I. Scientific Notation: Refresher

Scientific notation helps us write very large and very small numbers.

Scientific Notation to Numbers

Scientific Notation involves moving decimals.

1.5×10^4
$= 1.5000$
$= 15\,000$ ✓

Because the exponent is **Positive** 4, move the decimal point 4 places **to the right.**
Add in Zeroes to fill the empty gaps.

5.8×10^{-4}
$= 0.0005.8$
$= 0.00058$ ✓

Because the exponent is a **Negative** 4, move the decimal point 4 places **to the left.**
Add in Zeroes to fill the empty gaps.

Scientific Notation to Numbers

Scientific Notation involves moving decimals.

2.756×10^5
$= 2.75600$
$= 275\,600$ ✓

Because the exponent is **Positive** 5, move the decimal point 5 places **to the right.**
Add in Zeroes to fill the empty gaps.

3.76×10^{-3}
$= 0.003.76$
$= 0.00376$ ✓

Because the exponent is a **Negative** 3, move the decimal point 3 places **to the left.**
Add in Zeroes to fill the empty gaps.

You Try!

1) $7.36 \times 10^{-6} =$ _____

2) $3.67 \times 10^{3} =$ _____

3) $8.2 \times 10^{10} =$ _____

4) $9.0 \times 10^{-4} =$ _____

Numbers into Scientific Notation

15 000

The Number is **Greater than 10,** so the **Exponent will be Positive.**

$= 1.5000$ (4 places)

Move the Decimal point to the LEFT to create a number between 1 and 10.

$= 1.5$ ø ø ø

Remove Zeroes that are not needed.

$= 1.5 \times 10^4$ ✓

We moved **4 places** so Power of 10 is four : **10^4**

Numbers into Scientific Notation

0.0043

The Number is a decimal **less than 1,** so the **Exponent will be Negative.**

$= 0.0043$ (3 places)

Move the Decimal point to the RIGHT to create a number between 1 and 10.

$=$ ø ø ø **4.3**

Remove Zeroes that are not needed.

$= 4.3 \times 10^{-3}$ ✓

We moved **3 places** so Power of 10 is three : **10^{-3}**

You Try!

5) 86910000 = _____

6) 0.0000000000321 = _____

7) 794100 = _____

8) 0.0035 = _____

II. Scientific Notation: Calculators

When entering scientific notation into a calculator, use the 'EE' button, NOT the 10^x button. Also note that for many calculators the 'EE' button requires the shift button to be pressed first.

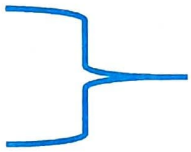
When displaying scientific or engineering notation, most calculators us 'E' instead of $\times 10$

For example: most calculators would display 3.9×10^{-5} as 3.9E-5
most calculators would display 7.55×10^{19} as 7.55E19

You Try!
To enter 8.6×10^{-3} into my calculator, I would do the following:
Type '8.6'
Hit the 'EE' key
Type '-3'
Your calculator should display: 0.0086 or 8.6E-3

Let's try the following multiplication problem $(3.2 \times 10^3)(7.3 \times 10^4)$
To enter it into the calculator, do the following:

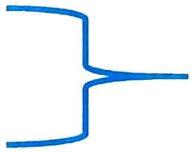
Type '3.2'
Hit the 'EE' key
Type '3'



This enters 3.2×10^3 into the calculator

Now type the multiply button

Type '7.3'
Hit the 'EE' key
Type '4'



This enters 7.3×10^4 into the calculator

Now hit the enter/equals button
Your calculator should display the answer:
233600000 (if your calculator is in Scientific Notation Mode)
2.336E8 (if your calculator is in Scientific Notation Mode)
233.6E6 (if your calculator is in Engineering Notation Mode)

For calculator practice, work all the problems in this handout using your calculator!

III. Scientific Notation: Adding and Subtracting

To add and subtract numbers in scientific notation, first convert them to standard form, then do the operation, and finally convert them back to scientific notation.

$8.2 \times 10^4 + 4.32 \times 10^3$	Original Problem
$8.2 \times 10^4 = 82000$ $4.32 \times 10^3 = 4320$	Convert from scientific notation to standard form
$82000 + 4320 = 86320$	Do the indicated operation
$86320 \rightarrow 8.632 \times 10^4$	Convert back into scientific notation.
$8.2 \times 10^4 + 4.32 \times 10^3 =$ 8.632×10^4	Final Answer

$3.4 \times 10^{-4} - 3.4 \times 10^{-3}$	Original Problem
$3.4 \times 10^{-4} = 0.00034$ $3.4 \times 10^{-3} = 0.0034$	Convert from scientific notation to standard form
$0.00034 - 0.0034 = -0.00306$	Do the indicated operation
$-0.00306 \rightarrow -3.06 \times 10^{-3}$	Convert back into scientific notation.
$3.4 \times 10^{-4} - 3.4 \times 10^{-3} =$ -3.06×10^{-3}	Final Answer

You Try!

1) $8.54 \times 10^{-6} - 1.2 \times 10^{-7} =$ _____

3) $7.88 \times 10^{-6} + 2.222 \times 10^{-4} =$ _____

2) $5.6 \times 10^4 + 6.782 \times 10^3 =$ _____

4) $-7.6 \times 10^4 - 2.7 \times 10^3 =$ _____

IV. Scientific Notation: Multiplication and Division

To multiply and divide numbers in scientific notation, break the problem up between the coefficients/constants and the exponents, always remember to check that your final answer is in proper standard notation form!

$(3.2 \times 10^3)(7.4 \times 10^2)$	Original Problem
$(3.2 \cdot 7.4)(10^3 \cdot 10^2)$	Use the **commutative property of multiplication** to rewrite the problem with the constants together and powers together.
$(3.2 \cdot 7.4)(10^3 \cdot 10^2)$ 23.68×10^5	Multiply the constants. Since your powers have like bases, you can add the exponents. This is not in proper form. I need to move the decimal!
23.68×10^5 From here I move the decimal 5 spaces to the right. If I move the decimal back one spot, then I would need to move it one extra space to the right, so change the exponent from 5 to 6. 2.368×10^6	I have to move the decimal back one space so that it is placed after the ones number. Change the exponent to a 6!
$(3.2 \times 10^3)(7.4 \times 10^2) =$ 2.368×10^6	Final Answer!

$\frac{3 \times 10^{-2}}{4 \times 10^5}$	Original Problem
$\frac{3 \times 10^{-2}}{4 \times 10^5}$ $.75$	Step 1: Divide the coefficients. (3/4 = .75)
$\frac{3 \times 10^{-2}}{4 \times 10^5} =$ $.75 \times 10^{-7}$	Step 2: Subtract the exponents of like bases. (-2 – 5 = -7)
$.75 \times 10^{-7}$ 7.5×10^{-8}	Step 3: .75 is not written in correct scientific notation. It must read 7.5, so we need to move the decimal to the right one space. Therefore, you have to change the exponent to -8, because you'll have to move one more space to the left!
$\frac{3 \times 10^{-2}}{4 \times 10^5} =$ 7.5×10^{-8}	Final Answer.

You Try!

1) $3.4 \times 10^{-6} (2.0 \times 10^{-7}) =$ _____

2) $-6.6 \times 10^{-6} / 3.0 \times 10^3 =$ _____

3) $6.12 \times 10^{99} / 3.0 \times 10^{98} =$ _____

4) $8.8 \times 10^{-6} / 4.0 \times 10^{-3} =$ _____

5) $-8.4 \times 10^4 (3.7 \times 10^3) =$ _____

6) $4.8 \times 10^8 (3.9 \times 10^{-2}) =$ _____

V. Rounding and Significant Figures

When translating numbers into scientific notation, one often rounds.

For example,

The speed of light in a vacuum is approximately 186,282 miles/second

We could write this in scientific notation as 1.86282×10^5 miles/second but this defeats the purpose of scientific notation—to make large and small numbers more manageable.

So, we often round when we write in scientific notaltion, we would say the speed of light in a vacuum is approximately 2×10^5 miles/second.

NOTICE we could round this number in many different ways:

2×10^5 miles/second

1.9×10^5 miles/second

1.86×10^5 miles/second

1.863×10^5 miles/second

So how do we know at which decimal place to round the number?

Often the problem will tell you. The instructions will indicate how to round off the number.

REMEMBER: ALWAYS ROUND AS THE **LAST** STEP OF SOLVING THE PROBLEM

You Try!

The gravitational constant is 6.67408×10^{-11}

1) Round to 3 decimals: _____

2) Round to the nearest whole number: _____

3) Round to 1 decimal: _____

Now try these:

4) $9.81 \times 10^{-6} / 4.7 \times 10^{-3}$ (round to three decimals) _____

5) $-6.68 \times 10^{-6} / 7.631 \times 10^{3}$ (round to six decimals) _____

6) $9.247 \times 10^{6} / 4.5 \times 10^{5}$ (round to the nearest whole number) _____

So how do we know at which decimal place to round the number?

More often, you will be told/know how many **significant figures** you should round to.

Significant Figures: Quick Review

Rule	Example
1. All non-zeroes are significant	2.25 (3 significant figures)
2. Leading zeroes are **NOT** significant	0.00000034 (2 significant figures)
3. Trailing zeroes are significant **ONLY** if an explicit decimal point is present	200 (1 significant figure) 200. (3 significant figures) 2.00 (3 significant figures)
4. Trapped zeroes are significant	0.0509 (3 significant figures) 2045 (4 significant figures)

Always ask your instructor, but in general…

- Round as the LAST STEP of the calculation
- For multiplication and division, least number of significant figures in any number determines the number of significant figures in the answer.

You Try!

378002.0030

Has many significant figures? _____

Written in scientific notation: _____

0.000000502

Has many significant figures? _____

Written in scientific notation: _____

378002.0030 (0.000000502)

Answer will have how many significant figures?

_____

Answer written in scientific notation:

_____

.00003420

Has many significant figures? _____

Written in scientific notation: _____

-1.003

Has many significant figures? _____

Written in scientific notation: _____

-1.003 / .00003420

Answer will have how many significant figures?

_____

Answer written in scientific notation:

_____

VI. Engineering Notation: A Variant

Engineering notation is a *special form* of scientific notation, where the exponent of the ten is *always* a multiple of three. To accomplish this, the decimal is moved as needed.

Number	In Scientific Notation	In Engineering Notation	Explanation
84200000	8.42×10^{7}	84.2×10^{6}	Move decimal point to the right one place so that 10^{7} becomes 10^{6} to make the exponent a multiple of three
.000039	3.90×10^{-4}	390×10^{-6}	Move decimal point to the right two spaces so that 10^{-5} becomes 10^{-6} to make the exponent a multiple of three
2400	2.4×10^{-3}	2.4×10^{-3}	No change because 10^{-3} is *already* a multiple of three.

You Try!

980,000,000,000
In scientific notation: _____

In engineering notation: _____

-0.000078
In scientific notation: _____

In engineering notation: _____

Most calculators can display in either scientific or engineering notation. Consult your manuals, but the option is typically under "mode"
'NORMAL' for regular notation 'SCI' for scientific notation 'ENG' for engineering notation

One of the benefits of engineering notation is that one can more *easily* speak about large or small numbers by using the following prefixes.

Value	Prefix	Symbol
10^{12}	tera	T
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f

For example,

Instead of saying a retaining wall holds back 4.0×10^{7} liters of water, one could use engineering notation: 40 mega liters of water (40×10^{6} liters).

Instead of saying a 7.3×10^{13} byte hard drive, one could use engineering notation: a 73 terabyte hard drive (73×10^{12} bytes)

Instead of saying a 6.1×10^{-7} meter wavelength, one could use engineering notation: a 610 nanometer wavelength (610×10^{-9})

Scientific Notation Key

STEM Center (BLRC 200)
Academic Success Center
HCC Brandon Campus

I. Scientific Notation Refresher

1) 0.000000736
2) 3760
3) 82000000000
4) 0.00090
5) 8.691×10^{7}
6) 3.21×10^{-11}
7) 7.941×10^{5}
8) 3.5×10^{-3}

III. Adding and Subtracting

1) 8.42×10^{-6}
2) 6.2782×10^{4}
3) 2.3008×10^{-4}
4) -7.87×10^{4}

IV. Multiplication and Division

1) 6.8×10^{-13}
2) -2.2×10^{-9}
3) 2.04×10^{1}
4) 2.2×10^{-3}
5) -3.108×10^{8}
6) 1.872×10^{7}

V. Rounding and Significant Figures

1) 6.674×10^{-11}
2) 7×10^{-11}
3) 6.7×10^{-11}
4) 2.087×10^{-3}
5) $-8.753768 \times 10^{-10}$
6) 2×10^{1}

Significant Figures: Quick Review

378002.0030
How many sig figs? 10
Written in scientific notation: $3.780020030 \times 10^{5}$

0.000000502
How many sig figs? 3
Written in scientific notation: 5.02×10^{-7}

378002.0030(0.000000502)
How many sig figs? 3
Answer: 1.90×10^{-1}

.00003420
How many sig figs? 4
Written in scientific notation: 3.420×10^{-5}

-1.003
How many sig figs? 4
Written in scientific notation: -1.003×10^{1}

-1.003 / .00003420
How many sig figs? 4
Answer: -2.933×10^{4}

VI. Engineering Notation

980,000,000,000
9.8×10^{11}
980×10^{9}

0.000078
-7.8×10^{-5}
-78×10^{-6}