Significant Figures in Scientific Measurements and Calculations

Background: When a mass can be reported to the nearest 0.001 g, one could use the following notation "2.234**±**0.001 g". In much of scientific work the "±" notation is dropped, with the understanding that in the measurement "2.234 g" the last digit has some uncertainty.
All digits in a measured quantity (mass, length, volume, temperature etc), including the uncertain one, are called **significant figures**.

A) Determine the number of Significant Figures in a reported measurement:

1. Read the number from left to right, counting the digits starting with the first digit that is not zero. *All non-zero digits are significant*.
   234 m (3 sig figs); 123.45 g (5 sig figs)

Zeros, however, may or may not be significant according to the following rules:

2. Zeros *between* non-zero digits are *always significant*:
   1005 kg (4 sig figs); 103 cm (3 sig figs)

3. Zeros at the *beginning of a number* are *never significant*; they merely indicate the position of the decimal point.
   0.02 g (1 sig fig); 0.0026 mm (2 sig figs)

4. Zeros at the *end of a number*, and to the right of a decimal point *are significant*.
   0.02000 g (4 sig figs); 3.0 cm (2 sig figs)

   Zeros at the end of a number that does not include a decimal point are not significant.
   22000 (2 sig figs); 400 (1 sig fig)

5. All digits in the *coefficient* of a number written in proper *scientific notation* are significant.
   1.030×10^4 g (4 sig figs); 1.03×10^4 g (3 sig figs)

B) Significant Figures in calculations:

When carrying measured quantities through calculations, *the least certain measurement limits the certainty of the calculated quantity and thereby determines the number of significant figures* in the final answer.

1) For addition and subtraction

The result has the same **number of decimal places** as the measurement with the fewest decimal places:

$$\begin{array}{r} 20.42 \\ +\ 1.322 \\ +\ 83.1 \\ \hline 104.842 \end{array}$$

Has to be rounded to 104.8 (1 decimal place). This answer has 1 decimal place and 4 sig figs, the latter is important if this number is subsequently used in a multiplication or division.

2) For multiplication and division

The result contains the same **number of significant figures** as the measurement with the fewest significant figures.

6.221 cm *(4 sig figs)* x 5.2 cm *(2 sig figs)* = 32 cm^2 *(2 sig figs)*

C) Significant Figures when combining rules:

Do not round until the end of calculations but keep track of appropriate significant figures at each step. Example:

(21.259-19.39)/20.556=

Following the rules for order of operations, subtract first and then divide.
21.259-19.39 = 1.869 (subtraction sig fig rule dictates a rounded answer with 2 decimal places...1.87...which has three sig figs…but we still use 1.869 in the next step of the calculation)

1.869/20.556 = 0.09092236… = 0.0909 is the final rounded answer
(1.87 has 3 sig figs, 20.556 has 5 sig figs and division sig fig rule dictates an answer with 3 sig figs)