

Scientific Notation, Significant Figures, and the Factor-Label Method of Solving Problems

Scientific Notation

Scientific notation is a type of exponential notation in which only one digit is kept to the left of the decimal point. Example: 8.4050×10^{-8} .

Significant Figures

It is reasonable that a calculated result can be no more precise than the least precise piece of information that went into the calculation. Thus it is common practice to write numbers in scientific notation with only the last place containing any uncertainty. When we do this we are keeping only the “significant figures.”

- To determine the number of significant figures in a number, you read the number from left to right and count all digits starting with the first non-zero digit. Do not count the exponential part.

Thus the number 0.002050 contains 4 significant figures and is written in scientific notation as 2.050×10^{-3} . The trailing zeros in a non-decimal number such as 1200 may or may not be significant: the number may be written as 1.2×10^2 , 1.20×10^2 or 1.200×10^2 depending on whether it has 2, 3, or 4 significant figures.

Significant Figures in Derived Quantities

When doing calculations, you should use all the digits allowed by your calculator in all intermediate steps. Then in the final step, round off your answer to the appropriate number of “significant figures” such that *only the last decimal place contains any uncertainty*. You do this by following the rules:

- When *adding or subtracting*, first express all numbers with the same exponent. Then the number of decimal places in the answer should be equal to the *number of decimal places in the number with the fewest decimal places*.
- In *multiplication or division*, the number of significant figures in the answer should be the same *as that in the factor with the fewest significant figures*.

When using these rules, assume that *exact* numbers have an infinite number of significant figures (or decimal places). For example, there are *exactly* 12 inches in one foot.

Ellena Bethea

Examples

1. Carry out the following mathematical operations and express your answer in *scientific notation* using the proper number of *significant figures*.

(a) $(4.28 \times 10^{-4}) + (3.564 \times 10^{-2})$

(b) $(0.00950) \times (8.501 \times 10^7) \div 3.1425 \times 10^{-11}$

2. Use the *factor-label method* to solve the following problem. Show your work, and give your answer in *scientific notation* using the proper number of *significant figures*.

The *calorie* (1 cal = 4.184 J) is a unit of energy. The burning of a sample of gasoline produces 4.0×10^2 kJ of heat. Convert this energy to *calories*. (10^3 J = 1 kJ.)

3. Use the *factor-label method* to solve the following problem. Show your work, and give your answer in *scientific notation* using the proper number of *significant figures*.

The distance from the sun to the earth is 93 million miles. How many minutes does it take light from the sun to reach earth?

Useful information: 1 km = 0.6214 mile, c = speed of light = 3.00×10^8 m/s)

Answers:

1. (a) 3.607×10^{-2} ; (b) 2.57×10^{16}
2. 9.6×10^4 calories
3. 8.3 minutes