SCIENTIFIC NOTATION

Scientific notation is a way of writing very large and very small numbers compactly. A number is said to be in scientific notation when it is written as the product of two factors as described below.

- The first factor is less than 10 and greater than or equal to 1.
- The second factor has a base of 10 and an integer exponent (power of 10).
- The factors are separated by a multiplication sign.
- A positive exponent indicates a number whose absolute value is greater than one.
- A negative exponent indicates a number whose absolute value is less than one.

Scientific Notation	Standard Form
$5.32 \cdot 10^{11}$	532,000,000,000
$2.61 \cdot 10^{-15}$	0.00000000000000261

It is important to note that the exponent does not necessarily mean to use that number of zeros.

The number $5.32 \cdot 10^{11}$ means $5.32 \cdot 100{,}000{,}000{,}000$. Thus, two of the 11 places in the standard form of the number are the 3 and the 2 in 5.32. Standard form in this case is 532,000,000,000. In this example you are moving the decimal point to the right 11 places to find standard form.

The number $2.61 \cdot 10^{-15}$ means $2.61 \cdot 0.000000000000001$.
You are moving the decimal point to the left 15 places to find standard form.
Here the standard form is 0.00000000000000261.

For additional information, see Year 2, Chapter 10, problem MG-65.

Example 1

Write each number in standard form.

$7.84 \cdot 10^{8} \Rightarrow$ 784,000,000 and $3.72 \cdot 10^{-3} \Rightarrow$ 0.00372

When taking a number in standard form and writing it in scientific notation, remember there is only <u>one</u> digit before the decimal point, that is, the number must be between 1 and 9, inclusive.

Example 2 52,050,000 $\Rightarrow$ $5.205 \cdot 10^{7}$ and 0.000372 $\Rightarrow$ $3.72 \cdot 10^{-4}$

The exponent denotes the number of places you had to move the decimal point in the standard form. In the first example above, the decimal point is at the end of the number and it was moved 7 places. In the second example above, the exponent is negative because the original number is very small, that is, less than one.

Problems

Write each number in standard form.

1. $7.85 \cdot 10^{11}$
2. $1.235 \cdot 10^{9}$
3. $1.2305 \cdot 10^{3}$
4. $3.89 \cdot 10^{-7}$
5. $5.28 \cdot 10^{-4}$

Write each number in scientific notation.

6. 391,000,000,000
7. 0.0000842
8. 123056.7
9. 0.000000502
10. 25.7
11. 0.035
12. 5,600,000
13. 1346.8
14. 0.000000000006
15. 634,700,000,000,000

> Note:
> On your scientific calculator, displays like 4.357^{12} and 3.65^{-03} are numbers expressed in scientific notation. The first number means $4.357 \cdot 10^{12}$ and the second means $3.65 \cdot 10^{-3}$. The calculator does this because there is not enough room on its display window to show the entire number.

Answers

1. 785,000,000,000
2. 1,235,000,000
3. 1230.5
4. 0.000000389
5. 0.000528
6. $3.91 \cdot 10^{11}$
7. $8.42 \cdot 10^{-5}$
8. $1.230567 \cdot 10^{5}$
9. $5.02 \cdot 10^{-7}$
10. $2.57 \cdot 10^{1}$
11. $3.5 \cdot 10^{-2}$
12. $5.6 \cdot 10^{6}$
13. $1.3468 \cdot 10^{3}$
14. $6.0 \cdot 10^{-12}$
15. $6.347 \cdot 10^{14}$