base → $2^5$ ← exponent

$= 2 \times 2 \times 2 \times 2 \times 2$

Examples:

$5^2$
$= 5 \times 5$
$= 25$

$3^4$
$= 3 \times 3 \times 3 \times 3$
$= 81$

$10^6$
$= 10 \times 10 \times 10 \times 10 \times 10 \times 10$
$= 1{,}000{,}000$

Practice: Evaluate the following

a) $3^3$ =

b) $2^4$ =

c) $10^5$ =

d) $(-2)^6$ =

e) $5^3$ =

f) $7^1$ =

Answers:

a) $3^3 = 27$

b) $2^4 = 16$

c) $10^5 = 100{,}000$

d) $(-2)^6 = 64$

e) $5^3 = 125$

f) $7^1 = 7$

Practice: Find the value of $x$

a) $4^x = 64$

b) $x^3 = 8$

c) $10^x = 10{,}000$

d) $x^3 = 27$

e) $13^x = 13$

f) $x^2 = 1{,}000{,}000$

Answers:

a) $4^3 = 64$

b) $2^3 = 8$

c) $10^4 = 10{,}000$

d) $3^3 = 27$

e) $13^1 = 13$

f) $1000^2 = 1{,}000{,}000$

**Product Law**

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

Examples:

$$8^5 \cdot 8^7 = 8^{12}$$

$$(-3)^{10} \cdot (-3)^9 = (-3)^{19}$$

$$\left(\frac{4}{7}\right)^6 \cdot \left(\frac{4}{7}\right)^4 = \left(\frac{4}{7}\right)^{10}$$

**Quotient Law**

$$x^a \div x^b = \frac{x^a}{x^b} = x^{a-b}$$

Examples:

$$4^9 \div 4^6 = 4^3$$

$$\frac{5^{11}}{5^4} = 5^7$$

$$\frac{(-2.8)^{30}}{(-2.8)^{10}} = (-2.8)^{20}$$

**Power Law**

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

Examples:

$$\left(11^3\right)^5 = 11^{15}$$

$$\left[\left(-3.9\right)^2\right]^{10} = (-3.9)^{20}$$

$$\left(84^3\right)^7 = 84^{21}$$

Practice: Simplify the following

a) $6^4 \cdot 6^3 \cdot 6^2 \cdot 6 =$

b) $\frac{(-5)^{21}}{(-5)^3} =$

c) $\left(\frac{2}{3}\right)^8 \cdot \left(\frac{2}{3}\right) \cdot \left(\frac{2}{3}\right)^{10} =$

d) $\left(5^4\right)^{11} =$

e) $\frac{8^5 \cdot 8^4 \cdot 8^3}{8^6} =$

f) $\left[\left(2^3\right)^4\right]^5 =$

g) $7 \cdot 7 \cdot 7 \cdot 7 \cdot 7 \cdot 7 \cdot 7 \cdot 7 \cdot 7 =$

h) $\frac{x^5 \cdot x^4 \cdot x^{13}}{x^6} =$

i) $\frac{x \cdot \left(x^5\right)^2 \cdot x^7}{\left(x^4\right)^3} =$

Answers:

a) $6^{10}$

b) $(-5)^{18}$

c) $\left(\frac{2}{3}\right)^{19}$

d) $5^{44}$

e) $8^6$

f) $2^{60}$

g) $7^9$

h) $x^{16}$

i) $x^6$

**Negative Powers**

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

Examples:

$$3^{-4} = \frac{1}{3^4} = \frac{1}{81}$$

$$10^{-2} = \frac{1}{10^2} = \frac{1}{100}$$

$$7^{-1} = \frac{1}{7^1} = \frac{1}{7}$$

Practice: Evaluate the following

a) $5^{-2} =$

b) $2^{-5} =$

c) $10^{-4} =$

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

e) $4^{-3} =$

f) $11^{-1} =$

Answers:

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

b) $2^{-5} = \frac{1}{32}$

c) $10^{-4} = \frac{1}{10,000}$

d) $(-3)^{-1} = -\frac{1}{3}$

e) $4^{-3} = \frac{1}{64}$

f) $11^{-1} = \frac{1}{11}$

Practice: Find the value of $x$

a) $2^x = \frac{1}{128}$

b) $x^{-3} = \frac{1}{1,000,000}$

c) $5^x = \frac{1}{625}$

d) $x^{-2} = \frac{49}{25}$

e) $x^{-83} = 1$

Answers:

a) $2^{-7} = \frac{1}{128}$

b) $100^{-3} = \frac{1}{1,000,000}$

c) $5^{-4} = \frac{1}{625}$

d) $\left(\frac{5}{7}\right)^{-2} = \frac{49}{25}$

e) $1^{-83} = 1$