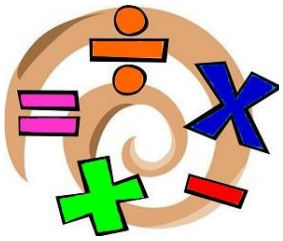

Significant Figures

in Physics

Nonzero Digits in a Measurement:

- ✓ All nonzero digits in a measurement are counted as significant.

  Example: 456 ft has three significant figures.

  Example: 67.12 W has four significant figures.

  Example: 7 lbs has one significant figure.

Rules for Zero:

- ✓ All zeros between nonzero digits are significant.

  Example: 12.0004 m has six significant figures.

- ✓ All trailing zeros for whole numbers (no decimal point shown) are not significant.

  Example: 5000 N has one significant figure.

- ✓ All trailing zeros to the right of the decimal point are significant.

  Example: 47.000 cal has five significant figures.

- ✓ All leading zeros to the right of the decimal point are not significant.

  Example: 0.00000456 m has three significant figures.

Rounding:

In our class we are going to use the traditional rounding convention.

If a number is being rounded to a desired place value, then look to the digit immediately to the right of the digit being rounded.

- ✓ If the digit is 0, 1, 2, 3, 4, then leave the digit as is and drop the rest of the digits to the right.
- ✓ If the digit is 5, 6, 7, 8, 9, then round the digit up one and drop the rest of the digits to the right.

Note that there is some rounding bias in the above convention. There is protocol for handing the situation of exactly half way between place values; for example, 2.5, 56.85, and 1000035 would be rounded to 2, 56.8, and 1000040 respectively. The protocol for the exactly halfway point between place values is called the *round to even rule*. We are going to omit this protocol since our textbook does not use it. Keep in mind that in some resources the *round to even* may be applied to the calculations.

Mathematical Operations:

It is important to know how to apply the conventions for rounding answers of calculations that use data (measurements). The rules for multiplication/division and addition/subtraction are shown below:

- ✓ When multiplying or dividing numbers that are measurements, round the result to the least number of significant figures in all the data used in the calculations, this includes any combination of multiplication and division.

  Example: (2.30 m)(323.5 m) = 744 m^2 (Rounded to three significant figures)
  Example: 145.076 N/24 kg = 6.0 m/s^2 (Rounded to two significant figures)

- ✓ When adding or subtracting numbers, count the **NUMBER OF DECIMAL PLACES** to determine the number of significant figures. The answer cannot **CONTAIN MORE PLACES AFTER THE DECIMAL POINT THAN THE SMALLEST NUMBER OF DECIMAL PLACES** in the numbers being added or subtracted.

  Example: 12.5 J – 4.0567 J = 8.4 J
  Example: 1.23×10^7 kcal + 4.567×10^7 = 5.80×10^7 kcal
  Example: (1.2×10^4 kg) + (3.5×10^3 kg) = (1.2×10^4 kg) + (0.35×10^4 kg) = 1.6×10^4 kg

The rule above can get a little tricky for whole numbers.

Example: Suppose 6, 543 m is added to 4,500 m. The first distance includes four significant figures and the second has two significant figures. Thus the sum would be rounded to the hundreds place.

6,543 m + 4,500 m = 11, 043 m
= 11, 000 m (Rounded to the hundreds place)
= 1.10×10^4 m (Scientific notation removes ambiguity)

Arithmetic Combinations:

In all calculations that contain a mixture of addition/subtraction and multiplication/ division you will need to apply the order of operations and use the two rules above for rounding; however, you should carry out all calculations without rounding until the last computation. For all

multiplications/divisions, remember the level of significance and use them to determine where to round any additions/subtractions. Carry all digits throughout the calculations and round the final result only.

Assume the numbers below are results of measurements.

Example: $(3.4)(2.157) + (6.01)(3.189) = 7.3338 + 19.16589$
$= 26.49969$
$= 26.5$ (Rounded to tenths place)

Note that the 7.3338 would have been rounded to two significant figures and the 19.16589 would have been rounded to three significant figures (assuming you were only multiplying); this suggests that the result of the sum should be rounded to the tenths place.

Example: $(2.56)(11.34) – (3.896)(2.1113) = 29.0304 – 8.2256248$
$= 20.8047752$
$= 20.8$

Example: $(250.0\ \text{N•m}) \div (24.36\ \text{m}) + 530.75\ \text{N} = 10.26272577\ \text{N} + 530.75\ \text{N}$
$= 541.01\ \text{N}$