

Significant figures

A common problem facing all beginning science students is using significant figures correctly. A significant figure is one that is either known precisely or can be estimated accurately.

When looking at a number it is important to recognize how many significant figures it contains because this tells you much about the kind of instrument that was used to make the measurement.

The following guidelines indicate whether or not a digit is significant:

(1) All non-zero digits are significant digits

Example 1: 345.76 has five significant digits.

(2) Zeros are significant if they:

(a) are the last digit of a measurement as long as they are to the **right** of the decimal point

(b) come between two other significant digits.

Example 2: 3.70 has three significant digits. The zero is significant because it is the last digit.

Example 3: 340.61 has five significant digits. The zero is significant because it falls between the 4 and the 6 which are both significant

Example 4: 1.500 has four significant digits. The first zero is significant because it is between two other v digits. The second zero is significant because it is the last digit.

(3) Zeros are **not** significant if they act as placeholders.

Example 5: 0.035 has two significant digits. The zeros are placeholders for locating the decimal point.

Example 6: 0.01060 has four significant digits. The first two zeros are placeholders and are not significant. The third zero is significant because it falls between two other significant digits. The fourth zero is significant because it is explicitly included as the last digit in a measurement.

(4) When the zeros are on the left of the decimal point, then they are not necessarily significant.

Example 7: 2100 may have 2, 3 or 4 significant figures.

Example 8: 350 may have 2 or 3 significant figures.

This ambiguity can be avoided by writing the numbers in scientific notation.

(5) In scientific notation, all digits in the coefficient are significant. The exponent is not considered in terms of significant figure.

Example 9: 2.100×10^3 will have with certainty 4 significant figures.

Example 10: 3.50×10^3 will have with certainty 3 significant figures.

Example 11: 3.54×10^5 has three significant digits.

Example 12: 1.6340×10^{-6} has five significant digits.

(6) Numbers that are known with complete certainty are said to be exact. Conversion factors, constants, values that are part of a formula are said to be exact. This “exact” numbers are considered to have an unlimited number of significant figures and are never used as a limited factor in determining the number of significant figures in the result of an operation.

Example 13: 1 cm = 10 millimeters. The number 10 will have an infinity number of significant figures.

Example 14: radius = diameter/2. The 2 will have an infinity number of significant figures.

Example 15: π (pi) will have an infinity number of significant figures.

Rules for Retaining Significant Figures in Calculations

There are several rules to remember regarding significant figures when manipulating numbers.

1. When measurements are multiplied or divided, the answer can contain no more significant figures than the least accurate measurement.
2. When measurements are added or subtracted, the answer can contain no more decimal places than the least accurate measurement.

$$\begin{array}{r} 150.0 \text{ g} \\ + 0.507 \text{ g} \\ \hline 150.5 \text{ g} \end{array} \quad \text{(using significant figures)}$$

3. When taking roots or evaluating trig functions retain the same number of significant figures in the result as are in the radicand (if taking roots) or in the argument of the trig function (if evaluating trig functions).

Rounding off

1. If the digit is smaller than 5, drop this digit and leave the remaining number unchanged. Thus, 1.684 becomes 1.68.
2. If the digit is 5 or larger, drop this digit and add 1 to the preceding digit. Thus, 1.247 becomes 1.25.