Scientific (Exponential) Notation

The numbers used in chemistry are often either extremely large or extremely small. Such numbers are conveniently expressed in the form of scientific notation.

$1 \le N < 10$ → $N \times 10^{n}$ ← n is an exponent of 10

The Avogadro number is written as 6.022×10^{23}.

Positive Exponents: Each time the decimal place is moved once place to the **left**, the exponent is **increased** by one.

$5237.3 \times 10^{0} = 523.73 \times 10^{1}$

$523.73 \times 10^{1} = 52.373 \times 10^{2}$

$52.373 \times 10^{2} = 5.2373 \times 10^{3}$

$= 5.2373 \times 10 \times 10 \times 10$

Negative Exponents: Each time the decimal place is moved once place to the **right**, the exponent is **decreased** by one.

$0.00386 \times 10^{0} = 0.0386 \times 10^{-1}$

$0.0386 \times 10^{-1} = 0.386 \times 10^{-2}$

$0.386 \times 10^{-2} = 3.86 \times 10^{-3}$

$= \dfrac{3.86}{10 \times 10 \times 10}$

Operations with Scientific Notation

Addition and Subtraction: In order to add or subtract numbers expressed in scientific notation, *the powers of 10 must be the same*.

Not equal — Equal

$(3.2 \times 10^{3}) + (7.23 \times 10^{4}) = (0.32 \times 10^{4}) + (7.23 \times 10^{4}) = (0.32 + 7.23) \times 10^{4}$

$= 7.55 \times 10^{4}$

The decimal is moved to the left to increase the exponent.

Multiplication: When numbers in scientific notation are multiplied, only the number is multiplied. The exponents are ***added***.

$(5.4 \times 10^{2})(2.1 \times 10^{3}) = (5.4)(2.1) \times 10^{2+3} = 11 \times 10^{5} = 1.1 \times 10^{6}$

Division: When numbers in scientific notation are divided, only the number is divided. The exponents are ***subtracted***.

$$\frac{3.2 \times 10^{5}}{6.5 \times 10^{2}} = \frac{3,2}{6.5} \times 10^{5-2} = 0.49 \times 10^{2} = 4.9 \times 10^{2}$$

Practice Problems

1. Convert the following numbers into scientific notation.

a) 923 _____

b) 0.00425 _____

c) 4523000 _____

d) 0.94300 _____

e) 92.03 _____

f) 7.80 _____

2. Convert the following numbers into standard notation.

a) 3.92400×10^{5} _____

b) 9.2×10^{6} _____

c) 4.391×10^{-3} _____

d) 6.825×10^{-4} _____

e) 8.36×10^{1} _____

f) 2.46×10^{-5} _____

3. Perform the following operations and express the answers in scientific notation.

a) $(1.2 \times 10^{5}) + (5.35 \times 10^{6})$

b) $(6.91 \times 10^{-2}) + (2.4 \times 10^{-3})$

c) $(3.67 \times 10^{2}) - (1.6 \times 10^{1})$

d) $(3.378 \times 10^{-3}) - (4.97 \times 10^{-5})$

e) $(5.98 \times 10^{12}) \times (2.77 \times 10^{-5})$

f) $(6.0 \times 10^{3}) \times (1.5 \times 10^{-2})$

g) $(7.8 \times 10^{3}) \div (1.2 \times 10^{4})$

h) $(6.48 \times 10^{5}) \div [(2.4 \times 10^{4})(1.8 \times 10^{-2})]$

References:
Tro, Chemistry: A Molecular Approach, 2nd ed., Pearson
Brown/LeMay/Bursten, Chemistry: The Central Science, 12th ed., Pearson

Answers

1. *a) 9.23×10^{2}; b) 4.25×10^{-3}; c) 4.523×10^{6}; d) 9.4300×10^{-1}; e) 9.203×10^{1}; f) 7.80×10^{0}*
2. *a) 3924000; b) 9200000; c) 0.0043091; d) 0.00068025; e) 83.6; f) 0.0000246*
3. *a) 5.47×10^{6}; b) 7.15×10^{-2}; c) 3.51×10^{-2}; d) 3.328×10^{-3}; e) 1.66×10^{8}; f) 9.0×10^{1} g) 6.5×10^{-1}; h) 1.5×10^{2}*