Bellwork

Simplify each of the following:

1. $\frac{xxxx}{xx} = xx = x^2$

2. $\frac{xyyzzz}{xxxyzzzz} = \frac{y}{xxz} = \frac{y}{x^2z}$

3. $\frac{xxxyyyyyzz}{xyyyyyz} = \frac{xxz}{y} = \frac{x^2z}{y}$

Properties of Exponents

1. Zero Exponent
2. Multiplying like bases
3. Dividing like bases
4. Power of a power
5. Product of a power
6. Quotient of a power
7. Negative Exponents

Zero Exponent

Anything to the power of zero = 1

Examples:

$x^0 = 1$

$(xy)^0 = 1$

$(xyz)^0 = 1$

Try these:

1. $a^2bc^0x^0y^0z$ a^2bz

2. $(a(b^6c^2d^3e^{-5}f^2g^0hi)^0)^0$ $(a \cdot 1)^0 = 1$

Multiplying Like Bases

Property:

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

Examples:

$bb^6 = b^{1+6} = b^7$

$a^9 a^{-2} = a^{9+(-2)} = a^{9-2} = a^7$

Try these:

1. $x^{-2}x^8y^{-3}y^6$

$x^{-2+8}y^{-3+6} = \boxed{x^6y^3}$

2. $m^{-4}m^{13}n^4$

$m^{-4+13}n^4 = \boxed{m^9n^4}$

Dividing Like Bases

Property:

$$\frac{a^m}{a^n} = a^{m-n}$$

Examples:

$$\frac{b^5}{b^3} = b^2 \qquad \frac{a^9}{a^{15}} = \frac{1}{a^6}$$

Try these:

1. $\frac{m^3n}{mn^8} = \frac{m^{3-1}}{n^{8-1}} = \frac{m^2}{n^7}$

2. $\frac{x^8y^{-5}z^2}{x^4y^{-3}z^6} = \frac{x^{8-4}}{y^{-3-(-5)}z^{6-2}} = \frac{x^4}{y^2z^4}$

Power of a Power

Property:

$(a^m)^n = a^{mn}$

Examples:

$(a^4)^3 = a^{4(3)} = a^{12}$

$a(b^2)^7 = ab^{2(7)} = ab^{14}$

Try These:

1. $(x)^3(y^{-2})^2(z^0)^3$

$x^{1(3)}\ y^{-2(2)}\ z^{0(3)} = x^3 y^{-4} z^0 = \boxed{x^3 y^{-4}}$

2. $a^0(b^{-7})^2c^3$

$b^{-7(2)}\ c^3 = \boxed{b^{-14}\ c^3}$

You could also use other properties...

$(a^4)^3 = a^4a^4a^4 = a^{4+4+4} = a^{12}$

$a(b^2)^7 = ab^2b^2b^2b^2b^2b^2b^2$
$= ab^{2+2+2+2+2+2+2}$
$= ab^{14}$

Product to a Power

Property:

$(a^n b^m)^c = a^{nc} b^{mc}$

Examples:

$(a^2 b^3)^2 = a^{2(2)} b^{3(2)} = a^4 b^6$

$a(b^5 c^2)^3 = a b^{5(3)} c^{2(3)} = a b^{15} c^6$

Try These:

1. $(5f^{-7} g^5 h^0)^2$

$5^2 f^{-7(2)} g^{5(2)} h^{0(2)} = 25 f^{-14} g^{10} h^0$

$= \boxed{25 f^{-14} g^{10}}$

2. $a^{-2} b^3 (b c^{-2} d^2)^3$

$a^{-2} b^3 b^{1(3)} c^{-2(3)} d^{2(3)}$

$a^{-2} b^3 b^3 c^{-6} d^6 = \boxed{a^{-2} b^6 c^{-6} d^6}$

Quotient to a Power

Property:

$$\left(\frac{a^m}{a^n}\right)^c = \frac{a^{mc}}{a^{nc}}$$

Example:

$$\left(\frac{3ab^2}{c}\right)^3 = \frac{3^{1(3)}a^{1(3)}b^{2(3)}}{c^{1(3)}} = \frac{3^3a^3b^6}{c^3} = \frac{27a^3b^6}{c^3}$$

Try this:

$$\left(\frac{-3x^2y^{-4}}{xy^{-8}}\right)^2 = \frac{(-3)^{1(2)}x^{2(2)}y^{-4(2)}}{x^{1(2)}y^{-8(2)}} = \frac{(-3)^2x^4y^{-8}}{x^2y^{-16}} = 9x^{4-2}y^{-8-(-16)}$$

$$= \boxed{9x^2y^8}$$

Negative Exponents

Property:

- No negative exponents allowed!
- If... $\frac{a}{b^{-n}} = ab^n$ - If... $\frac{b^{-n}}{a} = \frac{1}{ab^n}$

Examples:

$$\frac{3x^2y^{-6}}{z^{-3}} = \frac{3x^2z^3}{y^6}$$

Try this:

$$\frac{-2xy^{-8}z^9}{-2x^{-8}y^{-5}z^{-4}} = \frac{x\,x^{8}\,y^{5}\,z^{9}\,z^{4}}{y^{8}} = \frac{x^{1+8}\,z^{9+4}}{y^{8-5}} = \boxed{\frac{x^{9}\,z^{13}}{y^{3}}}$$