

Name _____

POGIL ACTIVITY **1**

All Numbers Big and Small: Power of Ten and Scientific Notation

A. The Power of Ten

Measurements vary over a wide range of magnitude, from very large to vanishingly small values. Numbers written in familiar decimal notation that contain a lot of zeros before or after the decimal point can be simplified by using a **power of ten**. Powers of ten are **exponential numbers** that result when 10 is multiplied by itself a number of times. The powers of ten can be abbreviated with a **prefix**. (Table A1).

Prefix		Decimal number	Power of Ten	name
Tera	T	1,000,000,000,000	10^{12}	Trillion
Giga	G	1,000,000,000	10^9	Billion
Mega	M	1,000,000	10^6	Million
kilo	k	1,000 <small>($1 \times 10 \times 10 \times 10 = 10^3$)</small>	10^3	Thousand
		1	10^0	One
centi	c	0.01 <small>($1 \times 1/10 \times 1/10 = 10^{-2}$)</small>	10^{-2}	Hundredth
milli	m	0.001	10^{-3}	Thousandth
micro	μ	0.000 001	10^{-6}	Millionth
nano	n	0.000 000 001	10^{-9}	Billionth
	Å	0.000 000 000 1	10^{-10}	Angstrom

All Numbers Big and Small

POGIL ACTIVITY.1

Name _____

Critical Thinking Questions

CTQ 1

Two units have non-English symbols. Write the symbol for these units.

CTQ 2

Explain why the correct use of capital letters and lower-case letters must be observed for prefixes; provide a specific example to support your answer.

CTQ 3

Complete the table by placing an “x” in the correct box.

	decimal number greater than 10	decimal number less than one
pos. exponent		
neg. exponent		

CTQ 4

What is the decimal number that is equal to (1×10^0) ? _____

CTQ 5

$(1 \times 10 \times 10 \times 10 \times 10 = 10^x)$ What is the value of the exponent? $x =$ _____

CTQ 6

Match decimal numbers with powers of ten by placing an “x” in the correct box.

	10^{-6}	10^{-3}	10^{-2}	10^{-1}	10^0	10^1	10^2	10^3	10^4	10^5	10^6
1000 =											
0.1 =											
10,000 =											
0.001 =											
100,000 =											
0.000 001 =											
0.01 =											
10 =											
1 =											

Name _____

B. Scientific Notation

A standard expression for writing numbers is **scientific notation**, an example of exponential notation. Any decimal number can be written in scientific notation using this form $a \cdot 10^x$ where a is called the **coefficient** and x is called the **exponent**. *By convention*, the coefficient is restricted to values of: $1 \leq a < 10$ (Table B1).

Table B1. Scientific Notation			
Numbers ten or greater		Numbers less than one	
Decimal	Exponential	Decimal	Exponential
10	1×10^1	0.1	1×10^{-1}
127	1.27×10^2	0.045	4.5×10^{-2}
1000	1×10^3	0.001	1×10^{-3}
1500	1.5×10^3	0.002 57	2.57×10^{-3}
1,000,000	1×10^6	0.000 001	1×10^{-6}
999,000,000	9.99×10^8	0.000 000 087	8.7×10^{-8}
1,000,000,000	1×10^9	0.000 000 001 68	1.68×10^{-9}

Critical Thinking Questions

CTQ 7

In scientific notation, the value of any exponent (x) can be:

- a. positive
- b. negative
- c. zero
- d. all of the above

CTQ 8

For any number written in scientific notation, how is the sign of the exponent related to the size of that number?

- a. a positive exponent indicates a number less than one
- b. a positive exponent indicates a number greater than ten
- c. a negative exponent indicates a number less than one
- d. a negative exponent indicates a number greater than one
- e. (b) and (c) are both correct
- f. (a) and (d) are both correct

All Numbers Big and Small

POGIL ACTIVITY.1

Name _____

CTQ 9

The value of the coefficient must be:

- a. less than zero
- b. less than or equal to one, but greater than zero
- c. greater than one
- d. less than ten
- e. greater than or equal to one, but less than ten

CTQ 10

To convert one-thousand (1000) into scientific notation, the decimal point is moved ____ to derive the coefficient ...

- | | |
|------------------------------|-----------------------------|
| a. one place to the right | d. one place to the left |
| b. two places to the right | e. two places to the left |
| c. three places to the right | f. three places to the left |

... and the exponent (x) = (-4) (-3) (-2) (-1) (0) (1) (2) (3) (4)

CTQ 11

To convert one-thousandth (0.001) into scientific notation, the decimal point is moved ____ to derive the coefficient ...

- | | |
|------------------------------|-----------------------------|
| a. one place to the right | d. one place to the left |
| b. two places to the right | e. two places to the left |
| c. three places to the right | f. three places to the left |

... and the exponent (x) = (-4) (-3) (-2) (-1) (0) (1) (2) (3) (4)

CTQ 12

To convert (1×10^{-2}) into a decimal number, the decimal point is moved _____ .

- | | |
|------------------------------|-----------------------------|
| a. one place to the right | d. one place to the left |
| b. two places to the right | e. two places to the left |
| c. three places to the right | f. three places to the left |

CTQ 13

Formulate a rule that describes how the value of the exponent relates to the movement of the decimal point when converting between decimal numbers and scientific notation.

Name _____

Exercises

1. Convert the following decimal numbers into scientific notation.

a. 10,005	
b. 10,405	
c. 0.994	
d. 1776	
e. 78.9	
f. 0.5001	
g. 0.0068	
h. 93 million	
i. 5.2 billionths	
j. 7 tenths	

2. Convert the following exponential numbers into decimal numbers.

a. 4.4×10^{-2}	
b. 8.977×10^4	
c. 4.05×10^{-6}	
d. 3.01×10^8	
e. 2.31×10^2	
f. 7.00006×10^{-3}	
g. 1.975×10^{-1}	
h. 2.46×10^1	
i. 2.54×10^{-10}	
j. 6.02×10^{23}	

All Numbers Big and Small

POGIL ACTIVITY.1

Name _____

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