Scientific Notation

Uses: Writing very large and very small numbers efficiently.

Recall: When **multiplying** a number by powers of 10, the decimal moves.

Examples: $7.5 \times 10 = 75$ (multiplying by 10 moves it one place to the right)
$7.5 \times 100 = 750$ (multiplying by 100 moves it twice to the right)
NOTE: $7.5 \times 10^4 = 75000$ (multiplying by 10,000 moves it four places right)
$7.5 \times 10^{-3} = 0.0075$ (multiplying by $\frac{1}{1000}$ moves it three places left)

When writing numbers in scientific notation there are a couple of rules...

1) The decimal is placed after the **first non-zero digit** in the given number.
the number can not be two digits (so it can't be 11, 12, 13, 21, 100, etc.) or more
the number can not be zero
2) The rest of the number is then written (omitting unnecessary zeroes after the decimal point)
3) "$\times 10$" to some power is always part of the number.
4) The exponent will be positive for large numbers(numbers greater than 1) and negative for small numbers (numbers between 0 and 1)

Let's look at some examples:

Example 1

$95{,}000{,}000{,}000{,}000$

- We place the decimal after the **first non-zero digit** which, in this case, is 9. (Currently, the decimal is at the end of the number--that is where it is when no decimal is written.)
- The exponent will be positive because we are dealing with a large number.
- The decimal will move 13 places so this is the exponent.
- NOTE: AS THE ORIGINAL NUMBER GETS SMALLER (WITH THE MOVEMENT OF THE DECIMAL POINT), THE EXPONENT GROWS

So, $95{,}000{,}000{,}000{,}000 = 9.5 \times 10^{13}$ in scientific notation. (Check it. They are equivalent.)

Example 2

0.0000000235

- We place the decimal after the **first non-zero digit** which, in this case, is 2.
- The exponent will be negative because we are dealing with a small number.
- The decimal will move 8 places so this is the exponent (but negative).
- NOTE: AS THE ORIGINAL NUMBER "GETS LARGER" (WITH THE MOVEMENT OF THE DECIMAL POINT), THE EXPONENT "GETS SMALLER"

So, $0.0000000235 = 2.35 \times 10^{-8}$ in scientific notation.

Example 3

Try writing this number, given in scientific notation, in standard form:

7.06×10^{-5}

- We know we are dealing with a small number because the exponent is negative.
- When written in standard form, the decimal will move 5 places left.

So, $7.06 \times 10^{-5} = 0.0000706$

Example 4

Try writing this number, given in scientific notation, in standard form:

4.81×10^{9}

- We know we are dealing with a large number because the exponent is positive.
- When written in standard form, the decimal will move 9 places right.

So, $4.81 \times 10^{9} = 4{,}810{,}000{,}000$

Note: If the exponent is 6 then the number is in the millions.
If the exponent is 9 then the number is in the billions.
If the exponent is 12 then the number is in the trillions.

So, 6.2×10^{9} may be read " six point two billion"

(and 6.2×10^{10} is sixty-two billion)

So, by looking at the exponents we can quickly compare the size of a number.