

Warm - up

Simplify.

a) $6^2 \times 6^3$

$$= 6^5$$

b) $\frac{7^5}{7^2}$

$$= 7^3$$

c) $(3^4)^3$

$$= 3^{12}$$

d) $\left(\frac{1}{2^3}\right)^2$

$$= \frac{1}{2^6}$$

ZERO AND NEGATIVE EXPONENTS

Learning Goals

- use the power rules to simplify and evaluate

Simplify

$$\frac{3^5}{3^7} = 3^{-2}$$

What does this mean?

$$\frac{\cancel{(3)}\cancel{(3)}\cancel{(3)}\cancel{(3)}\cancel{(3)}}{\cancel{(3)}\cancel{(3)}\cancel{(3)}\cancel{(3)}\cancel{(3)}(3)(3)} = \frac{1}{3^2}$$

$$\frac{3^{-2}}{1} = \frac{1}{3^2}$$

Exponent Rules

- ✓ Product
- ✓ Quotient
- ✓ Power of a power
- ✓ Power of a Quotient
- ✓ Power of a Product

Negative Exponents

$$a^{-n} = \frac{1}{a^n}$$

↖ (+)

Change to a positive exponent

$$3^{-5} = \frac{1}{3^5}$$

$$4^{-3} = \frac{1}{4^3}$$

$$\left(\frac{1}{7}\right)^{-2} = \left(\frac{7}{1}\right)^2$$

$$= 7^2$$

$$\frac{1}{6^{-5}} = \frac{6^5}{1}$$

$$= 6^5$$

Simplify

$$\frac{3^7}{3^7} = 3^{7-7} = 3^0 \leftarrow \text{must show zero}$$

What does this mean?

$$\frac{\overset{1}{\cancel{3}} \overset{1}{\cancel{3}} \overset{1}{\cancel{3}} \overset{1}{\cancel{3}} \overset{1}{\cancel{3}} \overset{1}{\cancel{3}} \overset{1}{\cancel{3}}}{\cancel{3} \cancel{3} \cancel{3} \cancel{3} \cancel{3} \cancel{3} \cancel{3}} = 1$$

Exponent Rules

- ✔ Product
- ✔ Quotient
- ✔ Power of a power
- ✔ Power of a Quotient
- ✔ Power of a Product
- ✔ Negative Exponents

Zero Exponents $a^0 = 1$

simplify

$$2^0 = 1$$

$$\left(\frac{a^2}{b^5} + \frac{7^2}{-2} \div 4\right)^0 = 1$$

$$\left(\frac{2}{3}\right)^0 = 1$$

evaluate

$$\begin{aligned} 5^3 + 3^2 + 157^0 \\ = 125 + 9 + 1 \\ = 135 \end{aligned}$$

$$\begin{aligned} 4^2 + 4^{-2} - 2^0 \\ = 16 + \frac{1}{4^2} - 1 \\ = 16 + \frac{1}{16} - 1 \\ = 15\frac{1}{16} \end{aligned}$$

On the Boards...

2. Evaluate. Express your answers as whole numbers or fractions.

a) $5^2, 5^{-2}$ 25, $\frac{1}{25}$

b) $2^1, 2^{-1}$ 2, $\frac{1}{2}$

c) $4^4, 4^{-4}$

d) $10^3, 10^{-3}$

e) $1^6, 1^{-6}$ 1, 1

f) $2^9, 2^{-9}$

g) $(-3)^4, (-3)^{-4}$

h) $(-8)^1, (-8)^{-1}$ -8, $-\frac{1}{8}$

3. Simplify (positive exponents) and evaluate

a) $12^0 = 1$

b) $8^{-1} = \frac{1}{8}$

c) $6^{-2} = \frac{1}{6^2}$

d) $100\,000^0$

e) $500^{-1} = \frac{1}{500}$

f) $5^{-3} = \frac{1}{5^3}$

g) $(-2)^{-8}$

h) $(-10)^{-3}$

i) $\left(\frac{1}{6}\right)^{-2} = \left(\frac{6}{1}\right)^2 = 6^2$

j) $3^{-5} = \frac{1}{3^5}$

k) $\left(\frac{1}{3}\right)^{-3} = \left(\frac{3}{1}\right)^3 = 3^3$

l) $(-7)^3$

4. Simplify (positive exponents) and evaluate

a) $\frac{8^7}{8^5} = 8^2$

b) $\frac{5^4}{5^9}$

c) $\frac{7}{7^3}$

d) $\frac{12^5}{12^8} = 12^{-3} = \frac{1}{12^3}$

e) $\frac{(-4)^7}{(-4)^8}$

f) $\frac{(-3)^2}{(-3)^7}$

a) $\frac{6^5}{6^5} = 6^0 = 1$

b) $\frac{8^4}{8^4} = 8^0 = 1$

a) $8^3 \times 8^{-1} = 8^2$

b) $\frac{4^2}{4^{-1}} = 4^3$

c) $\frac{1}{(2^4)^3} = \frac{1}{2^{12}}$

d) $(-3)^3(-3)^{-1} = (-3)^2$

e) $(10^{-2})^3 = 10^{-6} = \frac{1}{10^6}$

f) $\left(\frac{1}{2^4}\right)\left(\frac{1}{2^4}\right) = \frac{1}{2^8}$

g) $6^2 \div 6^5$

h) $5^{-7} \times 5^4 = 5^{-3} = \frac{1}{5^3}$

14. To estimate how much an item costing T dollars in 2007 would have cost in a given year (after 1914), C , you can use the formula $C = T(1.0323)^{-n}$, where n is the number of years before 2007.

- a) How much would a \$150 coat have cost in 1920?
Hint: Substitute the number of years before 2007 for n .
- b) How much would a \$20 000 car have cost in 1970?
- c) How much would a \$1.99 bag of dried fruit snacks have cost in 1962?
- d) How much would a \$200 000 condominium have cost in 1980?

$$\begin{aligned} \text{a.) } & 150 (1.0323)^{-87} \\ & = 9.44 \end{aligned}$$

Seatwork

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