Exponent laws

Introducing the Exponent Laws

Power 2^3 exponent, base

Multiplying Powers:

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

$4^4 \times 4^3 = (4 \times 4 \times 4 \times 4) \times (4 \times 4 \times 4) = 4^7$

$5^2 \times 2^2 = (5 \times 5) \times (2 \times 2) = 10^2$

$4^2 \times 3^3 =$

Multiplying Powers Rule:
When multiplying powers and you have the same base, add the exponents. $x^n \cdot x^m = x^{n+m}$

1. Simplify if possible.

a) $2^4 \times 2^3 = 2^7$ b) $5^8 \times 5^1 \times 5^6 = 5^{15}$ c) $6^5 \times 2 \times 6^4 = 6^9 \times 2$

Dividing Powers:

$\dfrac{2^5}{2^3} = \dfrac{2 \times 2 \times 2 \times 2 \times 2}{2 \times 2 \times 2} = 2^2$

$\dfrac{3^4}{5^2} = \dfrac{3 \times 3 \times 3 \times 3}{5 \times 5}$ cannot simplify

Dividing Powers Rule:
When bases are the same, subtract exponents $\dfrac{x^m}{x^n} = x^{m-n}$

$(7^{10})^{10}$

1^{10}

2. Simplify if possible.

a) $\dfrac{4^3}{4^2} = 4^{3-2} = 4$ b) $\dfrac{10^{50}}{10^{46}} = 10^{50-46} = 10^4$ c) $\dfrac{3^5 \times 3^{15}}{3^{10}} = \dfrac{3^{20}}{3^{10}} = 3^{10}$ d) $\dfrac{7^6}{7^6} = 7^{6-6} = 7^0$ e) $\dfrac{4^3}{4^5} = 4^{3-5} = 4^{-2}$

$\dfrac{5^{12}}{5^{12}} = 5^0$ $\dfrac{4 \times 4 \times 4}{4 \times 4 \times 4 \times 4 \times 4} = \dfrac{1}{4^2}$

3. Use examples 2d and 2e to determine the following rules:

Zero exponent law:	Negative exponent law:
$x^0 = 1$ $(5 \times 2)^0 = 1$ $-(5^0) = -1$	$x^{-n} = \dfrac{1}{x^n}$

Scientific Notation:

4. Convert to scientific notation:

Distance from earth to the sun is about 93,000,000 mi. 9.3×10^7

Mass of a hydrogen atom is about 0.00000000000000000000000017 g. 1.7×10^{-25}

5. Convert to decimal notation:

$6.402 \times 10^{14} = 640200000000000$ $5 \times 10^{-8} = 0.00000065$

6. Multiply and divide in scientific notation:

a) $(1.12 \times 10^{-8})(5 \times 10^{-7}) = 5.6 \times 10^{-15}$ b) $(9.1 \times 10^{-17})(8.2 \times 10^3) = 74.62 \times 10^{-14}$ $(7.462 \times 10) \times 10^{-14} = 7.462 \times 10^{-13}$

c) $\dfrac{(4.2 \times 10^5)}{(2.1 \times 10^{-8})} = 2 \times 10^{13}$ 10^{5+8} -4^{+7}

d) $\dfrac{(1.1 \times 10^{-4})}{(2 \times 10^{-7})} = 0.55 \times 10^3$ $(5.5 \times 10^{-1}) \times 10^3 = 5.5 \times 10^2$

Assignment:

Simplify

1. (a) $2^2 \times 2^2$ = 2^4

(b) $3^2 \times 2^3$ = $3^2 \times 2^3$

(c) $5^7 \times 5^7$ = 5^{14}

(d) $6^4 6^0 6^0$ = 6^4

(e) $4^3 \times 6^5 \times 4^2$ = $4^5 \times 6^5$

(f) $3^3 3^{-3}$ = $3^0 = 1$

(g) $7^4 7^7 7^{-9}$ 7^2

Simplify

2. (a) $\dfrac{3^5}{3^4}$ = 3

(b) $\dfrac{7^2}{7^2}$ = 1

(c) $\dfrac{8^1}{8^7}$ = 8^{-6} or $\dfrac{1}{8^6}$

(d) $\dfrac{3^2}{3^{-2}}$ = 3^4

(e) $\dfrac{1738293}{145802}$ = 1

(f) $\dfrac{6^{-5}}{6^{-8}}$ = 6^{-5+8} = 6^3

Evaluate

3. (a) 10^6 = $1\,000\,000$

(b) 3^5 = 243

(c) 21^0 = 1

(d) 71^1 = 71

(e) 0^1 = 0

(f) $1^0 + 2^0 + 3^0 + 4^0 + 5^0$ = 5

(g) $4^2 + 9^2 - 3^2$ = $16 + 81 - 9 = 88$

4. If you have $0 < 10^n < 1\,000\,000\,000$. What is the max value of 3^{-n}?

$n < 9$ $n = -\infty$ ← no limit

5. Multiply. Leave answer in scientific notation.

a) $(2.3 \times 10^6)(4.2 \times 10^{-11})$ 9.66×10^{-5}

b) $(6.5 \times 10^3)(5.2 \times 10^{-8})$ = 33.8×10^{-5}
= $(3.38 \times 10) \times 10^{-5}$ = 3.38×10^{-4}

c) $(2.34 \times 10^{-8})(5.7 \times 10^{-4})$ = 13.338×10^{-12}
$(1.3338 \times 10) \times 10^{-12}$
= 1.3338×10^{-11}

d) $(3.26 \times 10^{-6})(8.2 \times 10^9)$ = 26.732×10^3
$(2.6732 \times 10) \times 10^3$ = 2.6732×10^4

6. Divide. Leave answer in scientific notation.

a) $\dfrac{8.5 \times 10^8}{3.4 \times 10^5}$ = 2.5×10^3

b) $\dfrac{5.1 \times 10^6}{3.4 \times 10^3}$ = 1.5×10^3

c) $\dfrac{4.0 \times 10^{-6}}{8.0 \times 10^{-3}}$ = 0.5×10^{-3}
$(5.0 \times 10^{-1}) \times 10^{-3}$ = 5.0×10^{-4}

d) $\dfrac{7.5 \times 10^{-9}}{2.5 \times 10^{-4}}$ = 3×10^{-5}

7. Calculate. Leave answer in scientific notation.

a) $\dfrac{(6.1 \times 10^4)(7.2 \times 10^{-6})}{9.8 \times 10^{-4}}$ = 4.48×10^2 (−2)

b) $\dfrac{(8.05 \times 10^{-11})(5.9 \times 10^7)}{3.1 \times 10^{14}}$ = 15.32×10^{-18} (−4)
$(1.532 \times 10) \times 10^{-18}$ = 1.532×10^{-17}

8. The distance light travels in 100 yr is approximately 5.87×10^{14} mi. $\div 100 = 5.87 \times 10^{12}/yr$

a) How far does light travel in 13 weeks? $\frac{1}{4}$ of a year $5.87 \times 10^{12} \div 4$ = 1.4675×10^{12}

b) Calculate the number of kilometers light travels in 13 weeks given 1 mile = 1.609 kilometers.

$1.4675 \times 10^{14} \times 1.609$ = 2.361×10^{14}

Challenge: Compare 8×10^{-90} and 9×10^{-91}. Which is the larger value? How much larger?
Write scientific notation for the difference

larger.

89 zeros
$0.000\ldots\ldots00080$
$- 0.000\ldots\ldots 00009$
_____
$0.000\ldots\ldots 0071$ = 7.1×10^{-90}