

$$\begin{array}{l} \text{base} \rightarrow \mathbf{2^5} \leftarrow \text{exponent} \\ = \mathbf{2 \times 2 \times 2 \times 2 \times 2} \end{array}$$

Examples:

$$\begin{aligned} 5^2 \\ = 5 \times 5 \\ = 25 \end{aligned}$$

$$\begin{aligned} 3^4 \\ = 3 \times 3 \times 3 \times 3 \\ = 81 \end{aligned}$$

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

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**

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

Examples:

$$(11^3)^5 = 11^{15}$$

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

$$(84^3)^7 = 84^{21}$$

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)  $(5^4)^{11} =$

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

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

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

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)  $1^{-83} = 1$