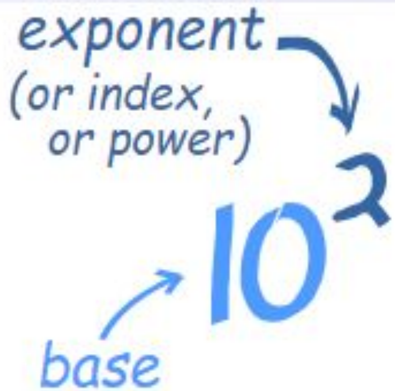
Scientific Notation

Please have pencil/pen and paper if possible

Index Notation and Powers of 10



The exponent (or index or power) of a number says **how many times** to use the number in a **multiplication**.

10^2 means **10** × **10** = 100

(It says **10** is used **2** times in the multiplication)

Example: $10^3 = 10 \times 10 \times 10 = 1{,}000$

- In words: 10^3 could be called "10 to the third power", "10 to the power 3" or simply "10 cubed"

Example: $10^4 = 10 \times 10 \times 10 \times 10 = 10{,}000$

- In words: 10^4 could be called "10 to the fourth power", "10 to the power 4" or "10 to the 4"

Powers of 10			
Power of 10	Standard Form	Fractional Form	Place Value
10^4	10,000	$\frac{10,000}{1}$	ten thousands
10^3	1,000	$\frac{1,000}{1}$	thousands
10^2	100	$\frac{100}{1}$	hundreds
10^1	10	$\frac{10}{1}$	tens
10^0	1	$\frac{1}{1}$	ones
10^{-1}	0.1	$\frac{1}{10}$	tenths
10^{-2}	0.01	$\frac{1}{100}$	hundredths
10^{-3}	0.001	$\frac{1}{1,000}$	thousandths
10^{-4}	0.0001	$\frac{1}{10,000}$	ten thousandths

Express the following powers of ten in "normal notation", for example 1000:

1) $10^4 =$

2) $10^7 =$

3) $10^{17} =$

4) $10^{-1} =$

5) $10^{-4} =$

6) $10^{-12} =$

Powers of 10

"Powers of 10" is a very useful way of writing down large or small numbers.

Instead of having lots of zeros, you show how many **powers of 10** will make that many zeros

Example: $5{,}000 = 5 \times 1{,}000 = 5 \times 10^3$

5 thousand is 5 times a thousand. And a thousand is 10^3. So 5 times $10^3 = 5{,}000$

Can you see that 10^3 is a handy way of making 3 zeros?

Scientists and Engineers (who often use very big or very small numbers) like to write numbers this way.

Example: The Mass of the Sun

The Sun has a Mass of 1.988×10^{30} kg.

It is too hard to write 1,988,000,000,000,000,000,000,000,000,000 kg

(And very easy to make a mistake counting the zeros!)

Example: A Light Year (the distance light travels in one year)

It is easier to use $\mathbf{9.461 \times 10^{15}}$ meters, rather than **9,461,000,000,000,000** meters

$$\textit{base of exponentiation} \rightarrow x^{a} \leftarrow \textit{the exponent}$$

By definition, every number which has 0 as its exponent is equal to 1. This means that, no matter how large is the base, if their exponent is equal to 0, that number is always equal to 1.

$$a^0 = 1 \qquad 1^0 = 1 \qquad 8^0 = 1 \qquad 3785^0 = 1$$

Express the following numbers as powers of ten.

7) 10 =

8) 100,000 =

9) 1,000,000,000,000,000,000 =

10) 0.001 =

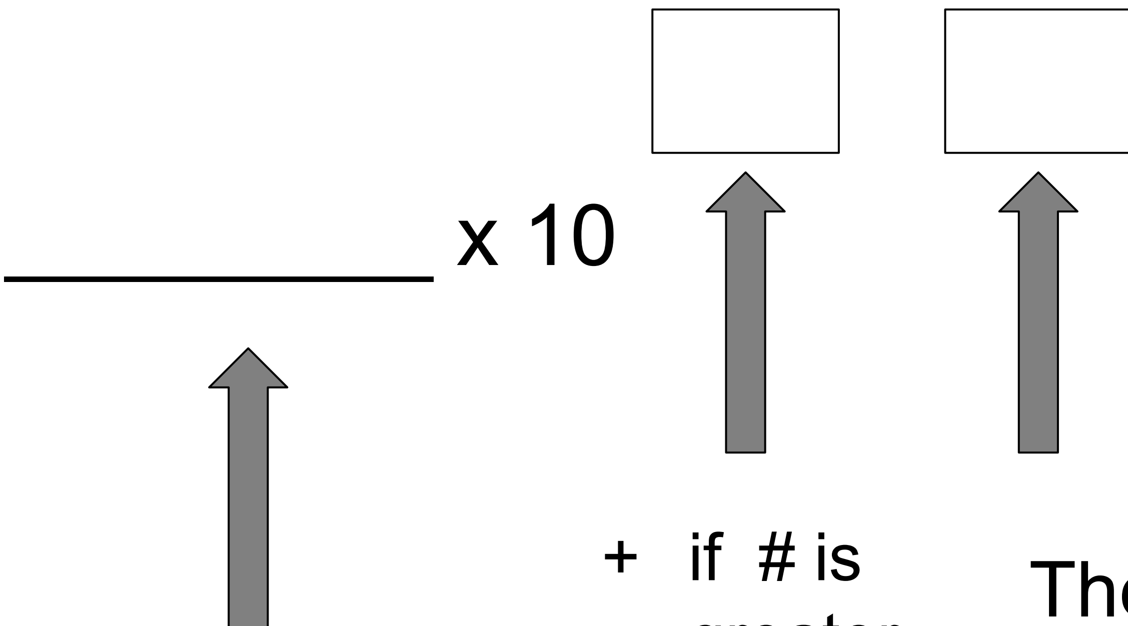
11) 1 =

12) 0.000000001 =

Scientific Notation

- Scientists often have to use very small and very large numbers – they are often expressed in powers of 10

Step 1 - Format



Number between 1-10

+ if # is greater than 1
- if # is less than 1

The number of times you moved your decimal

Step 2

Convert 1,500,000 to scientific notation

Determine if the number is greater than 1 or less than 1

If the number is greater than 1 - the exponent is +

If the number is less than 1 - the exponent is -

Step 2 continued

Convert 1,500,000 to scientific notation

The number 1,500,000 is greater than 1 so the exponent is +

Step 2 continued

Convert 1,500,000 to scientific notation

______________ x 10 [+] [ ]

Number between 1-10

\+ if # is greater than 1

\- if # is less than 1

The number of times you moved your decimal

Step 3

Convert 1,500,000 to scientific notation

Move the decimal place until the number is between 1 and 9

1,500,000.

Step 3

The number 1.500000 is between the number 1 and 9

Step 3 continued

Convert 1,500,000 to scientific notation

+

<u>1.5000000</u> x 10

Number between 1-10

+ if # is greater than 1
- if # is less than 1

The number of times you moved your decimal

Step 4

Convert 1,500,000 to scientific notation

+		6

1.500000 x 10

Number between 1-10

+ if # is greater than 1
- if # is less than 1

The number of times you moved your decimal

1.5×10^6

Convert the following into scientific notation

1. 0.005
2. 5,050
3. 0.0008
4. 1,000
5. 1,000,000
6. 0.25
7. 0.025
8. 0.0025
9. 500
10. 5,000

Scientific Notation: Addition and Subtraction

To add or subtract two numbers in scientific notation:

Step 1: Adjust the powers of 10 in the 2 numbers so that they have the same index. (Tip: It is easier to adjust the smaller index to equal the larger index).

Step 2: Add or subtract the numbers.

Step 3: Give the answer in scientific notation.

Example:

Evaluate $2 \times 10^3 + 3.6 \times 10^4$, giving your answer in scientific notation.

Solution:

$2 \times 10^3 + 3.6 \times 10^4$	
$= 0.2 \times 10^4 + 3.6 \times 10^4$	(change to the same indices)
$= (0.2 + 3.6) \times 10^4$	(add the numbers)
$= 3.8 \times 10^4$	(answer in scientific notation)

Example:

Evaluate $7 \times 10^5 - 5.2 \times 10^4$, giving your answer in scientific notatio

Solution:

$$7 \times 10^5 - 5.2 \times 10^4$$

$$= 70 \times 10^4 - 5.2 \times 10^4$$ (change to the same indices)

$$= (70 - 5.2) \times 10^4$$ (subtract the numbers)

$$= 64.8 \times 10^4$$

$$= 6.48 \times 10^5$$ (answer in scientific notation)

Examples:

$(3.769 \times 10^5) + (4.21 \times 10^5)$

$(8.14 \times 10^{-2}) - (2.01 \times 10^{-2})$

$(7.58 \times 10^5) + (2.871 \times 10^6)$

$(2.9785 \times 10^{-8}) - (5.72 \times 10^{-10})$

$(4.86 \times 10^3) - (4.72 \times 10^3)$

$$(2.9785 \times 10^{-8}) - (5.72 \times 10^{-10})$$

2.9785 x 10^-8 - (.000000000572)

2.9785 x 10^-8 - (.0572 x 10^-8)

2.9113 x 10^ -8