Writing Numbers in Scientific Notation

To write a number in scientific notation

1. Move the decimal point right or left to obtain a number n such that $1 \leq n \leq 10$.
2. Count the number of places *p* that the decimal point has been moved.
3. Multiply n by 10^p if the decimal point was moved to the left. Multiply n by 10^{-p} if the decimal point was moved to the right. Be sure to eliminate any meaningless zeros.

Example 1

Write in scientific notation:

a. 10,300,000
b. 0.00089

Solution

a. We need to move the decimal point to the left 7 places to get a number n such that $1 \leq n \leq 10$.

$$10300000 = 1.0300000$$

So we multiply n by 10^7. The zeros to the right of the 3 are meaningless, so we eliminate them, getting

$$1.03 \times 10^7$$

b. We need to move the decimal point to the right 4 places to obtain a number n such that $1 \leq n \leq 10$. Then we multiply the result by 10^{-4} and eliminate the meaningless zeros on the left.

$$0.00089 = 00008.9 \times 10^{-4} = 8.9 \times 10^{-4}$$

To write a number in standard notation

1. Move the decimal point the number of places, *p*, in 10^p. Move it to the right if the exponent is positive; move it to the left if the exponent is negative. (Add zeros as necessary.)
2. Eliminate the multiplication sign and power of 10.

Example 2

Write in standard notation:

a. 1.206×10^9
b. 3.05×10^{-7}

Solution

a. Because the exponent is 9, we move the decimal point 9 places to the right.

$$1.206 \times 10^9 = 1.206000000 = 1{,}206{,}000{,}000$$

b. Because the exponent is -7, we must move the decimal point 7 places to the left.

$$3.05 \times 10^{-7} = .000000305 = 0.000000305$$

Example 3

a. $(4.8 \times 10^{15}) \times (6.4 \times 10^{12})$
b. Divide the first of these numbers by the second.

Solution

a. To multiply two numbers in scientific notation, multiply the coefficients and then the powers of 10.

$$(4.8 \times 10^{15})(6.4 \times 10^{12})$$
$$= (4.8)(6.4) \times 10^{(15+12)}$$
$$= 30.72 \times 10^{27}$$

This number is not in scientific notation because 30 > 10. To write it correctly, we put the decimal part in the proper scientific notation and then simplify.

$$30.72 \times 10^{27} = (3.072 \times 10^{1}) \times 10^{27}$$
$$= 3.072 \times 10^{28}$$

b. To divide in scientific notation, we divide the coefficients and then subtract the powers of 10.

$$\frac{4.8 \times 10^{15}}{6.4 \times 10^{12}} = \frac{4.8}{6.4} \times 10^{(15-12)}$$

$$= 0.75 \times 10^{3}$$

$$= (07.5 \times 10^{-1}) \times 10^{2}$$

Practice:

Rewrite each number in scientific notation:

1. Number of pounds of advertising mail received by Americans in one year: 3,650,000,000 pounds
2. A red blood cell count is typically about 5,000,000/mm^3 blood. Express this count in scientific notation.
3. The average human brain is believed to have about 100 billion nerve cells. Express this in scientific notation.
4. $\frac{0.000072}{0.008}$
5. Time needed to compress a deuterium pellet by laser light: 0.000000001 second
6. Size of a DNA molecule: 0.00000217 millimeter

Rewrite each number in standard notation:

7. Energy given off by a hurricane: 5.0×10^{22} ergs
8. Number of gallons of water used by Americans daily: 4.5×10^{11} gallons
9. The pH value of a certain chemical is 1.0×10^{-2}.
10. Number of seconds in the month of January: 2.6784×10^{6} seconds
11. An x-ray has a wavelength of 1×10^{-10}

Compute and express your answers in scientific notation:

12. $(1.24 \times 10^{-13}) \div (6.2 \times 10^{20})$
13. $(1.24 \times 10^{-23}) \times (0.08 \times 10^{2})$
14. $(0.02) \times (0.000000078)$
15. $(5.6 \times 10^{18}) \div (2.8 \times 10^{15})$
16. $(1.2 \times 10^{-13}) \times (24000000)$

Answers:

1. 3.65×10^{9}
2. 5×10^{6}
3. 1×10^{11}
4. 9×10^{-3}
5. 1×10^{-9}
6. 2.17×10^{-6}
7. 50,000,000,000,000,000,000,000
8. 450,000,000,000
9. .01
10. 2,678,400
11. .0000000001
12. 2×10^{-34}
13. 9.92×10^{-23}
14. 1.56×10^{-9}
15. 2×10^{3}
16. 2.88×10^{-6}