Curriculum Outcome

(N1) Demonstrate an understanding of powers with integral bases (excluding base 0) and whole number exponents by: representing repeated multiplication using powers; using patterns to show that a power with an exponent of zero is equal to one; solving problems involving powers.

(N2) Demonstrate an understanding of operations on powers with integral bases (excluding base 0) and whole number exponents.

Student Friendly:
“Learning the laws of Exponents "
Simplifying expressions before we try to evaluate them.

Grade 9 Warm Up

Simplify then Evaluate

1) $(-2)^7 \div (-2)^3 - (-2)^5 \div (-2)^2$

2) $(-4)^9 \div (-4)^5 + (-4)^5 \div (-4)^2$

3) $\dfrac{2^4(2^3 \div 2^2) - 4^0}{3(3^4 + 2^2)}$

Grade 9
Warm Up

Simplify then Evaluate

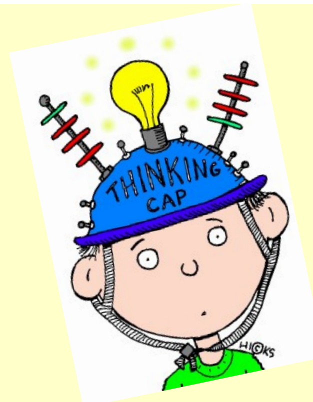
1) $(-2)^7 \div (-2)^3 - (-2)^5 \div (-2)^2$

$$\boxed{(-2)^4 - (-2)^3}$$

$$16 + (+8)$$

$$\boxed{= 24}$$

Grade 9 Warm Up



Simplify then Evaluate

2) $(-4)^9 \div (-4)^5 + (-4)^5 \div (-4)^2$

$$\boxed{(-4)^4 \quad + (-4)^3}$$

$$256 + (-64)$$

$$= 192$$

Grade 9 Warm Up

Simplify then Evaluate

3) $\dfrac{2^4(2^3 \div 2^2) - 4^0}{3^1(3^4 + 2^2)}$

$$= \frac{2^4(2^1) - 4^0}{3(3^4+2^2)}$$

$$= \boxed{\frac{2^5 - 4^0}{3(3^4+2^2)}}$$

$$\frac{32 - 1}{3(81+4)}$$

$$\frac{31}{3(85)}$$

$$\frac{31}{255}$$

① $x^0 = 1$

② $x^a \cdot x^b = x^{a+b}$

③ $\dfrac{x^a}{x^b} = x^{a-b}$

④ $(x^a)^b = x^{a \cdot b}$

⑤ $[x^a y^b]^c = x^{a \cdot c} y^{b \cdot c}$

⑥ $\left[\dfrac{x^a}{y^b}\right]^c = \dfrac{x^{a \cdot c}}{y^{b \cdot c}}$

Section 2.5 Exponent Laws II

Fill in the following chart

Power	As Repeated Multiplication	As a Product of Factors	As a power
$(3^2)^5$	$(3^2)(3^2)(3^2)(3^2)(3^2)$ 3 3 3 3 3 3 3 3 3 3	$3^{2\times5}$	3^{10}
$\boxed{(4^2)^3}$	$(4^2)(4^2)(4^2)$ 4 4 4 4 4 4	$4^{2\times3}$	$\boxed{4^6}$
$((-2)^4)^3$			$(-2)^{12}$

Exponent Law for a Power of a Power

To raise a power to a power, multiply the exponents.

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

Try this

Express the following as a single power then evaluate

1) $(2^3)^2$

$= 2^6$

$= 64$

2) $(5^2)^3$

$= 5^6$

$= 15625$

3) $[(-3)^2]^4$

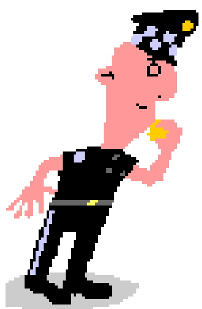
$= (-3)^8$

$= 6561$

Fill in the following chart

Power	As Repeated Multiplication	As a Product of Factors	As a product Powers
$(2^3 \times 3^2)^2$	$(2^3 \times 3^2)(2^3 \times 3^2)$ 2 2 2 3 3 2 2 2 3 3	$2^{3\cdot 2} \quad 3^{2\cdot 2}$	$2^6 \times 3^4$
$((-3) \times 5)^2$			

Exponent Law for a Power of a Product



$$(ab)^m = a^m b^m$$

$$(7^3 \times 2^5)^4 = 7^{12} \times 2^{20}$$

- $2^4 \times 2^2 = 2^6$

$(2 \times 3)^0 = 1$

$(2^4)^2 = 2^8$

$2^6 \div 2^4 = 2^2$

$[2^5 \times 2^2]^6 = 2^{30} \times 2^{12}$

$\boxed{2^{42}}$

$[2^7]^6$

$\boxed{2^{42}}$

What about a power of a quotient?

Let's Investigate

$$\left(\frac{4}{5}\right)^3 = \left(\frac{4}{5}\right)\left(\frac{4}{5}\right)\left(\frac{4}{5}\right) = \frac{4^3}{5^3}$$

$$\left[\frac{4^2}{3^2}\right]^3 = \left[\frac{4^2}{3^2}\right]\left[\frac{4^2}{3^2}\right]\left[\frac{4^2}{3^2}\right]$$

$$\frac{4\cdot4 \quad 4\cdot4 \quad 4\cdot4}{3\cdot3 \quad 3\cdot3 \quad 3\cdot3} = \frac{4^6}{3^6}$$

Step 3) Look at the denominators can you express that as a single power

What did you discover?

Exponent Law for a Power of a Quotient

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

examples:

$$\left[\frac{4^3}{5^2}\right]^7 = \frac{4^{21}}{5^{14}}$$

$$\left[2^8 \div 3^2\right]^2 =$$

Evaluating Powers of Product and Quotients

$$[(-6) \times 4]^2$$

Method 1

Use the exponent law for a power of a product

$[(-6) \times 4]^2$

$=$

$=$

$=$

Method 2

Use the order of operations

$[(-6) \times 4]^2$

$=$

$=$

You Decide

Try some more (use which ever method you want)

2) $-(5 \times 2)^3$

3) $\left(\frac{21}{-3}\right)^3$

Try this

Write as a power

1) $(3^5 \times 4^7)^6$

2) $(4^5 \div 3^4)^7$

Laws of Exponents

Date

Simplify.

1) $(-5)^3 \cdot (-5)^4$

2) $8^5 \cdot 8^2$

3) $(-3)^5 \cdot (-3)^2$

4) $(-6)^0 \cdot (-6)^4 \cdot (-6)^4$

5) $5 \cdot 5^2$

6) $5 \cdot 5^3$

7) $\dfrac{5^5}{5^2}$

8) $\dfrac{(-4)^3}{(-4)^0}$

9) $\dfrac{2^{12}}{2^6}$

10) $\dfrac{(-3)^0}{(-3)^0}$

11) $\dfrac{(-4)^{12}}{(-4)^5}$

12) $\dfrac{4^{17}}{4^{12}}$

13) $((-4)^3)^2$

14) $(-6)^2$

15) $(2^2)^3$

16) $((-3)^3)^4$

17) $(4^4)^4$

18) $(3^4)^2$

19) $\dfrac{2^4 \cdot 2^3}{2 \cdot 2^2}$

20) $\dfrac{2^{13}}{2 \cdot 2^4}$

21) $\dfrac{3^2}{9}$

22) $\dfrac{3^{14}}{3^2 \cdot 3^4}$

23) $\dfrac{7^2 \cdot 7^3}{7^4}$

24) $\dfrac{3^2 \cdot 3^2}{3^3}$

25) $\left(\dfrac{3^8}{3^3}\right)^3$

26) $\dfrac{(4^4)^4}{4}$

27) $\left(\dfrac{(-2)^5}{(-2)^4}\right)^2$

28) $\dfrac{((-2)^3)^2}{(-2)^3}$

29) $\dfrac{4^2}{4^2}$

30) $\dfrac{(4^3)^2}{4}$

31) $\dfrac{3^2 \cdot (3^2)^4}{3^4}$

32) $\left(\dfrac{3^6 \cdot 3^2}{3^4}\right)^4$

33) $\left(\dfrac{2^2 \cdot 2^4}{2}\right)^3$

34) $\dfrac{(-4)^{12} \cdot (-4)^2}{((-4)^4)^2}$

35) $\dfrac{(2^4)^2}{2^3 \cdot 2^2}$

36) $\left(\dfrac{3^{16} \times 3^8 \div 3^4}{3^6 \times 3^6}\right)^0$