

# Significant Figures

## In Measured Values and Rounding

In science, there are two types of numbers. Those that are *exact numbers* and *numbers obtained from measurements*. Exact numbers are those which are counted or specified and thus, are considered to be absolutely accurate. Exact numbers are considered to have an infinite number of significant figures and therefore cannot be used to determine the exact number of significant digits. Numbers obtained from measurements are not exact numbers and involve some amount of estimate. The number past the last absolutely known number on a measurement device is the estimated number. This estimated number is the best guess on the part of the person making the measurement. If a ruler is divided into eighths of an inch, then any number measured down to a sixteenth or less is the estimated number. 3-3/16", for example, has as its estimated number the third sixteenth and thus, is the last significant digit.

***1) The following examples demonstrate the rules for determining the significant figures. The significant figures are shown underlined for clarity.***

A) Trailing zeroes are significant if they are included as part of the measurement.

**Example:** 4.500 ml

This shows 4 significant figures if the measurement is to the nearest 0.001 ml.

B) Leading zeroes are never significant, because they are used just to position the decimal point. By rewriting the number in scientific notation we can eliminate the leading zeroes and show only the significant digits.

**Example:** 0.00028 g

This example shows 2 significant figures. Write as  $2.8 \times 10^{-4}$

C) The zeroes between the nonzero numbers are significant

**Example:** 130.6 m

This example shows 4 significant figures.

D) All the nonzero numbers in a measured value are significant, as shown in the above examples.

## II) Math problems involving significant figures.

### A) Addition and subtraction.

Answers must be rounded off to the least number of decimal places that is common to all the terms in the problem.

#### Examples:

$$\begin{array}{r} 64.12 \text{ cm} \\ 12.4 \text{ cm} \\ + \underline{321.012 \text{ cm}} \\ \hline 397.532 \text{ cm} = 397.5 \text{ cm} \end{array}$$

$$\begin{array}{r} 56.32 \text{ mm} \\ - \underline{36.204 \text{ mm}} \\ \hline 20.116 \text{ mm} = 20.12 \text{ mm} \end{array}$$

### B) Multiplication and division.

Answers must be rounded off to the same number of places as the term with the least number of significant figures.

#### Examples:

$$3.65 \text{ cm} \times 3.5 \text{ cm} = 12.775 \text{ cm}^2 = 13 \text{ cm}^2$$

$$463 \text{ m} \times 135.45 \text{ m} = 627.1335 \text{ m}^2 = 627 \text{ m}^2$$

$$6.65 \text{ m} / 2.324 \text{ s} = 2.861445783 \text{ m/s} = 2.86 \text{ m/s}$$

$$475.25 \text{ m} / 15.85 \text{ s} = 29.98422713 \text{ m/s} = 29.98 \text{ m/s}$$

## III) Rules for rounding answers.

- A) If the first non-significant number to the right is less than 5, drop all the non-significant numbers only.

**Example:** 73.526 cm = 73.5 cm

Shows the number rounded to 3 significant digits.

- B) If the first non-significant number to the right is greater than 5, drop all the non-significant numbers and add 1 to the last significant figure on the right.

**Example:** 35.437 m = 35.44 m

Shows the number rounded to 4 significant digits.

- C) If the first non-significant number to the right is equal to 5, drop all of the non-significant numbers and add 1 to the last significant figure on the right, if it is an odd number.

**Examples:** 34.35 ml = 34.4 ml ; 62.56 g = 62 g