



Significant Figures

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Significant digits are those figures in a number that are known with certainty plus the first digit that is uncertain.

Example: The quantity 162.35 cm has five significant digits. The last digit was estimated when measuring. Therefore, it is uncertain, but it is still significant.

Note for Conversions: Since the uncertainty of 162.35 cm is at a 10^{th} of a millimeter, 1623.5 mm also has 5 significant digits as does 1.6235 m and 0.0016235 km.

If you have a measured quantity like 2000 g for example, the number of significant digits may be unclear. Often a line is placed under the uncertain digit to indicate the number of significant digits. A better solution is to write the number in scientific notation with the decimal terminating after the least significant digit, ie. the uncertain part.

Example: 2000g has three significant digits with an uncertainty in the measurement in the tens place. (This could result from a measuring instrument having divisions marked off in 100 g and using an estimate for parts between the divisions.) This can also be written as 2.00×10^3 g using scientific notation. Scientific notation is the preferred way to express values in science.

In general if the number of significant figures is not indicated follow the rules below:

1. For measured data consider all digits significant except the zeroes that serve only to designate the place value.

Example:

- a) For the recorded measurements 12,000 cm and 0.000406 m
12,300 cm and 0.000406 m Both have only three significant figures.
 - b) For the measured quantities 100.05 grams and 0.0010520 liters
100.05 g and 0.0010520 L Both have five significant figures.
2. Consider numbers which are not measurements, eg. constants, numerical factors and terms in formulas, etc. as exact numbers with an infinite number or significant figures. (Be sure to approximate constants such as π to a number of significant figures larger than any of the measured values in your calculations.)

Computations with Significant Figures

Addition and Subtraction

The place value of the least significant digit of the least precise term will determine the place value of the least significant digit in the answer.

Example:

$$\begin{array}{r} 32.\underline{2} \\ 5.\underline{37} \\ +12.\underline{625} \\ \hline 50.\underline{193} \end{array}$$

The answer is 50.1 with the least significant digit (uncertain figure) in the tenths place.

Multiplication and Division

The product or quotient must not have more significant digits than the least precise factor.

Example: $23.32 \times \underline{2.01} \times 5.035 = \underline{235.9053585}$

The answer is 235 since 2.01 is the least precise factor and has three significant figures.

Note: These rules only apply to the measured values that contain uncertainty, not to the constant values that you will find in formulas.

Combined Calculations

Follow the order of operations and with each step find the number of significant figures that result. Do not round until you reach the final answer.

Exercises:

1. How many significant figures are there in each of the following numbers:
a) 17 b) 103 c) 1.035 d) 0.0010 e) 1.00×10^6 f) π

Perform the following operations:

2. a) $12.01 \text{ cm} + 17.3 \text{ cm} + 0.11 \text{ cm}$ b) $103 \text{ g} - 2.2 \text{ g}$
3. a) $12.07 \text{ cm} \times 1.2 \text{ cm}$ b) $180 \text{ kg} / 7.253 \text{ m}^3$
4. a) $2\pi(3.05 \text{ cm} - 2.178 \text{ cm})$ b) $3.025 \text{ m} \times .031 \text{ m} + 2(17.02 \text{ m}^2)$

Answer Key

1. a) 2 sf b) 3 sf c) 4 sf d) 2 sf e) 3 sf f) infinite sf
2. a) 29.4 cm b) 101 g
3. a) 14 cm² b) 25 kg/m³
4. a) 5.48 cm b) 34.13 m²