^{8}y^{4}$

22. $\left(4^{-1}s^{3}\right)^{-2}$

$4^{2}s^{-6}$

$\frac{16}{s^{6}}$

$a^{0}=1$

23. $\left(x^{4}y\right)^{3}$

$x^{12}y^{3}$

24. $\left(12b^{-2}\right)^{2}$

$144b^{-4}$

$\frac{144}{b^{4}}$

25. $\left(5a^{3}b^{5}\right)^{4}$

$625a^{12}b^{20}$

26. $\left(-16x^{-2}y^{-7}z^{3}\right)^{0}$

1

EXAMPLE 4: SIMPLIFYING A PRODUCT RAISED TO A POWER
Simplify each expression.

27. $\left(x^{-2}\right)^{2}\left(3xy^{2}\right)^{4}$

$x^{-4} \cdot 81x^{4}y^{8}$

$81\left(x^{-4} \cdot x^{4}\right)y^{8}$

$81x^{0}y^{8}$

$81y^{8}$

28. $\left(4x^{4}\right)\left(2xy^{3}\right)^{2}$

$4x^{4} \cdot 4x^{2}y^{6}$

$16x^{6}y^{6}$

29. $\left(x^{-4}\right)^{5}\left(x^{3}y^{2}\right)^{5}$

$x^{-20} \cdot x^{15}y^{10}$

$x^{-5}y^{10}$

$\frac{y^{10}}{x^{5}}$

30. $\left(3f^{4}g^{-3}\right)\left(f^{2}g^{-2}\right)^{-1}$

$3f^{4}g^{-3} \cdot f^{-2}g^{2}$

$3f^{2}g^{-1}$

$\frac{3f^{2}}{g}$

31. $\left(x^{5}y^{3}\right)^{3}\left(xy^{5}\right)^{2}$

$x^{15}y^{9} \cdot x^{2}y^{10}$

$x^{17}y^{19}$

32. $\left(m^{5}\right)^{-3}\left(m^{4}n^{5}\right)^{4}$

$m^{-15} \cdot m^{16}n^{20}$

mn^{20}

33. $\left(a^{3}b^{4}\right)^{-2}\left(a^{-3}b^{-5}\right)^{-4}$

$a^{-6}b^{-8} \cdot a^{12}b^{20}$

$a^{6}b^{12}$

34. Find *a*, *b*, and *c* if

$$\left(ax^{2}y^{b}z^{3}\right)^{2}\left(3x^{4}y^{2}z^{2}\right)^{c} = \frac{25y^{4}z^{4}}{3}$$

$y^{6}z^{6}$ $y^{-2}z^{-2}$

$a=5,\ b=3,\ c=-1$

EXAMPLE 5: RAISING SCIENTIFIC NOTATION TO A POWER
Simplify. Write each expression in proper scientific notation.

35. $\left(3\times10^{-6}\right)^{3}$

$27 \times 10^{-18+1}$

2.7×10^{-17}

36. $\left(5\times10^{2}\right)^{-3}$

$125\overline{)1.000}$ 0.008, -1000, 0

$5^{-3} \times 10^{-6}$

$\frac{1}{125} \times 10^{-6}$

$.008 \times 10^{-6-3}$

8×10^{-9}

37. $10^{-3}\left(2\times10^{3}\right)^{5}$

39. $\left(9\times10^{7}\right)^{2}$

40. $\left(3\times10^{5}\right)^{4}$

$81 \times 10^{20+1}$

8.1×10^{21}

41. $10^{5}\left(8\times10^{7}\right)^{3}$

Due Wed

Name _____ ***7-3 Practice Worksheet*** Period _____

Simplify each expression.

1. $(q^{10})^{10}$
2. $(x^3)^{-1}(x^2)^5$
3. $(12g^4)^{-1}$
4. $(2p^6)^0$
5. $(mg^4)^{-1}(mg^4)$
6. $(2a^2c^4)^{-5}(c^{-1}a^7)^6$
7. $(b^5)^3 b^2$
8. $(-2a^2b)^3(ab)^3$
9. $(4xy^2)^4(-y)^{-3}$
10. $(3.5\times10^{-4})^3$

Complete each equation.

11. $(b^2)^{?} = b^8$
12. $(5x^{?})^2 = 25x^{-4}$
13. $(m^2n^3)^{?} = \dfrac{1}{m^6n^9}$

Write each equation with only one exponent. Use parentheses.

14. $m^4 \bullet n^4$
15. $(a^5)(b^5)(a^0)$
16. $49x^2y^2z^2$
17. $\dfrac{12x^2}{3y^2}$

Solve each equation.

SAMPLE: $25^3 = 5^x$

$(5^2)^3 = 5^x$

$5^6 = 5^x$

$6 = x$

18. $5^6 = 25^x$

19. $8^2 = 2^x$

20. $3^x = 27^4$

21. $4^x = 2^6$

22. $3^{2x} = 9^4$

23. $2^x = \frac{1}{32}$

24. Earth has a radius of about 6.4×10^6 m. **(CALCULATOR ALLOWED.** ***Answers should be in scientific notation.*****)**

a.) Approximate the surface area of Earth using the formula for the surface area of a sphere, $S=4\pi r^2$.

b) Earth's surface is about 70% water, almost all of it in oceans. About how many square meters of Earth's surface are covered with water?

c) The oceans have an average depth of 3795 m. Estimate the volume of water on Earth.