

Using Properties of Exponents

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Exponents

- The definition of an expression a^n is the product of a used as a factor n times.
- This is a power. The base is a , and the exponent is n .
- Any base (numeric or variable) that doesn't have an exponent is understood to have an exponent of 1.
- Today we'll look at properties of exponents, and how to use them.

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Properties of Exponents

- Let a and b be real numbers and let m and n be integers.
- Product of Powers Property
■ $a^m * a^n = a^{m+n}$ $2^5 * 2^3 = 2^8$
When multiplying powers with the SAME BASE, add the exponents.
- Power of a Power Property
■ $(a^m)^n = a^{mn}$ $(3^4)^2 = 3^8$
When taking a power to a power, multiply the exponents.

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Properties of Exponents

- Let a and b be real numbers and let m and n be integers.
- Power of a Product Property
■ $(ab)^m = a^m b^m$ $14^2 = (7^2)(2^2)$
Factor your base, and take each factor to the same exponent.
- Negative Exponent Property
■ $a^{-m} = 1/a^m, a \neq 0$ $3^{-2} = 1/3^2$
A negative exponent tells you to flip the base over into the other side of the fraction.

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Properties of Exponents

- Let a and b be real numbers and let m and n be integers.
- Zero Exponent Property
■ $a^0 = 1, a \neq 0$ $172^0 = 1$
- Quotient of powers property
■ $a^m/a^n = a^{m-n}, a \neq 0$ $17^5/17^3 = 17^2$
■ When dividing powers with the SAME BASE, subtract their exponents.

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Properties of Exponents

- Let a and b be real numbers and let m and n be integers.
- Power of a Quotient Property
■ $(a/b)^m = a^m/b^m, b \neq 0$ $(3/4)^3 = 3^3/4^3$

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Properties of Exponents

- For the sake of convenience, we'll assume that any base with a zero or negative exponent is not zero.

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Examples

- $(3^4)^2$
- $= 3^{4*2}$
- $= 3^8$
- $= 3*3*3*3*3*3*3*3$
- $= 6561$

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Examples

- $(5/8)^3$
- $= 5^3/8^3$
- $= 5*5*5/8*8*8$
- $= 125/512$

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Examples

- $(-2)^{-3}/(-2)^9$
- $= -2^{-3-9}$
- $= -2^{-12}$
- $= 1/-2*-2*-2*-2*-2*-2*-2*-2*-2*-2$
- $= 1/64$

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Simplifying Algebraic Expressions

- For the sake of convenience, we'll assume that any base with a zero or negative exponent is not zero.
- A simplified algebraic expression has only positive exponents.

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Simplifying Algebraic Expressions

- $(a^2/b^{-3})^3$
- $= a^{2*3}/b^{-3*3}$
- $= a^6/b^{-9}$
- $= a^6b^9$

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Simplifying Algebraic Expressions

- $(-y^2)^5 y^2 y^{-12}$
- $= -y^{10} y^2 y^{-12}$
- $= -y^{10+2+(-12)}$
- $= -y^0 = -1$

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Simplifying Algebraic Expressions

- $rs^2/(rs^{-1})^3$
- $= rs^2/r^3 s^{-3}$
- $= rs^2 s^3/r^3$
- $= rs^5/r^3$
- $= s^5 r^{-2}$
- $= s^5/r^2$

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Real Life Problem

- The radius of the sun is about 109 times as great as Earth's radius. How many times as great as Earth's volume is the sun's volume? Volume of a sphere is $4/3\pi r^3$. Let r be Earth's radius.
- Sun's volume/Earth's volume = $(4/3\pi(109r)^3)/(4/3\pi r^3)$

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$\pi = \text{pi}$

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Real Life Problem

- $(4/3\pi(109r)^3)$ Items in red cancel out.
- $$\frac{(4/3\pi r^3)}{r^3}$$
- $$109^3$$
- 1,295,029
- The Sun's volume is approximately 1.3 million times that of Earth.

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Practice for You

- 1) $4^2 * 4^4$

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Practice for You

- 2) $(1/8)^{-4}$

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Practice for You

- 3) $(1/10)^{-3} \cdot (1/10)^3$

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Practice for You

- 4) $(2^3 x^2)^5$

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Practice for You

- 5) x^5/x^{-2}

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Practice for You

- 6) $y^{10}/2x^3 \cdot 20x^{14}/xy^6$

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Answers

- 1) 4096
- 2) 4096
- 3) 1
- 4) $32,768x^{10}$
- 5) x^7
- 6) $10x^{10}y^4$

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