PREPARATORY MATH SKILLS LAB

Lab PMS 4

MATH ACTIVITY

Learning How to Write Numbers in Scientific Notation

MATH SKILLS LAB OBJECTIVES

When you complete this activity, you should be able to do the following:

1. ***Write numbers that are given in decimal form (like 8174.3 and 0.00817) in scientific notation (like 8.1743×10^3 and 8.17×10^{-3}).***
2. ***Write numbers that are given in scientific notation as decimal numbers.***

Scientific notation makes use of "powers of ten." It is a convenient way to write large numbers or small numbers. For example, the large number 314,000,000,000 becomes 3.14×10^{11} in scientific notation. The small number 0.000000314 becomes 3.14×10^{-7}.

Before we learn how to write ordinary decimal numbers in scientific notation, let's learn a few definitions. Scientific notation involves a ***prefix***, a ***decimal point***, the ***number 10***, and a number called an ***"exponent,"*** or power. These are identified below.

Prefix — *Exponent or power*

$$3.14 \times 10^{8}$$

Decimal point — *Base number 10*

Any one of the numbers in the prefix—3, 1 or 4—is referred to as a digit.

Scientific notation is based on the fact that you can always write numbers as a prefix times a string of tens. A string of tens—like $10 \times 10 \times 10 \times 10$—can be written as 10^4 (four 10's multiplied together). Study the following examples.

$$100 = 1 \times 100 = 1 \times (10 \times 10) = 1 \times 10^2$$

$$150 = 1.5 \times 100 = 1.5 \times (10 \times 10) = 1.5 \times 10^2$$

$$3750 = 3.75 \times 1000 = 3.75 \times (10 \times 10 \times 10) = 3.75 \times 10^3$$

$$37{,}500 = 37.5 \times 10{,}000 = 3.75 \times (10 \times 10 \times 10 \times 10) = 3.75 \times 10^4$$

Note that in each case, a number (such as 3750) was written as a prefix (3.75) times a power of ten (10^3).

When a number is less than one, such as 0.1 or 0.015, it can also be written in scientific notation. For example:

$$0.1 = 1 \times \frac{1}{10} = 1 \times 10^{-1}; \quad \left(\frac{1}{10} = 10^{-1}\right)$$

$$0.01 = 1 \times \frac{1}{100} = 1 \times \frac{1}{10 \times 10} = 1 \times 10^{-2}; \quad \left(\frac{1}{10 \times 10} = \frac{1}{10^2} = 10^{-2}\right)$$

$$0.015 = 1.5 \times \frac{1}{100} = 1.5 \times \frac{1}{10 \times 10} = 1.5 \times 10^{-2}$$

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Note that in each case, a number less than one was written as a prefix times a power of ten. For numbers less than one, the exponent or power used with the number 10 is always ***negative.***

When a number like 81,000 is written as 8.1×10^4, it's called ***"scientific notation."*** It's called that because scientists, engineers and technicians often have to use very large or very small numbers. Writing these numbers as a prefix times a power of ten is easier and faster. To write numbers in scientific notation, follow these procedures.

Case 1: The general procedure for writing ***numbers greater than one*** (like 81,000) in scientific notation is:

a. Locate the decimal point in the number.

81,000. (Original decimal point location)

b. Count the number of places moved to the left to shift the decimal point so that only ***one digit*** remains to the left of the new decimal point.

(Four places to the left)
8.1000. (Original decimal point location)
(New decimal point location)

c. Use the *number of places moved to the left* (4) as the ***positive exponent*** in the power of ten (10) and write 81,000 in scientific notation as:

$$81{,}000 = 8.1 \times 10^4$$

Case 2: The general procedure for writing ***numbers less than one*** (like 0.0715) in scientific notation is as follows:

a. Locate the decimal point in the number.

0.0715 (Original decimal point location)

b. Count the number of places to the right to shift the decimal point so that only ***one digit***, other than zero, remains to the left of the new decimal point.

(Two places to the right)
0.07.15
(New decimal point location)
(Original decimal point location)

c. Use the *number of places moved to the right* (2) as the ***negative exponent*** in the power of ten (10^{-2}) and write 0.0715 in scientific notation as:

$$0.0715 = 7.15 \times 10^{-2}$$

In Table 1, the procedures outlined above have been used to change ordinary decimal numbers to numbers in scientific notation. Look over each number and be sure that you agree with the conversion.

TABLE 1

Converting Numbers to Power-of-ten Notation		
375,000	=	3.75×10^5
81,000	=	8.1×10^4
623,000,000,000	=	6.23×10^{11}
0.0715	=	7.15×10^{-2}
0.0025	=	2.5×10^{-3}
0.000000133	=	1.33×10^{-7}

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When changing a number like 81,000 to ***scientific notation***, it's written as 8.1×10^4. Other forms of power-of-ten notation, equally correct and equally useful, but ***not*** written in ***scientific notation*** are the following:

$$
\begin{aligned}
81{,}000 &= 81 \times 10^3 \\
&= 810 \times 10^2 \\
&= 8100 \times 10^1 \\
&= 0.81 \times 10^5
\end{aligned}
$$

Similarly, for numbers less than one, more than one form for the power-of-ten notation is possible. For example:

$$
\begin{aligned}
0.0025 &= 2.5 \times 10^{-3} \\
&= 25 \times 10^{-4} \\
&= 250 \times 10^{-5} \\
&= 0.25 \times 10^{-2}
\end{aligned}
$$

PRACTICE EXERCISES

Use the procedures given so far to convert numbers to ***scientific notation***.

Problem 1: Given the following numbers (larger than one), change them to ***scientific notation***—with only *one digit* remaining to the left of the decimal point in the final answer.

Example: $3{,}860 = 3.86 \times 10^3$

a. 38,600 = ______________
b. 157,300 = ______________
c. 300,000,000 = ______________
d. 147 = ______________
e. 93,000,000 = ______________

Problem 2: Given the following numbers (less than one), change them to ***scientific notation***—with only *one digit* (other than zero) remaining to the left of the decimal point in the final answer.

Example: $0.015 = 1.5 \times 10^{-2}$

a. 0.0036 = ______________
b. 0.715 = ______________
c. 0.000025 = ______________
d. 0.002 = ______________
e. 0.00083 = ______________

Problem 3: Given the following numbers in power-of-ten notation, change them to ordinary numbers.

Examples: $836 \times 10^{-3} = 0.836$
$3.01 \times 10^3 = 3010$

a. 81.5×10^{-1} = ______________
b. 47.71×10^2 = ______________
c. 326.1×10^{-4} = ______________
d. 4.771×10^4 = ______________
e. 389×10^{-5} = ______________
f. 3×10^8 = ______________

Problem 4: Given the following numbers, change them to an appropriate power-of-ten notation indicated by filling in the correct prefix.

Example: $3860 = 3.86 \times 10^3$

a. 38,600 = __________ $\times 10^2$
b. 157,300 = __________ $\times 10^4$
c. 23,600 = __________ $\times 10^5$
d. 0.00147 = __________ $\times 10^{-3}$
e. 0.056 = __________ $\times 10^{-2}$
f. 0.0791 = __________ $\times 10^{-3}$

Indicate which of the numbers above have been rewritten in ***scientific notation***.