**Math 9 Lesson 2-5 Exponent Laws (Part 2)**

**Power of a Power…**

We saw yesterday how to simplify powers when we multiply the same base. What happens when we have repeated multiplication of the same power? (ie. A power raised to a power) The key to simplifying lies in practising the expanded form of the power.

|  |  |  |
| --- | --- | --- |
| **Expression to be simplified** | **Work it out (expanded form)** | **End result (power form)** |
| $$\left(3^{2}\right)^{3}$$ | $$\left(3×3\right)^{3}=\left(3×3\right)\left(3×3\right)\left(3×3\right) $$$$=3×3×3×3×3×3$$ | $$3^{6}$$ |
| $$\left(4^{3}\right)^{5}$$ |  |  |
| $$\left(2^{3}\right)^{3}$$ |  |  |
| $$\left(8^{3}\right)^{1}$$ |  |  |
| $$\left(5^{3}\right)^{0}$$ |  |  |
| $$\left((-2)^{4}\right)^{6}$$ |  |  |
| $$-\left(2^{2}\right)^{3}$$ |  |  |
| $$3\left(5^{3}\right)^{3}$$ |  |  |

**Describe the pattern in your own words.**

**Power of a Power**

To raise a power to a power**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

$$\left(a^{m}\right)^{n }=a^{mn} where a is any integer except 0, m and n are any whole numbers$$

 **\*\*\***$mn means m×n$

**Power of a Product**

Sometimes the base of a power may be a product, for example $\left(3×4\right)^{3}.$ We can use the commutative property of multiplication (repeatedly) which says that the order which I multiply two numbers doesn’t matter.

 Example: $2×3×5=5×2×3=3×2×5$

The value is the same regardless of the order, so if I rearranged the numbers it would still give the same result.

|  |  |  |
| --- | --- | --- |
| **Expression to be simplified** | **Work it out (expanded form)** | **End result (power form)** |
| $$\left(3×4\right)^{3}$$ | $$\left(3×4\right)^{3}=\left(3×4\right)\left(3×4\right)\left(3×4\right) $$$$=3×3×3×4×4×4$$ | $$3^{3}×4^{3}$$ |
| $$\left(2×4\right)^{5}$$ |  |  |
| $$\left(3×1\right)^{3}$$ |  |  |
| $$\left(6×2\right)^{1}$$ |  |  |
| $$\left(4×2\right)^{0}$$ |  |  |
| $$\left((-2)×2\right)^{6}$$ |  |  |

**What is the pattern you see in the table?**

**Exponent Law for Power of a Product**

$$\left(ab\right)^{m}=a^{m}b^{m}$$

*a* and *b* are any integers, except 0.

*m* is any whole number.

**Exponent Law for Power Of a Quotient**

These problems also use multiplication of powers , but also multiplication of fractions. Recall we multiply two fractions by multiplying the tops and bottoms separately. For instance, $\frac{3}{4}×\frac{5}{2}=\frac{3x5}{4x2}=\frac{15}{8} $

|  |  |  |  |
| --- | --- | --- | --- |
| **Expression to be simplified** | **Work it out (expanded form)** | **End result (power form)** | **Standard Form** |
| $$\left(\frac{3}{2}\right)^{3}$$ | $$\left(\frac{3}{2}\right)\left(\frac{3}{2}\right)\left(\frac{3}{2}\right)=\frac{3×3×3}{2×2×2}$$ | $$\frac{3^{3}}{2^{3}}$$ |  |
| $$\left(\frac{5}{6}\right)^{4}$$ |  |  |  |
| $$\left(\frac{1}{2}\right)^{2}$$ |  |  |  |
| $$\left(\frac{-4}{7}\right)^{3}$$ |  |  |  |
| $$\left(\frac{1}{4}\right)^{3}$$ |  |  |  |

What is the pattern you see?

Exponent Law for Power of a Quotient

$$\left(\frac{a}{b}\right)^{n}=\frac{a^{n}}{b^{n}} b\ne 0$$

Where *a* and *b* are any integers, but *b* cannot be 0.

*n* is any whole number.

Does this rule work for $\left(\frac{5}{0}\right)^{3}$? Explain. If so, what do you get as the end result?

So now how do we put these rules all together?

Evaluate the following.

a)$\left[\left(-7\right)×5\right]^{2}$ b) $\left[24÷(-6)\right]^{4}$

c) $-\left(3×2\right)^{2}$ d) $\left(\frac{78}{13}\right)^{3}$

e) $\left(3^{2}×3^{3}\right)^{3}-\left(4^{3}×4^{2}\right)^{2}$ f) $\left(6×7\right)^{2}+(3^{8}÷3^{6})^{3}$

2. Why do you add the exponents to simplify $3^{2}×3^{4}$ , but multiply the exponents to simplify the expression $\left(3^{2}\right)^{4}$?

3. What is the difference between a quotient of powers and a power of a quotient?

4. What is the difference between a product of powers and a power of a product?

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