Scientific Notation: Small Numbers

When writing very small numbers in scientific notation, the exponent is negative. Recall that negative exponent does not signify a negative number, but a *fraction*: a reciprocal of the corresponding power of ten with a positive exponent. For example, $10^{-4} = \frac{1}{10^4} = \frac{1}{10{,}000}$. As a decimal, this is 0.0001.

Example 1. To write 0.00034 in scientific notation, we need to use 3.4 as the decimal that is multiplied by a power of ten. (Why?) Now note in which place the digit 3 is: it is in ten-thousandths place, which is the *fourth* digit after the decimal point. This means we use $\frac{1}{10{,}000} = \frac{1}{10^4} = 10^{-4}$ as the power of ten.

So, $0.00034 = 3.4 \cdot 10^{-4}$.

Example 2. To write $7.64 \cdot 10^{-6}$ in decimal notation, we note that the digit 7 has to be in the place indicated by the power of ten, which means 7 will be in the millionths place. The other digits will follow. The millionths place is the sixth decimal digit after the decimal point. So, $7.64 \cdot 10^{-6} = 0.00000764$.

1. Write the numbers given in scientific notation in decimal notation, and vice versa.

Scientific Notation	Decimal notation	Scientific Notation	Decimal notation
$3 \cdot 10^{-5}$			0.0000002388
	0.0008	$8.2 \cdot 10^{-4}$	
	0.00000203		0.00000000308
$6.108 \cdot 10^{-8}$		$4.539 \cdot 10^{-7}$	

2. Eric said that $7.61 \cdot 10^{-9}$ has a total of nine zeros, like this: 0.00000000761. Is he correct?

3. Compare the numbers, writing < or > in the box. How can you tell which of them is greater, without writing them in decimal notation?

a. $2 \cdot 10^{-7}$ ☐ $5 \cdot 10^{-8}$ **b.** $3 \cdot 10^{-9}$ ☐ $3 \cdot 10^{-7}$ **c.** $7.82 \cdot 10^{-5}$ ☐ 0.000075

d. $4 \cdot 10^{-4}$ ☐ 0.00046 **e.** $7 \cdot 10^{-4}$ ☐ 0.0065 **f.** 0.00000078 ☐ $2.8 \cdot 10^{-8}$

4. Write in order from smallest to greatest: $5.6 \cdot 10^{7}$ 10^{-6} 0.0003 10^{8} $6 \cdot 10^{7}$ 0.00002 $9 \cdot 10^{-7}$