

Appendix A

EXPONENTIAL NOTATION

A. INTRODUCTION

Exponential notation is a method of simplifying the writing and handling of very large or very small numbers. In exponential notation, a number usually is expressed as a coefficient between one and ten times an integral power of ten, the exponent.

EXAMPLES:

- a. $2230 = 2.230 \times 10^3$
- b. $0.00056 = 5.6 \times 10^{-4}$
- c. $5196000 = 5.196 \times 10^6$

To express a number in exponential notation, write it in the form: $c \times 10^n$, where c is a number between 1 and 10 (e.g. 1, 2.5, 6.3, 9.8) and n is an integer (e.g. 1, -3, 6, -2). To find n , count the number of places that the decimal point must be moved to give the coefficient, c . If the decimal point must be moved to the left, n is a positive integer; if it must be moved to the right, n is a negative integer. A positive exponent is how many times the coefficient must be multiplied by ten to generate the original number; a negative exponent is how many times the coefficient must be divided by ten to generate the original number.

B. EXPONENTIAL NOTATION ON A CALCULATOR

Numbers can be entered in scientific notation in a calculator using the key labeled EXP, EE, or EEX. The exponential notation key replaces the key strokes " $\times 10$ ". DO NOT TYPE IN " $\times 10$ "! For example, the number 2.4×10^{-6} is entered as "2.6 EXP +/- 6". Check your instruction manual for specific directions about the use of the exponential notation key on your calculator.

C. ADDITION AND SUBTRACTION

To add and subtract numbers in exponential notation manually, all exponents must be the same. When all the exponents are the same, then add or subtract the coefficients. The exponent in the answer is the same as the exponent of the numbers used in the calculation.

EXAMPLES:

- a. $(6.04 \times 10^3) + (2.6 \times 10^2) = (6.04 \times 10^3) + (0.26 \times 10^3) = (6.04 + 0.26) \times 10^3 = 6.30 \times 10^3$
Step 1. Make the exponents the same: $(6.04 \times 10^3) + (0.26 \times 10^3)$ or $(60.4 \times 10^2) + (2.6 \times 10^2)$
Step 2. Add the coefficients: $(6.04 + 0.26) \times 10^3 = 6.30 \times 10^3$ or $(60.4 + 2.6) \times 10^2 = 63.0 \times 10^2$
- b. $(9.82 \times 10^{-4}) - (8.2 \times 10^{-6}) = (9.82 \times 10^{-4}) - (0.08 \times 10^{-4}) = (9.82 - 0.08) \times 10^{-4} = 9.74 \times 10^{-4}$
Step 1. Make the exponents the same: $(9.82 \times 10^{-4}) - (0.08 \times 10^{-4})$
Step 2. Subtract the coefficients: $(9.82 - 0.08) \times 10^{-4} = 9.74 \times 10^{-4}$

When numbers in exponential notation are added or subtracted on a calculator, there is no need for the exponents to be the same. The calculator does this operation automatically.

D. MULTIPLICATION

To multiply numbers in exponential notation, multiply the coefficients and add the exponents.

EXAMPLES

a. $(5.00 \times 10^4) \times (1.60 \times 10^2) = (5.00 \times 1.60) \times (10^4 \times 10^2) = (5.00 \times 1.60) \times (10^{4+2}) = 8.00 \times 10^6$

Step 1. Multiply the coefficients: $(5.00 \times 1.60) = 8.00$

Step 2. Add the exponents: $(10^{4+2}) = 10^6$

b. $(6.01 \times 10^{-3}) \times (5.23 \times 10^6) = (6.01 \times 5.23) \times (10^{-3} \times 10^6) = (6.01 \times 5.23) \times (10^{-3+6}) = 31.4 \times 10^3 = 3.14 \times 10^4$

Step 1. Multiply the coefficients: $(6.01 \times 5.23) = 31.4$

Step 2. Add the exponents: $(10^{-3+6}) = 10^3$

Step 3. Change the form of the number so the coefficient is between 1 and 10: $31.4 \times 10^3 = 3.14 \times 10^4$

E. DIVISION

To divide numbers in exponential notation, divide the coefficients and subtract the exponents.

EXAMPLES

a. $(6.01 \times 10^{-3}) / (5.23 \times 10^6) = (6.01 / 5.23) \times (10^{-3} / 10^6) = (6.01 / 5.23) \times (10^{-3-6}) = 1.15 \times 10^{-9}$

Step 1. Divide the coefficients: $(6.01 / 5.23) = 1.15$

Step 2. Subtract the exponents: $(10^{-3-6}) = 10^{-9}$

b. $(5.23 \times 10^6) / (6.01 \times 10^{-3}) = (5.23 / 6.01) \times (10^6 / 10^{-3}) = (5.23 / 6.01) \times (10^{6+3}) = 0.870 \times 10^9 = 8.70 \times 10^8$

Step 1. Divide the coefficients: $(5.23 / 6.01) = 0.870$

Step 2. Subtract the exponents: $(10^{6+3}) = 10^9$

Step 3. Change the form of the number so the coefficient is between 1 and 10: $0.870 \times 10^9 = 8.70 \times 10^8$

F. POWERS AND ROOTS

To raise number in exponential notation to a power or to extract a root, perform the necessary operation on the coefficient (raise to a power or extract a root) and multiply the exponent by the power or root.

EXAMPLES

a. $(2.16 \times 10^{-3})^2 = (2.16)^2 \times (10^{-3})^2 = 4.67 \times 10^{-6}$

Step 1. Raise the coefficient to the power: $(2.16)^2 = 4.67$

Step 2. Multiply the exponent by power: $(10^{-3})^2 = 10^{-6}$

b. $(3.0 \times 10^7)^{1/5} = (300 \times 10^5)^{1/5} = (300)^{1/5} \times (10^5)^{1/5} = 3.1 \times 10^1 = 31$

Step 1. Change the form of the number so that the exponent multiplied by the root gives a whole number:

$$(300 \times 10^5)^{1/5}$$

Step 2. Take the root of the coefficient: $(300)^{1/5} = 3.1$

Step 3. Multiply the exponent by the root: $(10^5)^{1/5} = 10^1$