Physics
Chapter 1:
The Science of Physics

Section 1.3:

The Language of Physics

Significant Figures

--Significant figures are used by scientists to show the accuracy of a measurement.

--Significant figures include all digits which are certain in a measurement plus one digit that is uncertain or estimated.

Rules for Significant Figures

1) Non-zero digits are always significant.

(Ex: 123.3 g has 4 significant figures.)

2) Leading zeroes are never significant.

(Ex: 0.0024 has 2 significant figures.

3) <u>Captured zeroes</u> are always significant.
(Ex: 1.0056 has 5 significant figures.)

4) <u>Trailing zeroes</u> are significant if they contribute to the accuracy of the measurement.
(Ex: 0.003400 has 4 sf;
3400 is usually taken as having only 2 sf.

(See Table 4, page 18)

How Many Significant Figures?

9.567	4	
9600	2	
9.600×10^{3}	4	
0.005630	4	5.630×10^{-3}
98.009	5	

Rules for Calculations with SF

1) Addition and subtraction: The answer is rounded to the least number of decimal points.

Example: 25.61 g + 4.2 g = 29.8 g
2 dp 1 dp 1dp

2) Multiplication and division: The answer is rounded to the same number of significant figures as the number with the least number of significant figures.

Example: 14.23 g/2.0 mL = 7.1 g/mL

4 sf 2 sf 2 sf

Scientific Notation

--The use of scientific notation is a way to be clear about the number of significant figures in a measurement.

a) Example: In 2500 g, the number of significant figures is questionable:

--If the number is written as 2.500×10^3 g it is clear that it has 4 sf.

--If it is written as 2.50×10^3 g it has 3 sf.

b) Numbers written in scientific notation are always written with one non-zero digit to the left of the decimal point.

Order of Magnitude Estimation

--Estimating the order of magnitude of an answer can help determine whether a calculated answer is reasonable or not.

Example: Estimate the velocity of a car that travels 900 km in 10.2 hrs.

Estimate: Since 900 is closer to 1000 than to 100, and 10.2 is closer to 10, the order of magnitude of the answer is:

$$\frac{1000\ \text{km}}{10\ \text{h}} = 100\ \frac{\text{km}}{\text{h}}$$

Actual: $$V = \frac{d}{t} = \frac{900\ \text{km}}{10.2\ \text{h}} = 88.2\ \frac{\text{km}}{\text{h}}$$

(The estimate shows the answer is reasonable.)

Mathematical Relationships in Physics

--Data collected in an experiment may be represented on tables, graphs, and/or equations.

Dimensional Analysis and Problem Solving

--We can be more successful at problem solving if we make sure the units in the answer agree with the units given in the problem; this is called using <u>dimensional analysis or unit analysis</u>.

Example 1: What is the density of an object whose mass is 4.0 g if its volume is 2.0 cm^3.

Using the equation for density, D = m/v:
(show three steps in showing work)

$$D = \frac{m}{v}$$

$$D = \frac{4.0\ g}{2.0\ cm^3}$$

$$D = 2.0\ \frac{g}{cm^3}$$

Example 2: Unit cancellation using a conversion factor(s):

--conversion factors are always equal to one

--must show all units

--for example, changing years to seconds:

$$2.2\ \text{y} \times \frac{365\ \text{d}}{1\ \text{y}} \times \frac{24\ \text{h}}{1\ \text{d}} \times \frac{60\ \text{min}}{1\ \text{h}} \times \frac{60\ \text{s}}{1\ \text{min}} = 6.9 \times 10^{7}\ \text{s}$$