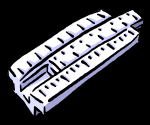
# Exponential Notation: Using Exponents Or Exponentials



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## Positional Numbering System

Each position left or right of decimal represents a "power"

Exponent

$10^{6}$ $10^{5}$ $10^{4}$ $10^{3}$ $10^{2}$ $10^{1}$ $10^{0}$ . $10^{-1}$ $10^{-2}$ $10^{-3}$ $10^{-4}$

Base (10)

We determine total " value" by adding positional values:

12045.67 is sum of:

1 x 10,000
2 x 1,000
0 x 100
4 x 10
5 x 1
6 x 0.1
7 x 0.01

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## Bases

Science mostly uses base 10

Computers use base 2 (binary)

$2^{6}$ $2^{5}$ $2^{4}$ $2^{3}$ $2^{2}$ $2^{1}$ $2^{0}$ . $2^{-1}$ $2^{-2}$ $2^{-3}$ $2^{-4}$

10111 Binary:

1 x 16 = 16
0 x 8 = 0
1 x 4 = 4
1 x 2 = 2
1 x 1 = 1

23 (Base 10)

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## Exponential Notation

Method of expressing numbers

Any number = coefficient x exponential

Example:

Exponent (Positional Value of Base)

$3456 = 3.456 \times 10^{3}$

Base

Coefficient (the digits)

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## Exponential Notation

Number = coefficient x exponential

$n = C \times 10^{exponent}$

$425 = 4.25 \times 10^{2}$

Coefficient - the digits

Exponent - gives decimal point location

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## Exponential Notation

Way to express very large and very small numbers

0.000000000000000000000000009107 g

$9.107 \times 10^{-25}$ (0.9107 yoctograms)

(mass of an electron, part of an atom)

602,300,000,000,000,000,000,000

$6.023 \times 10^{23}$ (0.6023 yottaatoms)

(# carbon atoms in 12.011 grams of carbon)

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## Exponential Notation

0.00000000000000000000000009107 g

602,300,000,000,000,000,000,000

Avoids calculator overflow

Saves time, paper, & copying errors

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## Exponential Notation

exponential = base $^{\text{exponent}}$

(base 4) $4^2 = 4 \times 4 = 16$

(base 5) $5^{-3} = 1/5 \times 1/5 \times 1/5 = 1/125$

(Anything to the negative = a fraction; a division)

(base 8) $8^0 = 1$

(Anything to the zero th =1)

(base 10) $10^4 = 10{,}000$

(Anything to the positive = a multiplication)

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## Examples

For Number: $5.91 \times 10^5$
Coefficient: 5.91
Exponential: $10^5$
Base: 10
Exponent: 5

For Number: $210 \times 10^{-8}$
Coefficient: 210
Exponential: $10^{-8}$
Base: 10
Exponent: -8

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## The Math for + Exponents

Exponent = a multiplying factor

$4^2$ = 4 x 4 = 16

$2^4$ = 2 x 2 x 2 x 2 = 16

$5^3$ = 5 x 5 x 5 = 125

$10^6$ = 10 x 10 x 10 x 10 x 10 x 10

$10^6$ = 1,000,000

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## The Math for - Exponents

Exponent = a dividing factor

$4^{-2}$ = 1/4 x 1/4 = 1/16

$2^{-4}$ = 1/2 x 1/2 x 1/ 2 x 1/2 = 1/16

$5^{-3}$ = 1/5 x 1/5 x 1/5 = 1/125

$10^{-6}$ = 1/10 x 1/10 x 1/10 x 1/10 x 1/10 x 1/ 10

$10^{-6}$ = 0.000001

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## The Math for 0 Exponents

Exponent of zero

Any base$^0$ = 1

$4^0$ = 1

$2^0$ = 1

$5^0$ = 1

$10^0$ = 1

Multiplying by $10^0$ is multiplication by number 1

$45.67 \times 10^0 \rightarrow 45.67 \times 1 = 45.67$

Often missed test question

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## Expressing Numbers

**Any number has a variety of exponentials:**

**Number = Coefficient x exponential**

| | | | |
|---|---|---|---|
| C | x | $10^{exponent}$ | = n |
| 337,000 | x | $10^{-1}$ | = 33,700 |
| 33,700 | x | $10^{0}$ | = 33,700 |
| 3,370 | x | $10^{1}$ | = 33,700 |

($10^0 = 1$)

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## Exponential Notation (+) exponents

The coefficient is *multiplied* by $10^{exponent}$

$33.7 \times 10^3 = 33,700$

$3.37 \times 10^4 = 33,700$

If coefficient gets smaller, exponent gets larger

If coefficient gets larger, exponent gets smaller

When changing expressions

Exponent and coefficient are inverse of each other

This keeps value for each expression the same

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## Exponential Notation (-) exponents

The coefficient is divided by $10^{-exponent}$

$337,000 \times 10^{-1} = 33,700$

$3,370,000 \times 10^{-2} = 33,700$

If coefficient gets smaller, exponent gets larger

If coefficient gets larger, exponent gets smaller

When changing expressions

Exponent and coefficient are inverse of each other

This keeps value for each expression the same

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## Exponential Notation (0) exponents

The Coefficient is multiplied $10^0$

$33{,}700 \times 10^0 = 33{,}700 \quad 10^0 = 1$

Multiplying by $10^0$ does not change the value

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## Standard Exponential Notation
## "Scientific Notation"

coefficient
greater than or equal to one
and less than ten
$1 \leq C < 10$

Examples:
3 = yes
0.01 = no
134 = no

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## Which is in scientific notation?

$33{,}700 = 337{,}000 \times 10^{-1}$

$33{,}700 = 33{,}700 \times 10^0$

$33{,}700 = 3{,}370 \times 10^1$

$33{,}700 = 337 \times 10^2$

$33{,}700 = 33.7 \times 10^3$

$33{,}700 = 3.37 \times 10^4$

$33{,}700 = 0.337 \times 10^5$

All expressions express same value
But only one is scientific notation

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## Express 15,208 in scientific notation 1

1. Determine the Coefficient
write down digits starting with the first nonzero digit
15208
2. Place decimal point between the 1st & 2nd digit
1.5208

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## Express 15,208 in scientific notation 2

3. Determine correct exponent (both number & sign)

$1.5208 \times 10^{\pm ?}$ ➔ 15,208

(What does 1.5208 need to be multiplied by?)

Count number of places the decimal needs to be moved
coefficient ➔ number

Move to right 4 places … so, exponent is 4

When coefficient gets smaller ➔ exponent gets larger
When coefficient gets larger ➔ exponent gets smaller

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## Expressing in Scientific Notation

$1.528 \times 10^{-4} = 0.0001528$
$1.528 \times 10^{4} = 15280$
$1.528 \times 10^{0} = 1.528$

From the Coefficient
Move to left = less (-)
Move to right = more (+)
No Move = 0

When coefficient gets smaller ➔ exponent gets larger
When coefficient gets larger ➔ exponent gets smaller

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## Fill In The Blanks

| Number | Coefficient | Exponential | Base | Exponent |
|---|---|---|---|---|
| $5.91 \times 10^{5}$ | | | | |
| $210 \times 10^{-8}$ | | | | |
| $0.061 \times 10^{-3}$ | | | | |
| $4.88 \times 10^{-6}$ | | | | |
| $3.83 \times 10^{9}$ | | | | |
| $6.023 \times 10^{23}$ | | | | |
| $4.18 \times 10^{0}$ | | | | |

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## Fill In The Blanks

| Number | Coefficient | Exponential | Base | Exponent |
|---|---|---|---|---|
| $5.91 \times 10^{5}$ | 5.91 | $10^{5}$ | 10 | 5 |
| $210 \times 10^{-8}$ | 210 | $10^{-8}$ | 10 | -8 |
| $0.061 \times 10^{-3}$ | 0.061 | $10^{-3}$ | 10 | -3 |
| $4.88 \times 10^{-6}$ | 4.88 | $10^{-6}$ | 10 | -6 |
| $3.83 \times 10^{9}$ | 3.83 | $10^{9}$ | 10 | 9 |
| $6.023 \times 10^{23}$ | 6.023 | $10^{23}$ | 10 | 23 |
| $4.18 \times 10^{0}$ | 4.18 | $10^{0}$ | 10 | 0 |

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## Scientific Notation?

Re-write these in scientific notation

$210 \times 10^{-8}$ $0.061 \times 10^{-3}$

$2.10 \times 10^{-6}$ $6.1 \times 10^{-5}$

When coefficient gets smaller ➔ exponent gets larger
When coefficient gets larger ➔ exponent gets smaller

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## Scientific Notation?

Write the following in scientific notation:

570,000 = 4,820 =

0.00699 = 0.000000311 =

$958 \times 10^{4}$ = $0.0744 \times 10^{-3}$ =

When coefficient gets smaller ➔ exponent gets larger
When coefficient gets larger ➔ exponent gets smaller

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## Scientific Notation?

Write the following in scientific notation:

570,000 = $5.7 \times 10^{5}$ 4,820 = $4.82 \times 10^{3}$

0.00699 = $6.99 \times 10^{-3}$ 0.000000311 = $3.11 \times 10^{-7}$

$958 \times 10^{4}$ = $9.58 \times 10^{6}$ $0.0744 \times 10^{-3}$ = $7.44 \times 10^{-5}$

When coefficient gets smaller ➔ exponent gets larger
When coefficient gets larger ➔ exponent gets smaller

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## Scientific Notation?

Write the following in ordinary decimal notation:

$6.18 \times 10^{4}$ = $225 \times 10^{-1}$ =

$3.86 \times 10^{-5}$ = $158 \times 10^{2}$ =

$3.99 \times 10^{-2}$ = $1.64 \times 10^{0}$ =

When coefficient gets smaller ➔ exponent gets larger
When coefficient gets larger ➔ exponent gets smaller

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## Scientific Notation?

**Write the following in ordinary decimal notation:**

$6.18 \times 10^{4} = 61{,}800$ $\quad$ $225 \times 10^{-1} = 22.5$

$3.86 \times 10^{-5} = 0.0000386$ $\quad$ $158 \times 10^{2} = 15{,}800$

$3.99 \times 10^{-2} = 0.0399$ $\quad$ $1.64 \times 10^{0} = 1.64$

When coefficient gets smaller ➔ exponent gets larger
When coefficient gets larger ➔ exponent gets smaller

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## Practice, Practice, Practice

**Vince Lombardi (Coach of Green Bay Packers) repeatedly said, "You win on fundamentals"**

**Practice, Practice, Practice**
**Unit Practice Problems**
**Unit Practice Quizzes**

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