

Important Concepts . . .

Preview Review



Mathematics Grade 9 TEACHER KEY
W1 - Lesson 2: Exponents

Important Concepts of Grade 9 Mathematics

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Materials Required

Paper
Pencil
Calculator

No Textbook Required

This is a stand-alone course.

Mathematics Grade 9

Version 6

Preview/Review W1 - Lesson 2

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Preview/Review Concepts for Grade Nine Mathematics

Teacher Key



W1 – Lesson 2:

Laws of Exponents

OBJECTIVES

By the end of this lesson, you will be able to:

- Explain, using examples, the exponent laws of powers with integral bases (excluding base 0) and whole number exponents.
- Evaluate a given expression by applying the exponent laws.

GLOSSARY

Product Law: $x^a x^b = x^{a+b}$

Power of a Product Law: $(x^a)^b = x^{ab}$

Division law: $\frac{x^a}{x^b} = x^a x^{-b} = x^{a-b}$

Zero Exponent Law: $x^0 = 1$ (if $x \neq 0$)

W1 – Lesson 2: Laws of Exponents

Materials required:

- Paper, Pencil, and Calculator

Part 1: Multiplication of Powers – The Product Law

In the expression $(x^5)(x^6)$, notice that the bases are the same. This expression can be simplified into one exponent instead of two: the key is to count factors.

So,

$$x^5 = (x)(x)(x)(x)(x) \text{ and } x^6 = (x)(x)(x)(x)(x)(x)$$

Multiply them together:

$$(x^5)(x^6) = (x)(x)(x)(x)(x)(x)(x)(x)(x)(x)(x) = x^{11}$$

There are five x factors from x^5 , and six x factors from x^6 , which yields 11 x factors in total.

The **Product Law** can then be written as:

$$x^a x^b = x^{a+b}$$

Example 1

Simplify $(5^4)(5^3)$

$$\begin{aligned}
 &= (5)(5)(5)(5) \quad (5)(5)(5) \\
 &= (5)(5)(5)(5)(5)(5)(5) \\
 &= 5^7
 \end{aligned}$$

Note: The rule above does not work when multiplying powers with a different base. For instance,

$$(x^3)(y^4) = (x)(x)(x)(y)(y)(y)(y)$$

When writing out the powers, there is no way to combine them.

However, if the bases are different but the exponents are the same, then they can be combined.

Example:

$$(x^3)(y^3) = (x)(x)(x)(y)(y)(y) = (xy)^3$$

So combining powers with different bases can be written as:

$$x^a y^a = (xy)^a$$

Example 1

Simplify $(4)^3 (5)^3$

$$\begin{aligned}
 &= (4)(4)(4) \quad (5)(5)(5) \\
 &= (4 \times 5)^3 \\
 &= 20^3
 \end{aligned}$$

Practice Questions

1. Simplify each of the following.

a. $(x^3)(x^6)$

x^9

b. $(3^5)(3^2)$

3^7

c. $-(8^4)(8^3)$

-8^7

d. $(9^6)(9^5)$

9^{11}

2. Simplify each of the following.

a. $(d^3)(f^5)$

$(df)^5$

b. $(8^4)(6^4)$

48^4

c. $(5^6)(3^6)$

15^6

d. $(6^4)(7^4)$

42^4

Part 2: Division of Powers

When dividing exponents, subtract the exponents when the bases are the same.

To simplify $x^8 \div x^6$, subtract the exponents.

$$x^8 \div x^6 = x^{8-6} = x^2$$

So the **Division Law** can be written as: $\frac{x^a}{x^b} = x^a x^{-b} = x^{a-b}$

Example 1

Simplify $(6^6) \div (6^3)$

$$\begin{aligned} &= (6)(6)(6)(6)(6)(6) \div (6)(6)(6) \\ &= (6)^{6-3} \\ &= 6^3 \end{aligned}$$

When dividing powers with different bases but a common exponent, this exponent can be applied to both the numerator and denominator. For instance, $x^3 \div y^3$.

$$\begin{aligned} &= \frac{(x)(x)(x)}{(y)(y)(y)} \\ &= \left(\frac{x}{y}\right)\left(\frac{x}{y}\right)\left(\frac{x}{y}\right) \text{ which is } \left(\frac{x}{y}\right)^3. \end{aligned}$$

$$\frac{x^a}{y^a} = \left(\frac{x}{y}\right)^a$$

Example 2

Simplify $(4)^6 \div (5)^6$

$$\begin{aligned} &= \frac{4^6}{5^6} \\ &= \left(\frac{4}{5}\right)^6 \end{aligned}$$

Practice Questions

1. Simplify each of the following.

a. $(j^5) \div (j^4)$

 j

b. $(2^5) \div (2^2)$

 2^3

c. $-(5^5) \div (5^3)$

 -5^2

d. $(9^9) \div (9^5)$

 9^4

2. Simplify each of the following.

a. $(h^5) \div (k^5)$

 $\left(\frac{h}{k}\right)^5$

b. $(3^4) \div (6^4)$

 $\left(\frac{3}{6}\right)^4$

Part 3: Power of a Power

With an expression like $(x^5)^4$, the rule can be worked out by counting.

$$(x^5)^4 = (x^5)(x^5)(x^5)(x^5)$$

Write this as an array:

$$\begin{array}{l} x^5 = (x) (x) (x) (x) (x) \\ x^5 = (x) (x) (x) (x) (x) \\ x^5 = (x) (x) (x) (x) (x) \\ x^5 = (x) (x) (x) (x) (x) \end{array}$$

There are 20 factors of x , therefore, $(x^5)^4 = x^{20}$

So the **Power of a Power Rule** can be written as:

$$(x^a)^b = x^{ab}$$

Note the difference between the **Power Rule**.

$$x^5 x^4 = (xxxxx)(xxxx) = x^9$$

Example 1

$$\begin{aligned} &\text{Simplify } (4^3)^5 \\ &= (4^3) (4^3) (4^3) (4^3) (4^3) \text{ or } 4^{3 \times 5} \\ &= 4^{15} \end{aligned}$$

Example 2

$$\begin{aligned} &\text{Simplify } (-5^3)^2 \\ &= (-5^3) (-5^3) \text{ or } (-5)^{3 \times 2} \\ &= (-5)^6 \end{aligned}$$

Lesson 2 Assignment

1. Evaluate each of the following.

a. $-(5)^6$

$-15\ 625$

b. 4^6

4096

2. Simplify each of the following.

a. $(3^3)(3^4)$

3^7

b. $(4^5)(4^6)$

4^{11}

c. $(h^7) \div (h^5)$

h^2

d. $(6^6) \div (6^4)$

6^2

3. Evaluate the following powers, then circle the lesser value in each set.

a. $\textcircled{2(2^2)^3}$ or $3(2^3)^2$

$(2)(2)^6$ or $(3)(2)^6$

128 or 192

b. $\textcircled{6^3 \times 6^4}$ or $3^6 \times 3^6$

6^7 or 3^{12}

$279\ 936$ or $531\ 441$

4. Simplify the following.

a. $(5^4)^5$

5^{20}

b. $(4^6)^5$

4^{30}

5. Simplify the following.

$$\text{a. } \frac{(8^2)(8^5)(8^{-3})}{(8^2)}$$

$$= \left(\frac{8^4}{8^2} \right) = 8^2$$

$$\text{b. } \frac{(6^7)(6^2)}{(6^2)}$$

$$= \left(\frac{6^9}{6^2} \right) = 6^7$$

$$\text{c. } \frac{[(-5)^2]^4}{(-5)^3}$$

$$= \frac{(-5)^8}{(-5)^3} = (-5)^5$$

$$\text{d. } [(a^2)(a^3)]^2$$

$$= (a^5)^2 = a^{10}$$

6. Write the following as a single power and then evaluate the expression.

$$\text{a. } 2^5 \times 2^7$$

$$= 2^{12}$$

$$= 4096$$

$$\text{b. } 3(mn)^4 \text{ where } m = 6 \text{ and } n = 5$$

$$= 3m^4n^4 = 3(6)^4(5)^4 = (3)(1296)(625) = 2\,430\,000$$

$$\text{c. } 8(3^5)^2$$

$$= (8)(3^{10}) = 472\,392$$

