# **PLTW** Engineering

## **1.1.3.AK Scientific and Engineering Notation**

#### Introduction

In electronics, we frequently work with very small and very large numbers. For example, the propagation delay (i.e., the time it takes for the output to change after the input has changed) for a standard digital logic gate is 0.000000095 seconds. Moreover, the clock speed of a typical personal computer is 240000000 Hz. Working with numbers of this magnitude, both large and small, can be cumbersome and is prone to error. For this reason we use a power-of-ten notation. With a power-of-ten notation, any number, no matter how large or small, can be expressed as a decimal number multiplied by a power-of-ten.

Scientific and engineering notations are the two most common forms of power-of-ten notation. In the field of electronics, engineering notation is the preferred notation because of the direct mapping between its powers and the **International System of Units** (the International System of Units is abbreviated **SI** from the French *Système International d'Unités*). The SI system is the modern form of the metric system. It is the world's most widely used system of units for science and engineering.

### Procedure

1. Express each of the following numbers in scientific notation.

a.	0.0000000356	= 3.56 x 10 <sup>-9</sup>
b.	934,000,000	= 9.34 x 10 <sup>8</sup>
c.	847	= <b>8.47</b> x 10 <sup>2</sup>
d.	0.00092	= 9.2 x 10 <sup>-4</sup>
e.	3,510,000	= 3.51 x 10 <sup>6</sup>

- 2. Express each of the following numbers in engineering notation.
  - a. 0.0000000356 = **3.56 x 10**-9
  - b. 934,000,000 = **934 x 10**<sup>6</sup>
  - c. 847 = **847**
  - d. 0.00092 = 920 x 10<sup>-6</sup>
  - e.  $3,510,000 = 3.51 \times 10^6$

Express each of the following numbers using the appropriate SI prefix.
Don't forget to retain the units.

	a.	0.000047 F	= 47μF
	b.	17500000 Hz	= 17.5 MHz
	C.	0.000000157 A	= 15.7 nA
	d.	6800000 Ω	= <b>6.8 M</b> Ω
	e.	0.00425 V	= 4.25 mV
4.	. Convert the following numbers into the SI prefix shown.		

a.	6800 pF	= .0068 μF
b.	2.7 M Ω	= <b>2700 k</b> Ω
c.	4.24 GHz	= 4240 MHz
d.	25.67 μF	= .02567 mF
e.	0.0127 nSec	= 12.7 pSec

#### Conclusion

- 1. Why is it helpful to use a power-of-ten notation (i.e., scientific or engineering) when expressing very large or very small numbers? Answers may vary.
  - It makes writing/reading the numbers easier/faster.
  - It makes calculations in decimal form easier/faster if a calculator is not available.
- 2. In engineering in general, and in electronics specifically, why do we use engineering notation rather than scientific notation? Answers may vary.
  - Many components in electronics have large/small values that need to be printed on them. It is easier to read the value on a component written with an SI prefix.
- 3. The SI prefix for 10<sup>-15</sup> is *femto* and is abbreviated f. We do not use this prefix in electronics. Why? Answers may vary.
  - This prefix represents an extremely small value. You would rarely (if ever) deal with a physical quantity this small.