NOVA Loudoun Math Lab Summary Notes:

MTH-154 – **Working with Powers of 10**

Exponential notation is a way of expressing a number in the form:

a^n which means that we have **n** factors of **a** multiplied together.

For example, $5^3 = 5 \times 5 \times 5$ ← 3 factors of 5.

Powers of 10: 10^n is a very important case of exponential notation because our number system is base-10. 10^n can be used to describe the **place value** of a digit in a number (see other side).

The base-10 system leads to these rules to move between powers of 10 and standard number format:

A **positive exponent** indicates the number of places to the right of the 1 (fill with 0's). Ex: $10^5 = 1\,0\,0\,,0\,0\,0\,.$ Take note: $10^0 = 1$ (zero 0's after the 1)	A **negative exponent** indicates the number of places to the right of the decimal point, *including* the 1 (fill with 0's). Ex: $10^{-5} = 0\,.\,0\,0\,0\,0\,1$

Scientific notation makes use of the powers of 10 to provide a concise way to write and work with very large and/or very small numbers. The number is expressed as the digits × a power of 10.

Examples: $-6{,}400{,}000 = -6.4 \times 10^6$ $0.00037 = 3.7 \times 10^{-4}$

number = digits × power of 10 number = digits × power of 10

Powers of 10 are in *exponential notation*, so here is a refresher on:

Rules of Exponents for Powers of 10:

To **multiply** powers of 10, *add* the exponents: $10^7 \times 10^4 = 10^{7+4} = 10^{11}$ $10^{-6} \times 10^4 = 10^{-6+4} = 10^{-2}$ $10^{-3} \times 10^3 = 10^{-3+3} = 10^0 = 1$	To **divide** powers of 10, *subtract* the exponents: $10^7 \div 10^4 = 10^{7-4} = 10^3$ $10^2 \div 10^6 = 10^{2-6} = 10^{-4}$ $10^7 \div 10^7 = 10^{7-7} = 10^0 = 1$
To **raise a power of 10 to a power**, *multiply* the exponents: $(10^3)^4 = 10^{3\times4} = 10^{12}$	To **add or subtract** powers of 10, first convert the numbers to *standard form*. $10^4 + 10^2 = 1000 + 100 = 1010$

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MTH-154 – **Ways to Describe Powers of 10**

Place Value	Power of 10	Standard Form	Fractional Form	Excel or Calculator entry
trillion	$\mathbf{10^{12}}$	1,000,000,000,000	$\frac{1000000000000}{1}$	1E12
hundred billion	10^{11}	100,000,000,000	$\frac{100000000000}{1}$	1E11
ten billion	10^{10}	10,000,000,000	$\frac{10000000000}{1}$	1E10
billion	$\mathbf{10^{9}}$	1,000,000,000	$\frac{1000000000}{1}$	1E9
hundred million	10^{8}	100,000,000	$\frac{100000000}{1}$	1E8
ten million	10^{7}	10,000,000	$\frac{10000000}{1}$	1E7
million	$\mathbf{10^{6}}$	1,000,000	$\frac{1000000}{1}$	1E6
hundred thousand	10^{5}	100,000	$\frac{100000}{1}$	1E5
ten thousand	10^{4}	10,000	$\frac{10000}{1}$	1E4
thousand	$\mathbf{10^{3}}$	1,000	$\frac{1000}{1}$	1E3
hundred	10^{2}	100	$\frac{100}{1}$	1E2
ten	10^{1}	10	$\frac{10}{1}$	1E1
one	$\mathbf{10^{0}}$	1	$\frac{1}{1}$	1E0
tenth	10^{-1}	0.1	$\frac{1}{10}$	1E-1
hundredth	10^{-2}	0.01	$\frac{1}{100}$	1E-2
thousandth	10^{-3}	0.001	$\frac{1}{1000}$	1E-3
ten-thousandth	10^{-4}	0.0001	$\frac{1}{10000}$	1E-4

Examples:

Four hundred thousand	$= 4 \times 10^{5}$	$= 4 \times 100{,}000$	$= 400{,}000$	$= 4E5$
6.32 million	$= 6.32 \times 10^{6}$	$= 6.32 \times 1{,}000{,}000$	$= 6{,}320{,}000$	$= 6.32E6$
seven hundredths	$= 7 \times 10^{-2}$	$= 7 \times 0.01$	$= 0.07$	$= 7E-2$
43 thousandths	$= 43 \times 10^{-3}$	$= 43 \times 0.001$	$= 0.043$	$= 43E-3$